

PREVENA™ INCISION
MANAGEMENT SYSTEM
Product Monograph

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INTRODUCTION

This publication will describe the current standard of care for surgical incisions and review the medical literature regarding the use of negative pressure wound therapy (NPWT; V.A.C.® Therapy, KCI USA, Inc., San Antonio, TX) over surgical incisions (incisional NPWT). The monograph will also provide clinical experience and scientific evidence regarding the PREVENA™ Incision Management System (KCI USA, Inc., San Antonio, TX), which provides incisional NPWT in an easy-to-use design.

PREVENA™ INCISION MANAGEMENT SYSTEM DESCRIPTION¹

PREVENA™ Therapy incorporates all of the functional elements of NPWT that are necessary for management of closed surgical incisions.² The system has the added advantages of being simple in concept and having anatomically adaptable dressings which are uniquely designed to manage and protect surgical incisions following primary closure. The dressings are easy to apply and use in the operating room (OR). The system may also transition from the OR to the hospital and/or outpatient setting for use by multiple care givers.

The PREVENA™ Incision Management System consists of the following components:

- The PREVENA™ 125 Therapy Unit delivers 7 days of continuous negative pressure at -125mmHg through the dressing to the incision site; the unit is battery powered, lightweight, easily portable, and designed for single-patient use.
- The PREVENA™ 45ml Canister for collection of incision exudate.
- PREVENA™ Patch Strips™, which may be used to help seal leaks around the dressing. All patient-contacting materials are manufactured without natural rubber latex and DEHP [Di(2-ethylhexyl)phthalate].
- The PREVENA™ Incision Dressings are applied over clean sutured or stapled incisions in a simple process.
 - o PEEL & PLACE™ Dressing - 20cm or PEEL & PLACE™ Dressing - 13cm:
 - The dressings (**Figure 1**) have a built-in pressure indicator that when compressed indicates that the negative pressure in the system is at an acceptable level. When the indicator is up, the system pressure is not acceptable.

Figure 1. PREVENA™ Incision Management System with PEEL & PLACE™ Dressing - 20cm and PEEL & PLACE™ Dressing - 13cm



- A polyurethane coated, polyester fabric interface layer with 0.019% ionic silver wicks fluid from the skin surface. The silver is not intended to treat infection but only to reduce bacterial colonization within the fabric.
- The polyurethane foam bolster that covers the interface layer has a pore size of 400-600 microns and a violet colorant; the foam manifolds negative pressure to the incision site.
- A polyurethane film with acrylic adhesive provides adhesion of the dressing to the skin surrounding the incision.
- A polyurethane shell encapsulates the foam bolster and interface layer, providing a closed system.
- The PEEL & PLACE™ Dressing - 20cm is designed to manage incisions up to 20cm long and should not be altered to fit longer, shorter, or curving incisions. This dressing is also available in 13cm length to manage incisions up to 13cm long.
- This dressing can be used directly with the PREVENA™ 125 Therapy Unit (above). The V.A.C.® Connector included in the dressing kit also allows physicians to use this dressing with the ACTIV.A.C.™, INFOV.A.C.™, V.A.C. ATS™, and V.A.C. FREEDOM™ Therapy Units.

The PREVENA PLUS™ Incision Management System (Figure 2) is designed for linear, non-linear and intersecting incisions up to 90cm in length and consists of the following components:

- The PREVENA PLUS™ 125 Therapy Unit delivers 7 days of continuous negative pressure at -125 mmHg through the dressing to the incision site. It includes a rechargeable battery, which eliminates the need for battery replacement.
- PREVENA PLUS™ CUSTOMIZABLE™ Dressing:
 - o The CUSTOMIZABLE™ Dressing with SENSAT.R.A.C.™ technology provides monitoring and adjustment of negative pressure at the incision site. Additionally, it can be customized to cover a variety of incision shapes and lengths that are up to 90cm.
 - o The PREVENA PLUS™ 150ml Canister allows for increased exudate storage capacity, requiring fewer canister changes.

Figure 2: PREVENA PLUS™ Incision Management System with CUSTOMIZABLE™ Dressing



DESIGN OF PREVENA™ INCISION DRESSINGS

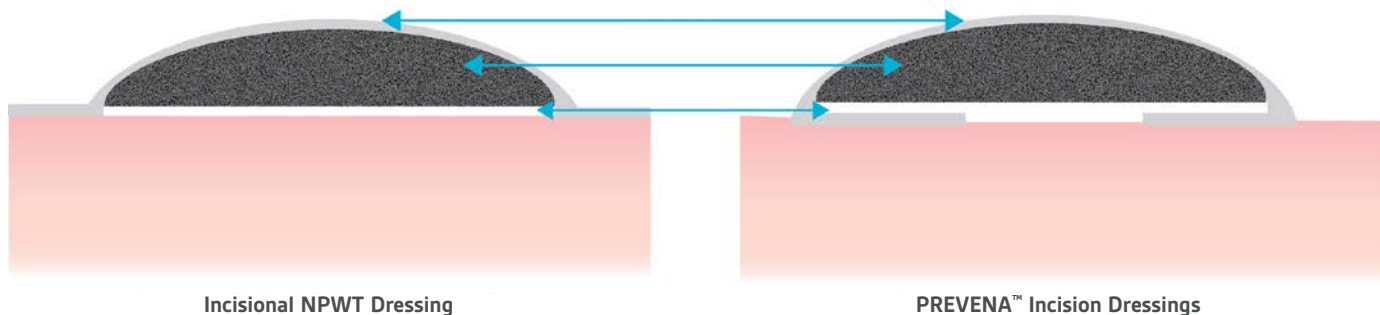
The design of the PREVENA™ Incision Dressings was derived from the NPWT dressing system described by a number of clinicians in their reported clinical studies of incisional NPWT.^{3-B} The dressing utilized in these clinical studies was constructed from commercially available materials:

- A skin interface layer (typically, a non-adhering dressing)
- V.A.C.® GRANUFOAM™ Dressing
- V.A.C.® Drape

It was configured as shown in **Figure 3** (Incisional NPWT Dressing) and was manually prepared by the surgeon using costly OR time to construct.

Figure 3 (PREVENA™ Incision Dressings) illustrates the configuration of these same elements in the PREVENA™ Incision Dressings, which are provided in a pre-constructed configuration that takes only several minutes to apply. **Table 1** directly compares these dressing materials.

Figure 3. Cross-Section of Dressings Systems (as applied to patient)



These dressing systems differ primarily only in the type of skin interface material that is used. The purpose of the non-adhering dressing was to protect the skin from direct contact with the V.A.C.® GRANUFOAM™ Dressing while allowing uninhibited delivery of negative pressure to the wound site and fluid removal from the wound site. The equivalent PREVENA™ Incision Dressing skin interface layer is a polyester knit fabric that performs the same functions as the non-adhering dressing in that it protects the skin from contact with the foam bolster, while allowing delivery of negative pressure and fluid removal.

In addition, the PREVENA™ 125 and PREVENA PLUS™ 125 Therapy Units deliver negative pressure wound therapy at -125mmHg equivalent to the V.A.C.® Therapy Units, which have been described in the reported clinical studies of incisional NPWT.

The equivalency of PREVENA™ Therapy to the incisional NPWT reported in the medical literature is thus established, and the clinical outcomes reported in those studies are also applicable to PREVENA™ Therapy.

INDICATIONS AND USE

In the U.S., the PREVENA™ Incision Management System is intended to manage the environment of clean closed surgical incisions that continue to drain following sutured or stapled closure by maintaining a closed environment and removing exudate via the application of negative pressure wound therapy.²

The PREVENA™ Therapy System is applied immediately post-surgery (i.e., in a sterile field) to closed incisions for a minimum of 2 days and up to a maximum of 7 days. The only contraindication is sensitivity to silver due to its presence in the skin interface layer, although the concentration is very low (0.019%).¹

Complete safety information is provided in product labeling and available on acelity.com.

STANDARD OF CARE (SOC) FOR SURGICAL INCISIONS

Surgical incisions have traditionally been closed by primary intention using sutures,⁹ staples,¹⁰ tissue adhesives,^{11,12} paper tape,¹³ or a combination of these methods.

- Easterlin and colleagues reported that a drawback of sutures and staples is that they are tensioning devices, which concentrate the spreading force to small points along the incision. These tension points may result in ischemia and, possibly, necrosis of the tissue.⁹
- In 2009, Livesey, et al. in a randomized controlled trial (RCT) compared skin adhesive versus surgical staples in total hip replacement surgeries. They reported that staples were quicker and easier to use than skin adhesive, and surgeons found skin adhesive to be more technically challenging.¹⁴ However, laparoscopic surgeons have found that proficient use of tissue adhesive comes with experience.¹¹ A disadvantage to the use of tissue adhesive over incisions is that the adhesive may interfere with healing since it can act as a barrier to epithelialization.¹⁵
- Paper tape has been used alone or in conjunction with sutures or staples for the treatment of surgical incisions.¹⁶ Atkinson reported in an RCT that paper tape was fast to apply, significantly decreased scar volume and prevented hypertrophic scars.¹³ A disadvantage to the use of paper tape is that it is not effective in moist or bleeding wounds, as moisture may wash away the adhesive or compromise the integrity of the paper itself.¹⁶ Atkinson recommends that paper tape should not be applied until after 5 days post-surgery or after the surgical incision has epithelialized.¹³

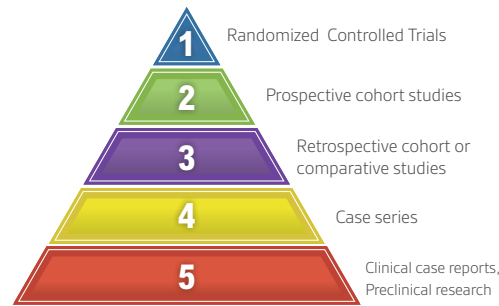
Many products have been used for the treatment of closed surgical incisions. These include traditional gauze dressings¹⁷ and advanced therapies such as hydrocolloids,¹⁷ growth factors,¹⁸ cultured skin,¹⁹ low energy ultrasound,²⁰ and NPWT.³⁻⁵ Advanced therapies, such as topically applied growth factors,¹⁸ cultured skin,¹⁹ and NPWT,^{3-5, 21, 22} were initially developed to assist patients with open chronic and acute wounds that were difficult to heal and then found to be useful over closed incisions.

LITERATURE REVIEW OF INCISIONAL NPWT

NPWT as delivered by V.A.C.® Therapy (KCI USA, Inc., San Antonio, Texas) has become a proven advanced wound therapy system for treating acute and chronic open wounds.²¹⁻²⁶ Physicians and clinicians recognize the potential utility of this adjunctive therapy in their day-to-day practice and report using it in novel ways to address patient needs.

The body of evidence for using NPWT over clean closed surgical incisions has been growing steadily since 2006. Based on the Evidence Rating Scale for Therapeutic Studies (**Table 2**), developed by the American Society of Plastic Surgeons (ASPS),²⁷ there are currently 5 Level 1 RCTs reporting clinical experience with incisional NPWT and PREVENA™ Therapy. **Figure 4** categorizes the 33 incisional NPWT and PREVENA™ Therapy journal articles according to their ASPS levels of evidence: 5 RCTs (Level I), 4 prospective comparative studies (Level II), 8 retrospective cohort or comparative studies (Level III), 12 case series (Level IV), and 5 case reports (Level V). As shown in **Figure 4**, the types of incisions treated with incisional NPWT and PREVENA™ Therapy continue to expand and include fractures (eg, hip, lower extremity), abdominal wall reconstruction, laparotomy, sternal, and vascular surgical sites.

Figure 4. Incisional NPWT and PREVENA™ Therapy clinical journal articles sorted according to ASPS Level of Evidence²⁷



| LEVEL | FIRST AUTHOR (YEAR) | THERAPY | INCISIONS |
|----------------------------------|--|--------------------------------------|---|
| I | Stannard (2012) ⁴ Stannard (2006) ³ (Interim Analysis) Masden (2012) ²⁸ | NPWT* NPWT NPWT | High-energy fractures† RCT1 = Draining injuries RCT2 = High-energy fractures Multiple (most lower extremity amputations) |
| | Pachowsky (2012) ²⁹ Pauser (2014) ³⁰ | PREVENA™ Therapy PREVENA™ Therapy | Hip Lower extremity |
| II | Grauhan (2012) ³¹ | PREVENA™ Therapy | Sternal |
| | Weir (2014) ³² | PREVENA™ Therapy | Lower extremity |
| | Grauhan (2014) ³³ | PREVENA™ Therapy | Sternal |
| | Swift (2015) ³⁴ | PREVENA™ Therapy | C-section |
| III | Reddix (2010) ⁸ | NPWT | Acetabular fractures |
| | Tauber (2013) ³⁵ | NPWT | Groin |
| | Matatov (2013) ³⁶ | PREVENA™ Therapy | Groin wounds |
| | Blackham (2013) ³⁷ | NPWT | Surgical oncology wounds |
| | Bonds (2013) ³⁸ | NPWT | Surgical oncology (colorectal) |
| | Soares (2014) ³⁹ | NPWT | Abdominal |
| | Chadi (2014) ⁴⁰ | NPWT | Abdominal |
| | Mark (2014) ⁴¹ | PREVENA™ Therapy | Abdominal |
| | Atkins (2009) ⁵ | NPWT | Sternal |
| | Gabriel (2016) ⁴² | NPWT | Breast (mastectomy) |
| | Cooper (2015) ⁴³ | NPWT | Hip/knee |
| | Reddy (2016) ⁴⁴ | NPWT | Sternal |
| | IV | Reddix (2009) ⁷ | NPWT |
| Colli (2011) ⁴⁵ | | PREVENA™ Therapy | Sternal |
| Stannard (2009) ⁴⁶ | | NPWT | Sternal, foot, abdominal |
| Gomoll (2006) ⁵ | | NPWT | Hip, lower extremity |
| Bollero (2015) ⁴⁷ | | PREVENA™ Therapy | Surgical scar excisions |
| Maclin (2014) ⁴⁸ | | PREVENA™ Therapy | Abdominal |
| Said (2015) ⁴⁹ | | NPWT | Sternal |
| Schmedes (2012) ⁵⁰ | | PREVENA™ Therapy | Flap donor sites |
| Pauli (2013) ⁵¹ | | PREVENA™ Therapy | Hernia repair |
| Cónde-Green (2013) ⁵² | | NPWT | Abdominal |
| Vargo (2012) ⁵³ | | Incisional V.A.C Therapy | Abdominal |
| V | Haghshenasskashani (2011) ⁵⁴ | PREVENA™ Therapy | Lower extremity |
| | Dutton (2012) ⁵⁵ | NPWT | Abdominal |
| | Scalise (2015) ⁵⁶ | PREVENA™ Therapy | Abdominal |
| | Kilpadi (2014) ⁵⁷ | PREVENA™ Therapy | Surgical incision |
| | Altintas (2014) ⁵⁸ | PREVENA™ Therapy | Lower extremity |

*NPWT = Incisional NPWT as delivered by V.A.C.® Therapy †Calcaneus, pilon, and tibial plateau fractures

The incisional NPWT and PREVENA™ Therapy clinical publication summaries below and in **Table 3** are listed in order according to their ASPS rating level.

EVIDENCE LEVEL I

- In a prospective multicenter RCT, Stannard and colleagues compared the use of incisional NPWT against standard postoperative dressings (Control) over clean closed surgical incisions after high-energy fractures. The study population consisted of 249 patients with 263 calcaneus, pilon, or tibial plateau fractures.⁴
 - Of those patients, 130 with 141 fractures were randomized to incisional NPWT and 119 with 122 fractures were randomized to Control (standard postoperative dressings).
 - The results revealed 23 total infections in the Control group compared to 14 in the NPWT group ($p = 0.049$) and 20 cases of dehiscence in the Control group compared to only 12 in the NPWT group ($p = 0.044$).⁴
 - These findings illustrate the effective use of NPWT over clean closed surgical incisions after high-energy fractures.
- Stannard, et al., presented interim results from 2 RCTs that compared the use of incisional NPWT against standard postoperative dressings (Control) for draining hematomas and clean closed surgical incisions after high energy fractures.³
 - A total of 44 patients were randomized into the hematoma study. The Control group ($n = 31$) drained for a mean of 3.1 days compared to only 1.6 days for the NPWT group ($n = 13$) ($p = 0.03$).
 - An additional 44 patients were randomized into the fracture study. The Control group ($n = 24$) drained for 4.8 days compared to only 1.8 days for the NPWT group ($n = 20$) ($p = 0.02$).
 - These preliminary findings demonstrated decreased drainage time following NPWT treatment of patients with hematomas or severe fractures.³
- In the RCT by Masden and colleagues, 81 high-risk patients with multiple comorbidities were randomized to receive either incisional NPWT or standard dry silver dressing over closed surgical incisions.²⁸
 - While there were various wound types, the majority (74/81) of patients underwent lower extremity wound closure post amputation.
 - All incisions were evaluated on postoperative day 3, at first outpatient visit, and at subsequent visits. Average follow-up period was 113 days.
 - There were no differences in demographic, preoperative, and operative variables between groups. Wound complication rates between the groups did not achieve statistical significance:
 - » Infection: NPWT, 3/44 (6.8%) vs. Control, 5/37 (13.5%), $p = 0.46$;
 - » Dehiscence: NPWT, 16/44 (36.4%) vs. Control, 11/37 (29.7%), $p = 0.53$;
 - » Reoperation: NPWT, 9/44 (21%) vs. Control, 8/37 (22%), $p = 0.89$;
 - » Overall, 40% of NPWT and 35% of Control groups experienced wound infection, dehiscence, or both.²⁸
- The first prospective RCT of the PREVENA™ Incision Management System was published in 2011 by Pachowsky, et al.²⁹ The study included 19 consecutive patients treated with PREVENA™ Therapy or standard postoperative dressings (Control) over closed incisions following total hip arthroplasty.²⁹
 - Ten patients were randomized to the Control arm and 9 to the PREVENA™ Therapy arm.
 - Postoperative seromas were measured in both groups on the fifth and tenth postoperative days.
 - Results showed significantly decreased volume of postoperative seromas in the PREVENA™ Therapy group versus the Control on day 10 (1.97 vs. 5.08ml; $p = 0.021$). A seroma was present in 44% of the NPWT patients and 90% of Control patients.
 - In addition, the PREVENA™ Therapy group required significantly fewer days of antibiotics (8.44 ± 2.24 vs. 11.8 ± 2.82 days, $p = 0.005$), and a secretion in the wound after day 5 was reported in fewer patients in the PREVENA™ Therapy group versus the Control (1 vs. 5 patients, respectively).
 - The authors concluded in their study the use of NPWT decreased the development of postoperative seromas and improved wound healing.²⁹

- In a prospective RCT by Pauser, et al., 21 patients with femoral neck fractures (FNF) treated with hip hemiarthroplasty (HA) were randomized to receive either incisional NPWT (ciNPT) or standard postoperative dressings (Control) over clean sutured wounds.³⁰
 - Eleven patients were randomized to the ciNPT group and received PREVENA™ Therapy; ten patients received the standard postoperative dressing.
 - There were no differences in patient age, coagulation time, postoperative wound size, or wound secretion volume.
 - Compared to the Control, ciNPT patients had:
 - » Reduced seroma volume at postoperative day 5 ($0.257 \pm 0.75\text{cm}^3$ vs. $3.995 \pm 5.01\text{cm}^3$, respectively; $p < 0.05$); at postoperative day 10, no difference was reported.
 - » Fewer days of wound secretions (0.9 ± 1.0 days vs. 4.3 ± 2.45 days, respectively; $p = 0.005$)
 - » Fewer dressing changes (5.4 vs. 9.5, respectively, $p < 0.0001$)
 - » Reduced time (and materials) for dressing changes (14.9 ± 3.9 minutes vs. 42.9 ± 11.0 minutes, respectively; $p < 0.0001$)
 - The authors concluded that using ciNPT for closed wounds in the HA setting "might help to reduce complications of prolonged wound healing and postoperative seroma in the wound...and save time needed for wound care."³⁰

EVIDENCE LEVEL II

- In a prospective comparative study, Grauhan and associates analyzed 150 consecutive obese (BMI ≥ 30) cardiac surgery patients, whose sternotomy wound incisions were treated with either PREVENA™ Therapy (n = 75) or conventional sterile wound dressings (Control; n = 75).³¹
 - Wound infection within 90 days was the primary study endpoint.
 - Patients were assigned to treatment groups by alternating based on time of operation. Patients with diabetes were assigned "half and half to both groups, with priority."
 - PREVENA™ Incision Dressing was placed under sterile conditions in the OR and remained in place at a negative pressure of -125mmHg for the first 6 to 7 postoperative days. Control dressings were changed on the first or second postoperative day and every 1-2 days thereafter.
 - All patients in both groups were followed for at least 90 days. There were no significant preoperative differences between the groups.
 - PREVENA™ Therapy group had significantly fewer wound infections than the Control group: 3/75 (4%) vs. 12/75 (16%), respectively; $p = 0.0266$; odds ratio, 4.57; 95% confidence interval (CI), 1.23-16.94.
 - PREVENA™ Therapy group also had significantly fewer patients that had wound infections with Gram-positive skin flora: 1 vs. 10, respectively; $p = 0.0090$; odds ratio, 11.39; 95% CI, 1.42-91.36.
 - In the PREVENA™ Therapy group, 71/75 (95%) of the incisions were primarily closed when the dressing was removed in 6 to 7 days. No wound infections occurred after this closure. In contrast, 9 of the 12 reported Control group wound infections occurred beyond postoperative day 7 and up to day 35.
 - The authors concluded that PREVENA™ Therapy over clean, closed surgical incisions for the first 6 to 7 postoperative days significantly reduced wound infection after median sternotomy for high-risk obese cardiac surgery patients.³¹

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- In a prospective case-control pilot study, Weir evaluated the use of PREVENA™ Therapy in 8 patients undergoing vascular bypass procedures.³²
 - Patients requiring bilateral femoral incisions received PREVENA™ Therapy over one femoral area, while the contralateral femoral area received a standard postoperative dressing (Control).
 - Patients required intraoperative heparin and postoperative anticoagulation therapy.
 - Patients had at least one of the following risk factors for development of wound complications: obesity, diabetes, hypertension, hypercholesterolemia, smoking within 6 weeks prior to surgery, and HIV/AIDS.
 - Wound complications requiring surgical intervention occurred in three of the control wounds, while no wound complications occurred where PREVENA™ Therapy was applied.
 - The author suggested that using PREVENA™ Therapy in high risk patients undergoing vascular surgery potentially reduced wound complications with no observable increase in hemorrhage.³²
 - In a prospective comparative study, Grauhan, et al., compared the wound infection rate of 3,745 cardiac surgery patients whose sternotomy incisions were treated with either PREVENA™ Therapy (n = 237) or conventional sterile wound tape dressings (Control; n = 3,508).³³
 - PREVENA™ Incision Dressing was applied immediately after skin suturing and remained in place for 6-7 days. Control dressings were changed on the first or second postoperative day and every 1-2 days thereafter.
 - Wound infection within 30 days was the primary endpoint.
 - The PREVENA™ Therapy group had a significantly lower infection rate than the Control group: 3/237 (1.3%) vs. 119/3508 (3.4%), respectively ($p < 0.05$; odds ratio 2.74).
 - In the PREVENA™ Therapy group, 234/237 (98.7%) of the incisions were primarily closed when the dressings were removed 6-7 days after application.
 - The authors concluded using PREVENA™ Therapy for the first 6-7 days over clean, closed surgical incisions reduced the incidence of postoperative wound infections, and the reduced rate in wound infections may be cost effective for patients, hospitals, and health insurance companies.³³
 - Swift and colleagues conducted a prospective comparative study that analyzed 319 women at increased risk for infectious morbidity and wound complications whose wounds were treated with NPWT (PREVENA™ Therapy) or conventional skin sutures (or staples) without the use of NPWT (Historical Control) after cesarean delivery.³⁴
 - Historical control (n = 209): Patients' chart reviews between 19 Apr 2007 and 07 Sep 2011.
 - NPWT group (n = 110): Patients who presented for delivery between August 2012 and January 2013.
 - Patients were followed as part of postpartum care or were followed up at 6 weeks postpartum.
 - Wound/infection (any deep or superficial surgical site infection, as defined by the Centers for Disease Control) and wound separation without infection were the primary study endpoints.
 - Compared to the Historical Control, NPWT patients had:
 - » Fewer postoperative complications (21.0% vs. 6.4%, respectively; $p = 0.0007$)
 - » Fewer wound infections (11.5% vs. 2.7, respectively; $p = 0.008$)
 - » Fewer cases of endometritis (6.7% vs. 0.9%, respectively; $p = 0.023$)
 - » Approximately the same number of wound separation cases (3.8% vs. 2.7%, respectively; $p = 0.754$)
 - The NPWT group, who were at increased risk for postoperative infections and wound complications, had significant reductions in deep and superficial infectious morbidity after the NPWT system was applied to closed cesarean section incisions.³⁴

EVIDENCE LEVEL III

- In a retrospective study by Reddix, et al., comparisons of wound infection and dehiscence were made in patients 5 years (August 1996-June 2001) before NPWT over incisions was used as part of the postoperative protocol for acetabular fracture surgery and 4 years (July 2001-April 2005) after NPWT over incisions became standard at the author's institution.⁸
 - Sixty-six consecutive patients treated with standard institutional postoperative care in the previous 5 years had 4 (6.06%) deep wound infections and 2 (3.03%) dehiscences.
 - After establishment of NPWT, 235 patients had 3 (1.27%) deep wound infections and 1 (0.426%) had a dehiscence.
 - The authors noted that their NPWT infection rate of 1.27% represented a significant decrease in comparison to other groups (infection rates of 4.2%,⁵⁹ 4%,⁶⁰ and 5%⁶¹) of similar size ($p = 0.0282$; reference rate=4%), and concluded that the application of NPWT decreased their incidence of perioperative incision complications.⁸
- Tauber and associates conducted a retrospective comparative review of 24 patients who underwent 45 inguinal lymph node dissections (LNDs) as treatment for penile or urethral cancer.³⁵
 - Sixteen patients with 30 LNDs were treated with conventional wound care (compression dressings; Control) and 8 patients with 15 LNDs received incisional NPWT using V.A.C.® WHITEFOAM™ Dressing. The NPWT dressing remained in place for up to 7 days.
 - Compared to NPWT, Control patients tended to have:
 - » Higher levels of maximum drained fluid per day ($p = 0.496$)
 - » Longer duration of drainage ($p = 0.632$)
 - » More reinterventions (23% (7 patients) vs. 7% (1 patient), respectively; $p = 0.631$).
 - Control patients also had significantly longer hospitalization ($p = 0.049$).
 - NPWT patients had significantly fewer wound complications ($p = 0.032$) than Control patients: 20% vs. 62% incidence of lymphoceles, 7% vs. 45% persistent lymphorrhoea, 0% vs. 46% lower extremity lymphoedema, respectively.
 - Along with shorter hospital stay, the authors commented that NPWT patients benefitted because "... further oncological treatments could be administered without delay."³⁵
- A comparative retrospective study by Matatov and associates evaluated the infection incidence and severity in 90 pts with 115 groin incisions that were treated with either PREVENA™ Therapy ($n = 41$ pts with 52 incisions) or a skin adhesive or absorbent ($n = 49$ pts with 63 incisions; Control).³⁶
 - Severity of infection was graded using the Szilagyi scale, which ranks degree of infection from grade I (lowest) to grade 3 (highest).
 - PREVENA™ Therapy was applied intraoperatively and removed after 5-7 days.
 - Mean times of wound evaluation in the PREVENA™ Therapy group were 7 and 33 days postoperatively vs. 10 and 40 days in the Control group.
 - PREVENA™ Therapy-treated incisions had a significantly lower overall rate of infection: 3/52 (6%) vs. 19/63 (30%), $p = 0.0011$.
 - The 3 infections in the PREVENA™ Therapy group were all rated as Szilagyi grade I, whereas the 19 in the Control group included 10 (16%) grade I, 7 (11%) grade II, and 2 (3%) grade III infections.
 - The authors reported PREVENA™ Therapy "significantly decreased the incidence of groin wound infection in patients after vascular surgery."³⁶
- Blackham, et al., conducted a comparative retrospective study to assess the effectiveness of negative pressure therapy (incisional NPWT using V.A.C.® Therapy) in reducing surgical site infections (SSIs) in surgical oncology patients at high-risk for surgical wound complications.³⁷
 - Data for 189 patients who underwent 191 surgical procedures for pancreatic, colorectal, or peritoneal surface malignancies were analyzed in this comparative study.
 - » Control patients ($n = 87$ cases) were treated with standard sterile dressings (SSDs).
 - » Patients treated with NPWT ($n = 104$ cases) had multiple risk factors for development of SSIs. These factors included morbid obesity, multiple comorbidities, colorectal resection, operation time >6 hours, and estimated blood loss >1L.
 - Compared to SSD pts, NPWT patients had significantly more neoadjuvant chemotherapy ($p = 0.024$), more clean-contaminated operations ($p < 0.001$), longer operation times ($p < 0.001$), greater intraoperative blood loss ($p < 0.001$) and more frequent blood

-
- transfusions ($p = 0.002$).
- NPWT patients had significantly fewer incisional SSIs compared to SSD pts: 6.7% vs. 19.5%, $p = 0.015$.
 - In a subset analysis of clean-contaminated cases, NPWT was associated with "fewer superficial incisional SSIs (6.0% vs. 27.4%, $p = 0.001$), fewer total SSIs (16.0% vs. 35.5%, $p = 0.011$), and fewer wound openings for any reason (16.0% vs. 35.5%, $p = 0.011$)."³⁷
 - In this retrospective study, the authors concluded that NPWT decreased the incidence of SSIs in surgical oncology patients. They also stated that an RCT is planned to further evaluate the efficacy of incisional NPWT in this patient population.³⁷
 - In a retrospective study, Bonds, et al., evaluated the effect of known risk factors and the use of incisional NPWT on the surgical site infection rate among 254 patients undergoing open colectomy.³⁸
 - Patients were treated with standard wound closures followed by incisional NPWT ($n = 32$) or standard wound closures followed by occlusive dressings (Control; $n = 222$).
 - Patient charts were reviewed between August 2009 and August 2011.
 - Follow-up of all patients was included; however, the length of follow-up time was not specified in the study.
 - The presence or absence of SSI was the primary endpoint.
 - Overall, 69/254 patients (27.2%) experience an SSI.
 - The incisional NPWT group had a lower infection rate compared to the Control group; 4/69 (12.5%) vs. 65/254 (29.3%), respectively (OR 0.32, $p < 0.05$).
 - Diabetes mellitus was found to be associated with a higher SSI rate compared to patients without this risk factor: 39.4% vs. 29.7%, respectively (OR 1.98, $p < 0.05$).
 - The authors concluded that using incisional NPWT over clean, standard wound closures appeared to reduce the incidence of SSIs in patients undergoing open colectomy.³⁸
 - In a 5-year retrospective analysis, Soares, et al., evaluated surgical site infections in 199 patients undergoing ventral hernia repair whose incisions were treated with either a modified NPWT technique ($n = 115$) or standard wound dressings without the use of NPWT (Control; $n = 84$).³⁹
 - Patients' chart reviews were performed between January 2008 and February 2013.
 - Control group: The skin was closed with staples and standard wound dressings were applied over the incision. Dressing was removed on postoperative day 2, and the incision was exposed to air.
 - NPWT group: In order to decompress the extensive dead space and restore abdominal wall anatomy and function, NPWT white foam dressing strips were inserted vertically into the subcutaneous space along the incision, spaced at 6-8cm intervals, and extended 1cm above the surface of the skin. Exposed areas of skin between the strips were covered with silver-impregnated non-adherent dressing, and NPWT black foam was secured over the area with adhesive dressing.
 - » NPWT was applied continuously at -125mmHg.
 - » Dressings were removed on postoperative day 3.
 - Primary outcome: Presence of any surgical site infections on or before day 90.
 - Follow-up period: 8.7 ± 9.9 months.
 - Compared to the Control, NPWT patients had:
 - » Lower likelihood of surgical site occurrences (17% vs. 42%, respectively; $p = 0.001$)
 - » Lower overall SSIs (9% vs. 32%, respectively; $p < 0.001$)
 - » Lower rates of major morbidity (32% vs. 52%, respectively; $p = 0.001$)
 - » Fewer 90-day reoperations (5% vs. 14%, respectively; $p = 0.02$)
 - The authors concluded the modified NPWT technique "may decrease the complication rates, making this an acceptable approach in VHR patients with risk factors for occurrence of SSOs and hernia recurrence."³⁹
 - In a retrospective analysis, Chadi, et al., reviewed the rates of perineal surgical site infections in 59 patients undergoing elective abdominoperineal resection whose incisions were treated with either NPWT ($n = 27$) or standard wound dressings without the use of NPWT (Control; $n = 32$).⁴⁰
-

- Control group: Patients who received standard wound dressings without NPWT between January 2008 and December 2010.
- NPWT group: Patients who received NPWT over their perineal incisions between January 2011 and December 2012.
- Primary outcome: Presence of perineal surgical site infections on or before postoperative day 30.
- Follow-up period: All patients were followed with the surgeon 4 weeks after discharge.
- Both groups had similar perioperative risk factors; however, there were increased levels of blood urea nitrogen, more hypertensive patients, and longer mean operative time in the NPWT group.
- Compared to the Control, NPWT patients had:
 - » Lower rates of perineal SSIs (15% vs. 41%, respectively; $p = 0.04$)
 - » Longer length of stay (11 vs. 8 days, respectively; $p = 0.03$)
- The authors concluded that NPWT plays a role in decreasing perineal surgical site infection rates following abdominoperineal resection.⁴⁰
- Mark, et al., evaluated 69 morbidly obese patients (BMI>45) at increased risk for wound complications after cesarean delivery who were treated with conventional skin sutures (or staples) followed by incisional NPWT or conventional skin sutures (or staples) without the use of NPWT (Control).⁴¹
 - Control group (n = 48): Patient chart reviews between 01 Sept 2008 and 31 Aug 2009.
 - NPWT group (n = 21): Patients who presented for delivery between 01 Sept 2009 and 30 Sept 2010.
 - Incisional NPWT was applied over standard surgical closures and remained in place at a negative pressure of -125mmHg for 2-4 days. Control dressings were applied over standard surgical closures and remained in place for 2 days postoperatively.
 - The primary outcome was any postoperative wound complication; all postoperative wound complications were identified a mean of 6 days following delivery.
 - Incisional NPWT patients, when compared to the Historical Control, had the following risk factors:
 - » Slightly younger (26.1 vs. 29.5, respectively; $p = 0.04$)
 - » More unscheduled cesarean sections (47.6% vs. 22.9%, respectively; $p = 0.04$)
 - » Longer length of labor (261 vs. 78 minutes, respectively; $p = 0.02$)
 - » Longer length of surgery (76 vs. 64 minutes, respectively; $p = 0.03$)
 - » Incision closure with subcuticular sutures rather than staples (95.2% vs. 14.6%, respectively; $p < 0.001$)
 - There were no wound complications in the incisional NPWT group compared to five in the Control group: 0/21 (0.0%) vs. 5/48 (10.4%), respectively ($p = 0.15$).
 - The results of this study suggest using incisional NPWT over clean, closed incisions decreases wound complications in morbidly obese patients undergoing cesarean section.⁴¹
- In a retrospective review, Atkins, et al., reported on 57 adult cardiac surgery patients whose sternotomy incisions were treated with NPWT for 4 days.⁵
 - These patients were deemed high risk for sternal wound infections after sternotomy based on a risk assessment model using pooled data from the Society of Thoracic Surgeons National Cardiac Database.⁶²
 - Risk factors included obesity, diabetes, length of cardiopulmonary bypass, and need for intra-aortic balloon pump. Of the 57 NPWT-treated patients, 77.2% were obese, 54.4% were diabetic, and 50.9% were both obese and diabetic.
 - Based on preoperative and intraoperative risk factor analysis, a minimum of 3 predicted cases of sternal wound infection (SWI) (based on the average estimated risk, $6.1 \pm 4\%$, for postoperative SWI) were anticipated.
 - No complications were observed in the NPWT group.
 - The authors recommended that NPWT should be strongly considered for sternotomy patients with increased SWI risk.⁵
- In a retrospective study, Gabriel evaluated the effectiveness of using closed incision negative pressure therapy (ciNPT) with a customizable dressing over closed incisions following immediate postmastectomy reconstruction as part of 2-stage expander/implant breast reconstruction.⁴²

-
- Charts were reviewed from breast reconstruction surgery patients (n=13; 25 breasts) who received ciNPT over closed, postmastectomy incisions.
 - As part of immediate postmastectomy reconstruction, all patients had ciNPT using a customizable dressing applied over the closed incision in the sterile field of the operating room followed by continuous negative pressure at -125mmHg for an average of 4.3 days.
 - » Patients underwent one of 3 types of mastectomies: nipple sparing, reduction-pattern, or skin-sparing
 - » Surgical drains were used with ciNPT (mean drain placement was 8.2 days); all incisions were closed with absorbable sutures and protected with a sterile dressing.
 - All patients were followed for 3-months.
 - Fourteen breasts underwent nipple-sparing mastectomies, 6 breasts had a reduction-pattern mastectomy, and 5 breasts received a skin-sparing mastectomy.
 - In the nipple-sparing mastectomy group, one breast developed a delayed hematoma on postoperative Day 13 that resolved by the 3-month follow-up visit.
 - In the reduction-pattern mastectomy group, 3 breasts developed superficial dehiscence that resolved with local wound care. One breast developed flap necrosis that required surgical revision.
 - No complications were reported in the skin-sparing mastectomy group.
 - At the 3-month follow-up, 24/25 (96%) breasts achieved complete healing
 - The authors concluded that ciNPT with customizable or peel-and-place dressings "...could be a viable option over closed incisions following immediate postmastectomy reconstruction as part of 2-stage expander/implant breast reconstruction."⁴²
 - Cooper et al conducted a retrospective review and assessed the efficacy of closed incision negative pressure therapy (ciNPT) compared to a sterile antimicrobial dressing (control) on wound complications, surgical site infections (SSIs), and reoperations after hip and knee revision surgery.⁴³
 - Charts were reviewed from patients (n=138) who underwent major hip or knee procedures from October 2012 through August 2015.
 - » ciNPT group: 30 patients
 - » Control group: 108 patients
 - ciNPT was applied immediately after skin suturing and remained in place at a negative pressure of -125mmHg. Control dressings were applied over standard surgical sutures and left in place for a minimum of 5 days unless a premature dressing change was required due to saturation.
 - The primary outcome measures were incidence of wound complications, incidence of total SSIs, and reoperation rate for wound complications; all patients were followed for 90 days.
 - Compared to Control, ciNPT resulted in:
 - » Fewer overall wound complications (6.7% vs. 26.9%, respectively; p=0.024)
 - » Fewer total SSIs (3.3% vs. 18.5%, respectively; p=0.045)
 - » A trend toward fewer reoperations (3.3% vs. 13.0%, respectively; p=0.191)
 - The authors' findings suggest that "ciNPT may decrease wound complications and SSIs in patients undergoing revision hip and knee surgery."⁴³

- Reddy reported on the use of closed incision negative pressure therapy (ciNPT) on complex cardiothoracic surgery patients.⁴⁴
 - Charts were reviewed from complex, cardiothoracic surgery patients (n=27) who received ciNPT over closed sternal incisions.
 - ciNPT was applied immediately after skin suturing and remained in place at a negative pressure of -125mmHg for a mean duration of 5.6±0.9 days.
 - » All patients received antibiotics prior to surgery (-30 minutes), during surgery (4 hours), and up to 24 hours postoperatively.
 - All patients were evaluated within the first 30 days post-surgery; mean follow-up was 6.7±3.1 weeks.
 - Patient risk factors included: obesity (BMI ≥ 30 kg/m²; 27/27,100%), diabetes (25/27, 92.6%), hypertension (16/27, 59.3%) and ≥5 comorbidities (20/27, 74%).
 - Within the first 30 days post-surgery, ciNPT resulted in:
 - » A majority of patients with intact incisions with good approximation and no major sternal complications (21/27; 77.8%)
 - » Two patients experienced minor dehiscences, and 4 patients had superficial cellulitis that were treated and resolved.
 - All patients had intact incisions at the final follow-up visit.
 - The author concluded that in these cardiac patients "...ciNPT over closed sternal incisions resulted in favorable outcomes within 30 days of surgery."⁴⁴

EVIDENCE LEVEL IV

- Reddix, et al., retrospectively reviewed patient records from a 9-year period and presented the results of 19 morbidly obese (Body Mass Index (BMI) >40) patients who had NPWT applied to clean, closed surgical incisions after surgery for acetabular fractures.⁷
 - Mean follow-up period was 21 months.
 - There were no incision complications or infections during the perioperative period and no complications at the final follow-up visit.
 - The authors concluded NPWT over clean, closed incisions may be a useful adjunctive therapy for reducing post-operative complications in morbidly obese patients with acetabular fractures.⁷
- The first case series evaluating use of the PREVENA™ Incision Management System was published in 2011 by Colli.⁴⁵
 - A total of 10 patients with mean Fowler risk score of 15.1 received application of PREVENA™ Therapy over clean, closed sternal incisions for 5 days following cardiac surgery.
 - All wounds and surrounding skin showed complete wound healing and an absence of skin lesions following removal of the dressing.
 - There were no cases of infection. No device-related complications were observed and no other wound complications occurred during the 30-day follow-up period.
 - Authors concluded the system "may help achieve uncomplicated wound healing in patients at risk of developing wound complications following cardiothoracic surgery."⁴⁵
- Along with a case series of 4 patients, Stannard and colleagues present an overview of incisional NPWT and practical considerations for using this technique.⁴⁶
 - Use of incisional NPWT was reported for 1 patient with coronary artery bypass grafting, 1 patient with a transmetatarsal amputation, and 2 patients with abdominal hysterectomies.
 - Patient comorbidities included obesity, diabetes, hypertension, and peripheral artery disease.
 - Three patients healed without complication; one patient with an abdominal hysterectomy experienced superficial skin separation (3mm – 5mm) after staple removal.
 - Authors also shared practical tips, including a patient grading scale to help identify patients who could benefit from incisional NPWT or PREVENA™ Therapy.⁴⁶

-
- In a case series by Gomoll, et al., NPWT was placed over clean closed sutured incisions of 35 patients.⁶
 - The procedures included revision hip arthroplasty, proximal femoral and tibial fracture fixation, and foot and ankle trauma.
 - The average length of NPWT per patient was just over 3 days, and no infections occurred during the 3-month follow up visit.
 - The authors concluded using NPWT over incisions in their practice made a difference in post-operative care for procedures associated with large dead spaces, obese patients, and areas prone to postoperative edema.⁶
 - Bollero and colleagues evaluated use of PREVENA™ Therapy after excision of wide pathological scars in a series of 8 patients.⁴⁷
 - Mean age of the patients was 33 years (range 20-60 years) and treated scars were mature and usually the result of hypertrophic scars.
 - Scar sites were located in body areas with skin stretch during flexion/extension movements. PREVENA™ Therapy was placed to improve incision edge apposition.
 - PREVENA™ Therapy Dressing was applied intraoperatively at continuous -125mmHg.
 - Seven of 8 patients completed treatment successfully.
 - » One incision was longer than the PREVENA™ Incision Dressing but closed without complications.
 - The scar of one patient was close to the pubic area and, even though the area was shaved, an air-tight seal could not be achieved. Consequently, the patient discontinued treatment after 1 day.
 - The authors concluded "Easy intraoperative application and postoperative management, associated with good compliance of patients, make PREVENA™ [Therapy System] a safe home-care device."⁴⁷
 - In a small case series by Maclin, et al., NPWT utilizing the 'French Fry' technique was evaluated in high-risk surgical patients after undergoing panniculectomy with ventral hernia repair.⁴⁸
 - In order to decompress the extensive dead space of deep incision closures at risk for breakdown, channel drains were placed vertically through a closed incision and in contact with NPWT white foam dressing strips (French Fries).
 - NPWT was applied to the incision line for 7-10 days; subsequent NPWT was applied only to French Fry portal sites.
 - Patient co-morbidities included obesity, diabetes, hypertension, hypercholesterolemia, emphysema, ulcerative colitis, and post-gastric bypass.
 - Wound incision healed without complications for two patients. Superficial partial thickness necrosis at the T-junction occurred with one patient's incision; however, the incision healed with local wound care.
 - NPWT allowed for superficial control of the incision line while the French Fry portal sites contributed to deep control by compressing undermined deep dead spaces.
 - The authors concluded the "use of NPWT helped to address and minimize serious complications in these high-risk surgical patients."⁴⁸
 - Condé-Green and colleagues conducted a retrospective review of patients who underwent abdominal wall reconstruction to repair large ventral hernias. Between September 2008 and May 2011, 23 patients were treated with incisional NPWT (group I) and 33 patients with standard gauze dressings (group II).⁵²
 - Incisional NPWT dressing was applied intraoperatively, maintained at a continuous negative pressure of -125mmHg, and removed after 5 days.
 - Compared to standard dressing patients, incisional NPWT patients had significantly better overall wound complication rates: 63.6% vs. 22%, respectively ($p = 0.020$)
 - Skin dehiscence rates: 39% vs. 9%, respectively ($p = 0.014$)
 - Rates of infection, skin and fat necrosis, seroma, and hernia recurrence were also lower for incisional NPWT patients.⁵²

- In a small retrospective review, Vargo analyzed wound infection rates in 30 high-risk patients undergoing abdominal surgery whose incisions were treated with incisional NPWT (V.A.C.® Therapy). Published historical data were used as the control group (n = 30).⁵³
 - Treatment: All patients received antibiotics. Incisional NPWT was applied at -75mmHg continuously for an average of 5.6 days (range 5-7 days).
 - Primary outcome: Wound infection rate
 - Secondary outcomes: Device safety and overall surgical site complication rate
 - Follow-up period: Wounds were assessed at the time of dressing removal and at 2 weeks and 4 weeks post-surgery.
 - No ischemia, skin necrosis, or wound infections were identified in the incisional NPWT group.
 - Compared to the control, incisional NPWT patients had a lower overall complication rate (6% vs. 20%, respectively; $p < 0.05$).
 - The authors concluded the "negative-pressure wound therapy applied to a closed, high-risk surgical wound is safe, with no evidence of skin necrosis and decreased wound infection rate."⁵³

EVIDENCE LEVEL V

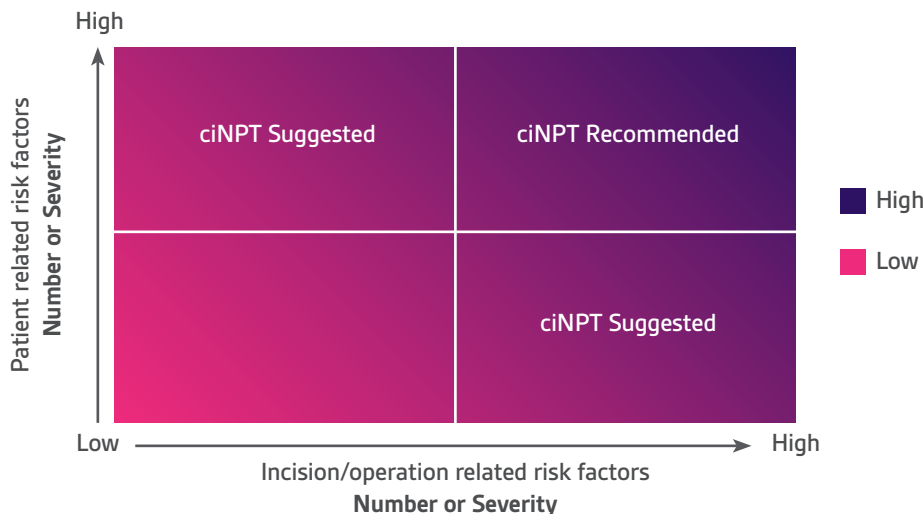
- A single case study of a patient with a distal lower limb incision site treated with PREVENA™ Incision Management System following popliteal-tibial bypass grafting has also been reported.⁵⁴
 - The author noted the incision did not become edematous or deteriorate at any time, even after the PREVENA™ Incision Dressing was removed.
 - Ongoing tissue healing was maintained without any complications, and the patient was discharged on postoperative day 12 after regaining full mobility and removal of sutures.⁵⁴
- In a case report Dutton and Curtis reported using incisional NPWT as a "splinting" technique to help prevent laparotomy breakdown.⁵⁵
 - The patient had multiple factors (obesity, malnutrition, fistula, and previous surgeries in the area of wound break-down) that increased the likelihood of wound complications.
 - In addition to laying the foam NPWT dressing over the vertical incision, three bars of foam were placed horizontally along the length of the incision to both splint the incision and provide support for the weight of the pannus.
 - NPWT was applied for 7 days with only small, superficial breakdown at distal end of the incision. At follow-up visits 4 and 6 weeks later, no further complications were reported.⁵⁵

Collectively, findings from these studies demonstrate the potential value of NPWT over clean closed surgical incisions. This evidence also supports the ability of the PREVENA™ Incision Management System to provide incisional NPWT comparable to traditional V.A.C.® Therapy Systems. Findings published in the literature report that patients benefiting from incisional NPWT or PREVENA™ Therapy were often those at greater risk for infection, seroma, hematoma, and dehiscence.⁶³ These patients were often found to have one or more risk factors (Table 4) that might affect wound healing⁶⁴⁻⁶⁶ and/or were undergoing high-risk surgery. A multidisciplinary group of surgical and infectious disease experts met in December 2014 and developed an algorithm for when a surgeon might consider using ciNPT (Figure 5).

Figure 5. ciNPT Risk Factor Assessment⁶⁷

Patient Related Risk Factors

- Diabetes mellitus
- ASA score ≥3
- Advanced Age
- Obesity
- Active tobacco use
- Hypoalbuminemia
- Corticosteroid usage
- Active alcoholism
- Male sex
- Chronic renal insufficiency
- Chronic obstructive pulmonary disease
- Hematoma



General Incision Related Risk Factors

- High-tension incision
- Repeated incisions
- Extensive undermining
- Traumatized soft tissue
- Edema
- Contamination
- Emergency procedure
- Mechanically unfavorable site
- Prolonged operation time
- Post surgical radiation

Operation Related Risk Factors

| General | Plastic | Orthopaedic | Vascular | Cardiovascular |
|--|---|--|---|--|
| <ul style="list-style-type: none"> • Open General • Open Colorectal • Open Urology • Open OB/Gyn • Incisional Hernia Repair | <ul style="list-style-type: none"> • Postbariatric abdominoplasty • Breast reconstruction • Big soft tissue defects (Necrotizing Fasciitis) • High tension incision • Soilage risk • Repeat incisions | <ul style="list-style-type: none"> • Open reduction and internal fixation of fractures: Acetabulum, Pilon, Calcaneous, Tibial Plateau • Fasciotomy • Above knee amputation • Below knee amputation | <ul style="list-style-type: none"> • Above knee amputation • Below knee amputation • Synthetic graft implantations | <ul style="list-style-type: none"> • Sternotomy |

SCIENCE SUPPORTING PREVENA™ THERAPY – BENCH AND ANIMAL STUDIES

As adjunctive therapy, the PREVENA™ Incision Management System provides a closed environment for managing clean, closed surgical incisions through application of Negative Pressure Wound Therapy. Data from bench testing, computer modeling and animal studies have shown PREVENA™ Therapy helps hold the closed incision edges together and protects the incision from external contamination. Preliminary data suggest PREVENA™ Therapy may play a role in realigning and reducing tensile forces across the incision and improving fluid flow; however, such results have not been confirmed in humans. **Tables 5A** and **5B** summarize the biomechanical and physiological study results, respectively, of the PREVENA™ Incision Management System.

Biomechanical Properties

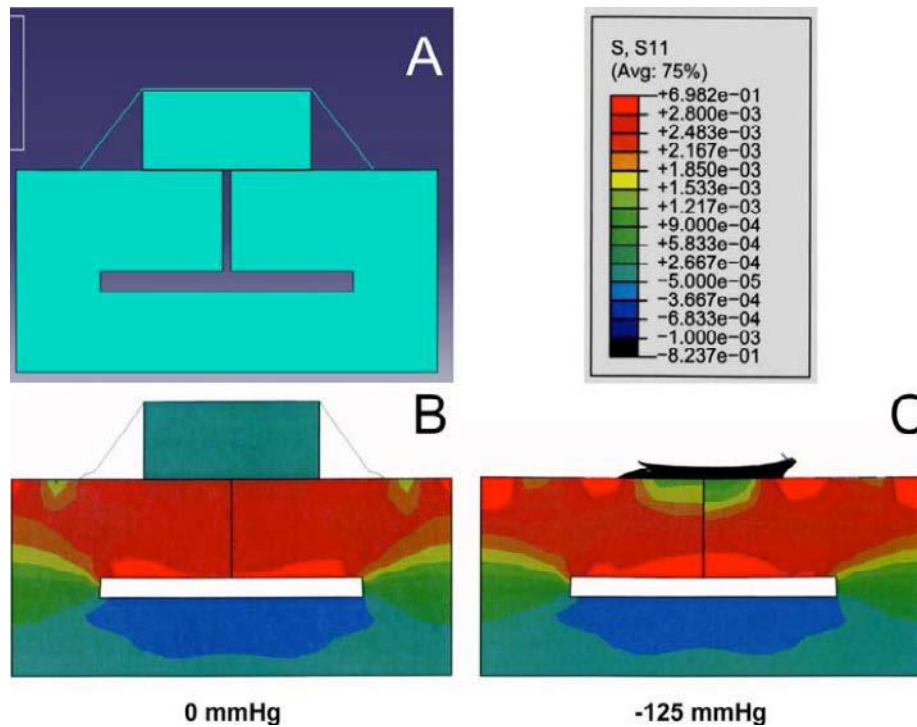
When there is a disruption in the skin's integrity from an incision, the edges immediately retract.⁶⁸ Typically, sutures or staples are used to re-approximate the incision edges; however, these closure methods may not be sufficient for some incisions, which re-open as a result of excessive edema or other factors. Both bench and computer finite element studies (summarized below and in **Table 5A**) have provided insight into the biomechanical effects of NPWT over closed incisions.

- Because lateral tension (appositional tension/force) can increase the risk of a dehiscence, a simulated closed incision model was used to determine the force required to separate sutured or stapled incisions with and without PREVENA™ Therapy.⁶⁹
 - o The data showed that a force of $61.7 \pm 0.3\text{N}$ was required to extend the sutured incision edges approximately 10mm compared to a force of $92.9 \pm 2.6\text{N}$ when the PREVENA™ Therapy was applied over the closed incision ($p < 0.05$), resulting in an increase of 51% in force for the same displacement without the therapy.
 - o Furthermore, a force of $69.3 \pm 0.4\text{N}$ was required to extend the stapled incision edges approximately 10mm compared to a force of $98.8 \pm 0.0\text{N}$ with PREVENA™ Therapy ($p < 0.05$), resulting in an increase of 43% in force for the same displacement without the therapy.⁶⁹
 - o These results are summarized in **Table 6** and suggest PREVENA™ Therapy in conjunction with sutures or staples may aid in holding together incision edges subjected to appositional forces, more than either sutures or staples alone.

To further evaluate the biomechanical effects of PREVENA™ Therapy on the integrity of the incisional closure, a scientific study was performed using 2 finite element computer models.⁶⁹

- The first finite element computer model assessed the effects of PREVENA™ Therapy on lateral tension.⁶⁹
 - o This model simulated a sutured incision with the incision being sutured throughout the depth.
 - o Lateral tension in the range of 2.2 to 2.5 kPa at the skin surface was then created by computer software.
 - o When negative pressure was applied with PREVENA™ Therapy, the simulated lateral strain was reduced by approximately 50% (0.9 to 1.2 kPa) along the incision (**Figure 6**), which helped relieve the tension created by the sutures.
 - o Literature suggests that reduction in lateral strain is important for maintaining the integrity of the closed incision.⁶⁹

Figure 6. Finite Element Analysis model 1: a 2mm wide incision cuts from the skin surface to the void (A). Incision was sutured (B) and lateral stress was recorded (color contours, MPa). Negative pressure (-125mmHg) was applied to the dressing (C), and lateral stresses were decreased (color contours, MPa).⁶⁹ Color indicates relative magnitude of lateral tension. Note that the red and orange colors correspond to areas of high lateral strain and yellow and green colors correspond to areas of low lateral strain.

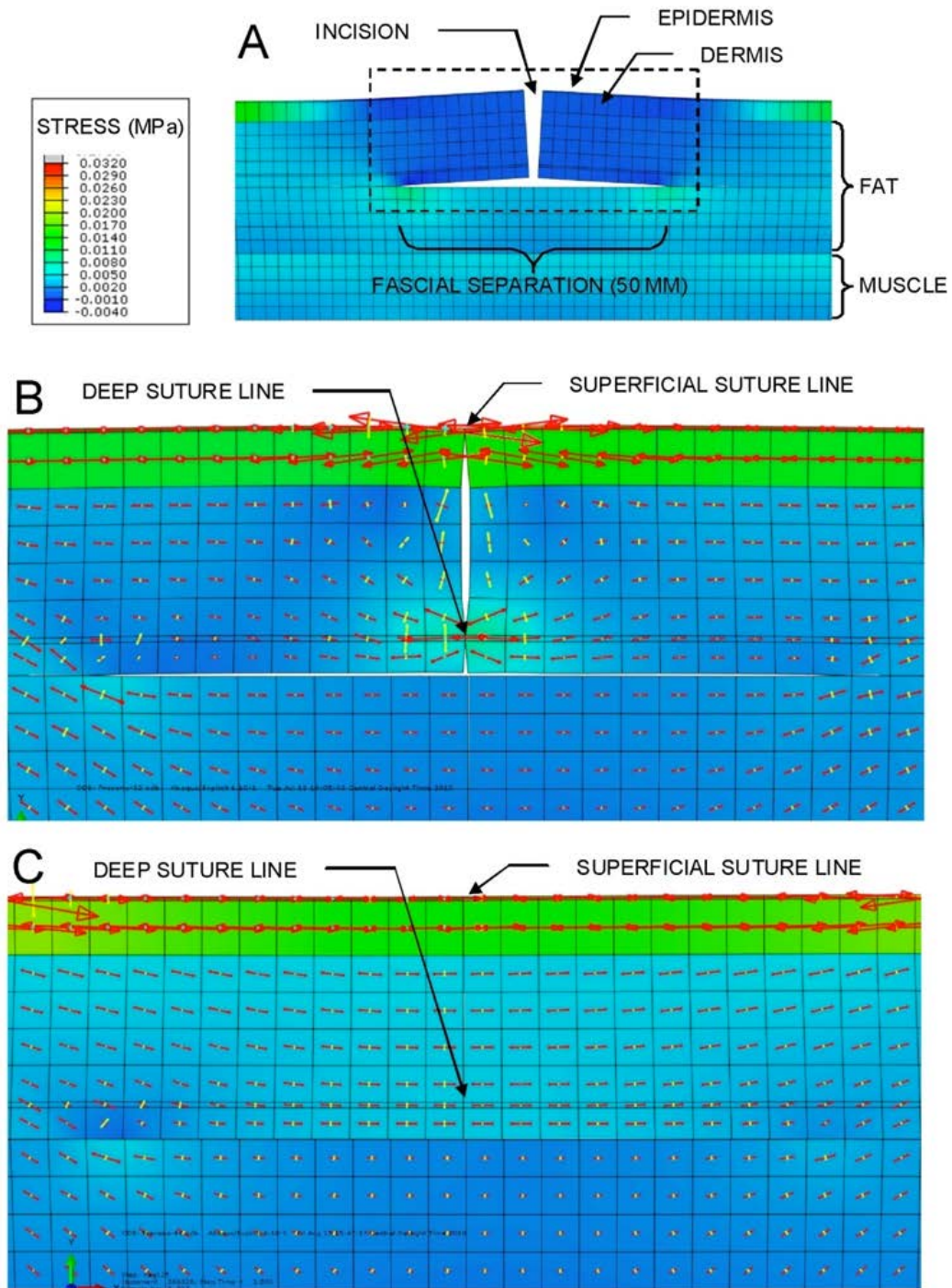


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- The second computer model simulated a cross-section of an incision with sutures, represented as tied surfaces, at the epidermal and subdermal levels (**Figure 7A**).⁶⁹
 - o Skin tension was applied as a smooth increase from 0 to 150 kPa (-125mmHg) over 0.2 seconds.
 - o Negative pressure was applied from 0 to 16.7 kPa (-125mmHg), starting at 0.4 seconds and attaining target negative pressure at 1 second.
 - o With only sutures in place, the lateral tensile stress was substantial at the superficial (27.8 kPa) and deep (8.4 kPa) layers (**Figure 7B**).⁶⁹
 - o With the PREVENA™ Incision Dressing under negative pressure, the gap in the simulated incision closed and the vertical compression in the sides of the incision was eliminated (**Figure 7C**). The lateral tensile stress at the superficial sutures decreased to 15.4 kPa (decrease of 45%) and at the deep suture to 4.2 kPa (decrease of 50%).⁶⁹

These bench evaluations showed the PREVENA™ Therapy system significantly increased the force required to disrupt the closed incision approximately 50% as compared with closure alone. With negative pressure, the direction of the stress was normalized to a distribution typical of intact tissue, and appositional forces were bolstered at the incision.

Figure 7. Finite Element Analysis model 2: lateral stress color contour plot of the incision (A). PREVENA™ Therapy model results for strain, after application of skin tension over a sutured incision. Red arrows indicate direction and relative magnitude of principal strain at each element. Tensile loads across the incision were concentrated at the sutures (B). PREVENA™ Therapy model results for strain, after application of skin tension and then negative pressure (-125mmHg) through the PREVENA™ Incision Dressing. Red arrows indicate direction and relative magnitude of principal strain at each element (C). Tensile loads were distributed more evenly across the incision plane, without local shear and in a direction commensurate with intact native tissue.⁶⁹



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Physiological Properties

The data from appositional and finite element models showed PREVENA™ Therapy may favorably alter the biomechanical environment of the incision area. The increased apposition of tissue and the decreased tension along the incision may also allow for improved fluid flow. This may be because flow of fluid through the capillaries, interstitium and lymphatics is modulated by the biomechanical environment of the extracellular matrix. By relieving tension on tissue and redistributing tension in a more uniform manner (similar to native tissue), vessels may remain open and less constricted, supporting lymph flow and edema reduction, and reduction of inflammation which may ultimately facilitate healing of the closed incision.

In vivo studies summarized below and in **Table 5B** have provided evidence of improved fluid flow with the PREVENA™ Incision Management System. However, these results have not been confirmed in clinical studies.

- A hematoma/seroma study used a porcine model in which subcutaneous voids with overlying sutured incisions were created on the ventral sides of 8 swine.⁷⁰
 - o Stable isotope-labeled nanospheres were introduced into each subcutaneous dead space.
 - o Each contralateral incision was randomly assigned to PREVENA™ Therapy or the Control (semipermeable film dressing; 3M™ Tegaderm™ Dressing) for 4 days.
 - o After therapy, the hematoma/seroma in each defect was weighed (with differences averaged for each animal), fluid levels in the canister were monitored, 5 pre-identified lymph nodes were harvested, and 5 key organs were biopsied.
 - o Results showed a 63% decrease in hematoma/seroma mass with the PREVENA™ Incision Dressing versus the Control (mean 15 ± 3 g vs. 41 ± 8 g, respectively; $p < 0.002$), without any fluid collection in the PREVENA™ Canister.
 - o In lymph nodes, there were ~ 60 μg ($\sim 50\%$) more 30- and 50-nm nanospheres from PREVENA™ Therapy-treated incisions compared to Control sites ($p = 0.04$ and $p = 0.05$, respectively).
 - o Nanosphere incidence was significantly greater from PREVENA™ Therapy sites versus Control sites in lungs, liver and spleen ($p < 0.05$); no nanospheres were found in kidney biopsies.
 - o In this scientific model, application of PREVENA™ Therapy significantly decreased hematoma/seroma levels without fluid collection in the canister, which may be explained by increased lymph clearance.⁷⁰
- Another porcine study compared PREVENA™ Therapy to standard dry dressings (Control) over closed spinal incisions. Scar quality, biomechanical characteristics, and histology were endpoints of interest.⁷¹
 - o In 8 mature, miniature pigs, the two dressings were applied to adjacent sutured incisions over the spine.
 - o After 3 or 5 days, incisions were assessed using scar scale, biomechanical (e.g., failure load, failure energy, and stress), and histological testing. ANOVAs compared the groups (3 vs. 5 days, PREVENA™ Therapy vs. Control, $p < 0.05$).
 - o Incisions treated with PREVENA™ Therapy had a significantly improved scar scale height grade ($p < 0.026$) compared to those treated with standard dressings, which showed inflammation, edema and swelling around the incision (**Figures 8A and 8B**). The incision line treated with PREVENA™ Therapy was barely visible, indicating progression of healing.
 - o Control group scores were lower for failure load (4.9 ± 4.0 vs. PREVENA™ Therapy, $16.5 \pm 14.6\text{N}$), energy absorbed (8.0 ± 9.0 vs. 26.9 ± 23.0 MJ), and ultimate stress (62 ± 53 vs. 204 ± 118 N/mm²).
 - o Histological analysis demonstrated no differences in incision scar width between the two groups.
 - o In this porcine study the authors noted, “a trend toward improved early healing strength and in a significantly improved incision appearance,” for incisions treated with PREVENA™ Therapy.⁷¹

Figure 8. (A) Representative sample with scar height score 1 (score of 5/8 control-treated incisions). (B) Representative sample with scar height score 0 (score of 8/8 PREVENA™ Therapy-treated and 3/8 control-treated incisions).



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- The impact of PREVENA™ Therapy was assessed by means of a whole-genome microarray study that measured the biological processes that the PREVENA™ Incision Management System may affect at later time periods.⁷²
 - o Samples were obtained from contralateral sutured porcine incisions treated with PREVENA™ Therapy versus ABD pads (Control) for 5 days.
 - o Signal intensities across microarrays were normalized. Features with signal/noise values ≥ 3 and quality flag values < 5000 were considered "detected" and were subjected to analysis with a $p < 0.05$
 - o Pilot study analysis indicated there was decreased inflammation (expressed by key chemokine and cytokine markers) in PREVENA™ Therapy treated incisions versus the Control.
 - o Additionally, PREVENA™ Therapy affected fewer genes compared to the Control, thereby resuming negative pressure gene expression to a normalized skin phenotype.⁷²
 - o This decreased gene expression in PREVENA™ Therapy treated incisions may be correlated to the observed biomechanical strength of negative pressure-treated incisions in porcine models.⁵⁷
- In a pilot study performed by Kilpadi, et al., contralateral incisions of swine were sutured and treated with PREVENA™ Therapy or ABD pads (Control) for 5 days. Incisions were then left untreated.⁵⁷
 - o Compared with the Control at 40 days post-surgery, PREVENA™ Therapy treated incisions had improved mechanical properties (peak strain and strain energy density) and narrower healed incisions in the deep dermis. Peak stress and elastic moduli for both groups did not differ statistically when compared to naïve skin. **(Table 7)**
 - o Compared with the Control at 5 days post-surgery, PREVENA™ Therapy treated incisions had fewer genes differently expressed and showed reduced up-regulation of genes associated with inflammation, hypoxia, retardation of re-epithelialization, impaired wound healing, and scarring.
 - o These data suggest that short-term negative-pressure treatment over incisions may improve scar biomechanics compared to ABD pads, potentially enhancing tissue compliance and function, and reducing the likelihood of scar dehiscence.⁵⁴ However, these animal results have not been confirmed in humans.
 - o These results parallel a previous porcine incision study showed PREVENA™ Therapy treated incisions had significantly improved scar height grade versus Control-treated samples.⁷¹ Strength testing in that study also suggested that negative pressure may have greater effect at earlier stages of healing.⁷¹ A previous study by Aarabi and colleagues showed that increased strength of a healed incision may be a result of early reduced incisional tension, which has been shown to decrease hypertrophic scarring.⁷³ These results have not been confirmed for PREVENA™ Therapy or NPWT over closed incisions in humans.

The PREVENA™ Incision Management System also facilitates incision healing by protecting the incision from external contamination.

- The protection provided by the polyurethane layer was assessed by challenging the film with one of the smallest non-pathogenic viruses.
 - o The Phi-X174 bacteriophage (27nm in size)⁷⁴ was used in a phage penetration test.
 - o Test squares were cut from the polyurethane film drape on the dressing and clamped into a penetration test cell.
 - o The top side of the film was exposed to air and the bottom side of the film was in contact with the foam.
 - o A 60ml bacteriophage suspension was introduced into the top side of the test cell for 5 minutes.
 - o After this time, a 2 pound–force per square inch gauge (PSIG) pressure was applied to the viral suspension for a 1 minute interval.
 - o The film was monitored for penetration before and after pressure was applied.
 - o A total of 4 samples were prepared from the films at random locations.
 - o Resulting bacteriophage concentrations⁷⁵ are listed in **Table 8**.
 - o The biological assay and visual inspection showed no penetration.
 - o These results indicate that the exterior drape of the PREVENA™ Incision Dressing can act as a microbial barrier to viral contamination (as small as 27nm)⁷⁵ and bacterial sources.

CASE STUDIES

Clinical experience with the PREVENA™ Incision Management System is reported in the following case studies in which PREVENA™ Therapy was used over clean closed surgical incisions.

As with any case study, the results and outcomes should not be interpreted as a guarantee or warranty of similar results. Individual results may vary depending on the patient's circumstances and condition.

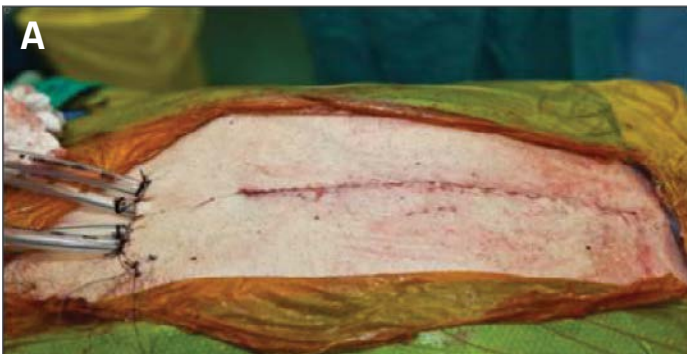
Case Study 1: Sternotomy Incision (Figure 9)

A 70-year-old male patient presented with a non-ST elevation myocardial infarction. Medical history included type II diabetes, peripheral vascular disease, renal insufficiency, hyperlipidemia and pulmonary hypertension. After further investigation, patient was diagnosed with triple vessel coronary artery disease and severe mitral insufficiency. An urgent triple coronary artery bypass grafting (CABG) and mitral valve replacement (MVR) were performed.

Due to the patient's critical state, comorbidities, and combined procedures, he was at elevated risk for postoperative incision complications (**Figure 9A**). The PREVENA™ Incision Dressing was applied along the incision with special care taken to leave enough distance between the inferior aspect of the incision and the chest tubes to secure a proper seal (**Figure 9B**). On postoperative Day 3, the patient cardiopulmonary arrested, requiring immediate resuscitative chest compressions. However, the integrity of the PREVENA™ Incision Dressing was maintained.

When the PREVENA™ Incision Dressing was removed, the incision edges appeared well apposed and were healing appropriately (**Figure 9C**). In contrast, the chest tube sites, which were not treated with PREVENA™ Therapy, demonstrated some drainage. The patient was discharged home on postoperative Day 18 with his incision continuing to heal well.

Figure 9. Postoperative CABG and MVR via sternotomy on a 70-year-old male patient. (A) Clean closed surgical incision. (B) Application of PREVENA™ Incision Management System. (C) Surgical incision following removal of PREVENA™ Incision Dressing.

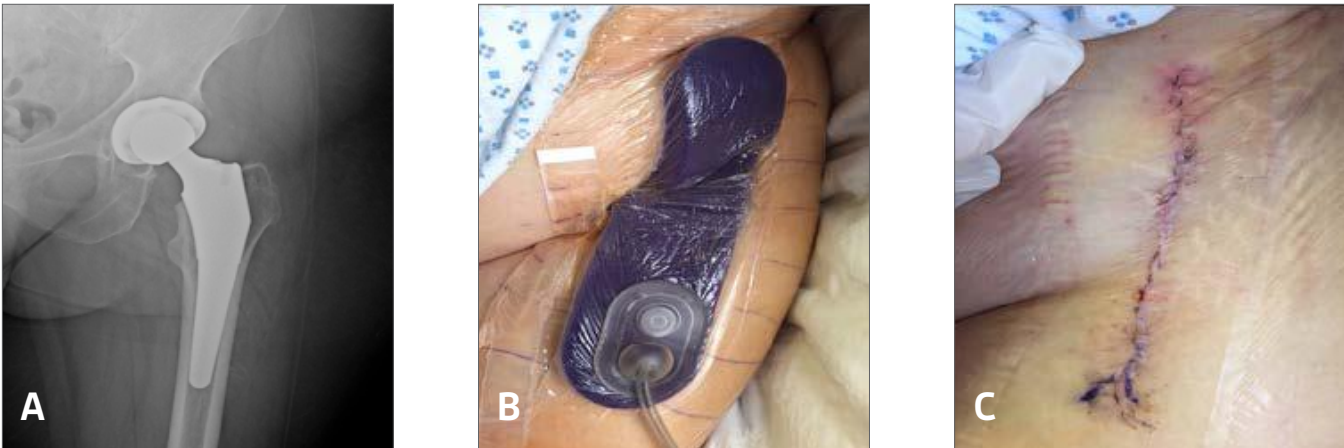


Patient data and photos courtesy of Broadus Z. Atkins, MD

Case Study 2: Total Hip Arthroplasty Revision (Figure 10)

A 68-year-old female underwent total hip arthroplasty (THA) revision for a femoral stress fracture. Medical history included previous hip surgery and Class I obesity (BMI = 32.6) at time of surgery. X-rays were performed to locate the original hip prosthesis (**Figure 10A**). After removal and replacement of the THA hardware, the PREVENA™ Incision Management System was applied over the incision (**Figure 10B**), and the PEEL & PLACE™ Dressing - 20cm remained in place until removal on Day 7 (**Figure 10C**).

Figure 10. Total hip arthroplasty (THA) revision on a 68-year-old female patient. **(A)** X-ray film of hip prosthesis. **(B)** Application of PREVENA™ Incision Management System with PEEL & PLACE™ Dressing - 20cm. **(C)** Incision after dressing removal on Day 7.



Patient data and photos courtesy of H. John Cooper, MD

Case Study 3: Total Knee Replacement (Figure 11)

A 47-year-old male with a history of refractory Hodgkin's lymphoma on chemotherapy fell down a flight of stairs and suffered a complex proximal tibial fracture (Figure 11A).

The patient received initial closed reduction and initial external fixation, after which he developed significant medial skin blisters and was eventually treated with open reduction with internal fixation with a lateral locking plate (Figure 11B). At 7 months post surgery, the patient had a range of motion of -5 to 75 degrees after multiple rounds of physical therapy (Figure 11C). He subsequently underwent a total knee arthroplasty after the removal of hardware and lysis of adhesions (Figure 11D).

Following the total knee arthroplasty, the PREVENA™ Incision Management System with the CUSTOMIZABLE™ Dressing (KCI, an Acelyty company, San Antonio, TX) was applied over the closed incision at -125mmHg (Figure 11E).

PREVENA™ Therapy was discontinued after 3 days (Figure 11F). Patient was discharged from the hospital on postoperative Day 3. At 2 weeks post surgery, the incision was progressing toward healing (Figure 11G). By 3 months post surgery, the patient had a range of motion of 0 to 110 degrees, and the incision had healed well with no drainage or incision problems (Figure 11H).

Figure 11. Total knee replacement on a 47-year-old male patient. (A) X-rays of complex tibial plateau fracture after falling down a flight of stairs. Patient had initial closed reduction and external fixator placement. (B) X-rays post open reduction and internal fixation. (C) X-rays at 7 months post surgery. Range of motion was -5 to 75 degrees after multiple rounds of physical therapy. (D) Removal of hardware and lysis of adhesions, showing the extensive incision/dissection for the total knee arthroplasty. (E) PREVENA™ Therapy with the CUSTOMIZABLE™ Dressing placed over the closed incision. (F) Incision after the CUSTOMIZABLE™ Dressing was removed on postoperative Day 3. (G) Incision 2 weeks post surgery. (H) Healed incision at 3 months post surgery.

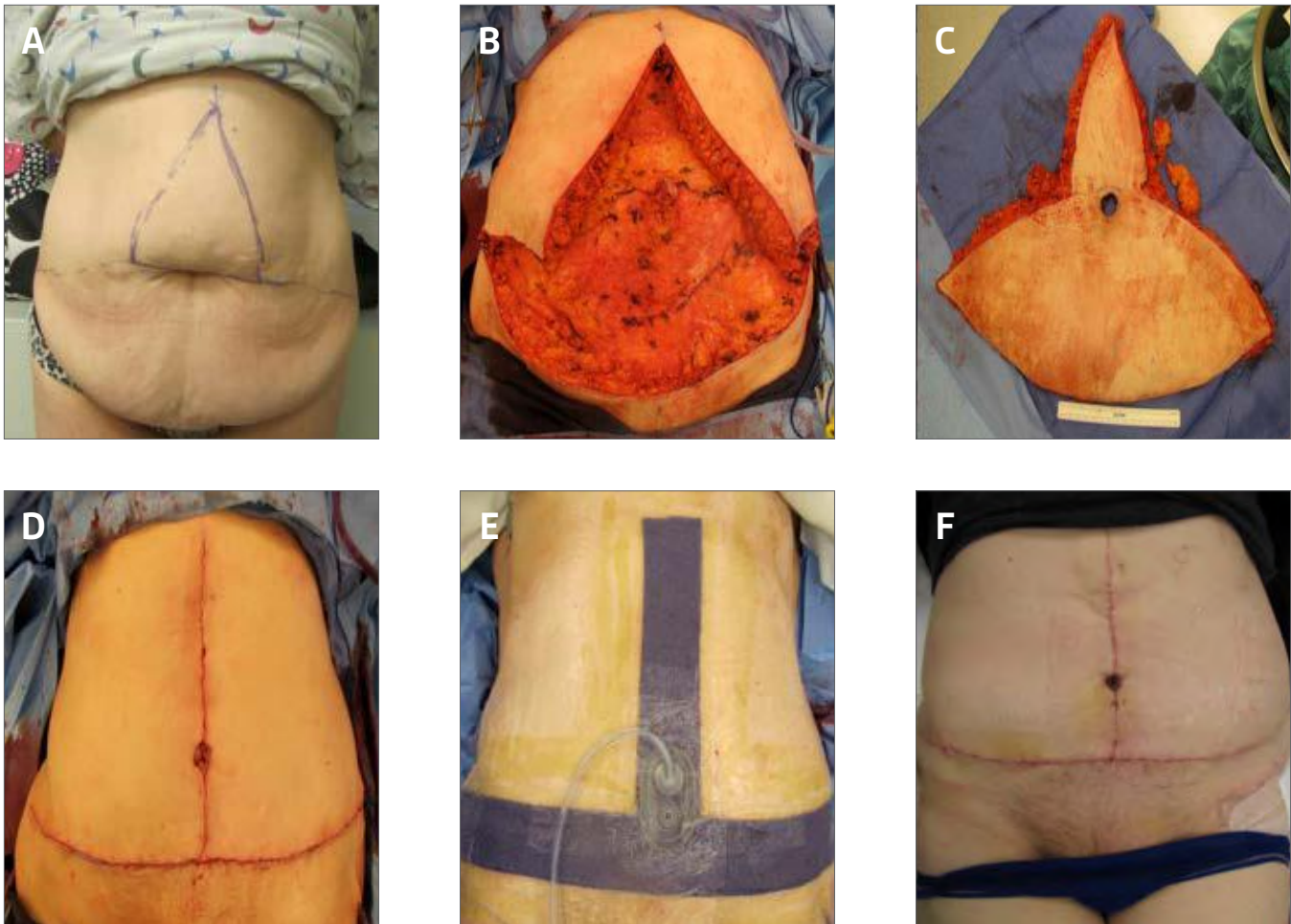


Patient data and photos courtesy of Dr. Ericka R. Johnson

Case Study 4: Abdominal Wall Reconstruction (Figure 12)

A 38-year-old obese female underwent abdominal Fleur-de-Lis style panniculectomy 1 year post-laparoscopic gastric bypass. The patient lost 85 pounds and had a stable weight for 6 months. Markings were performed with the patient in the standing position prior to surgery (**Figure 12A**). A Fleur-de-Lis pattern horizontal and vertical panniculectomy was performed, leaving the umbilicus in its natural position, attached to its stalk (**Figures 12B-C**). Primary closure was achieved with an inverted "T" pattern, using resorbable intradermal sutures (**Figure 12D**). The PREVENA™ CUSTOMIZABLE™ System was applied over the incision (**Figure 12E**) and remained in place until removal on Day 7 (**Figure 12F**). The patient did not have any postoperative incision complications.

Figure 12. Abdominal wall reconstruction on a 38-year-old female patient. **(A)** Surgical markings prior to surgery. **(B)** Surgical incision for panniculectomy. **(C)** Tissue that was removed. **(D)** Incision after primary closure. **(E)** Application of PREVENA™ Therapy. **(F)** Incision after dressing removal on Day 7.



Patient data and photos courtesy of Dr. Ron Silverman, University of Maryland, School of Medicine, Baltimore, MD and Senior Vice President and Chief Medical Officer, Acelyty, San Antonio, TX.

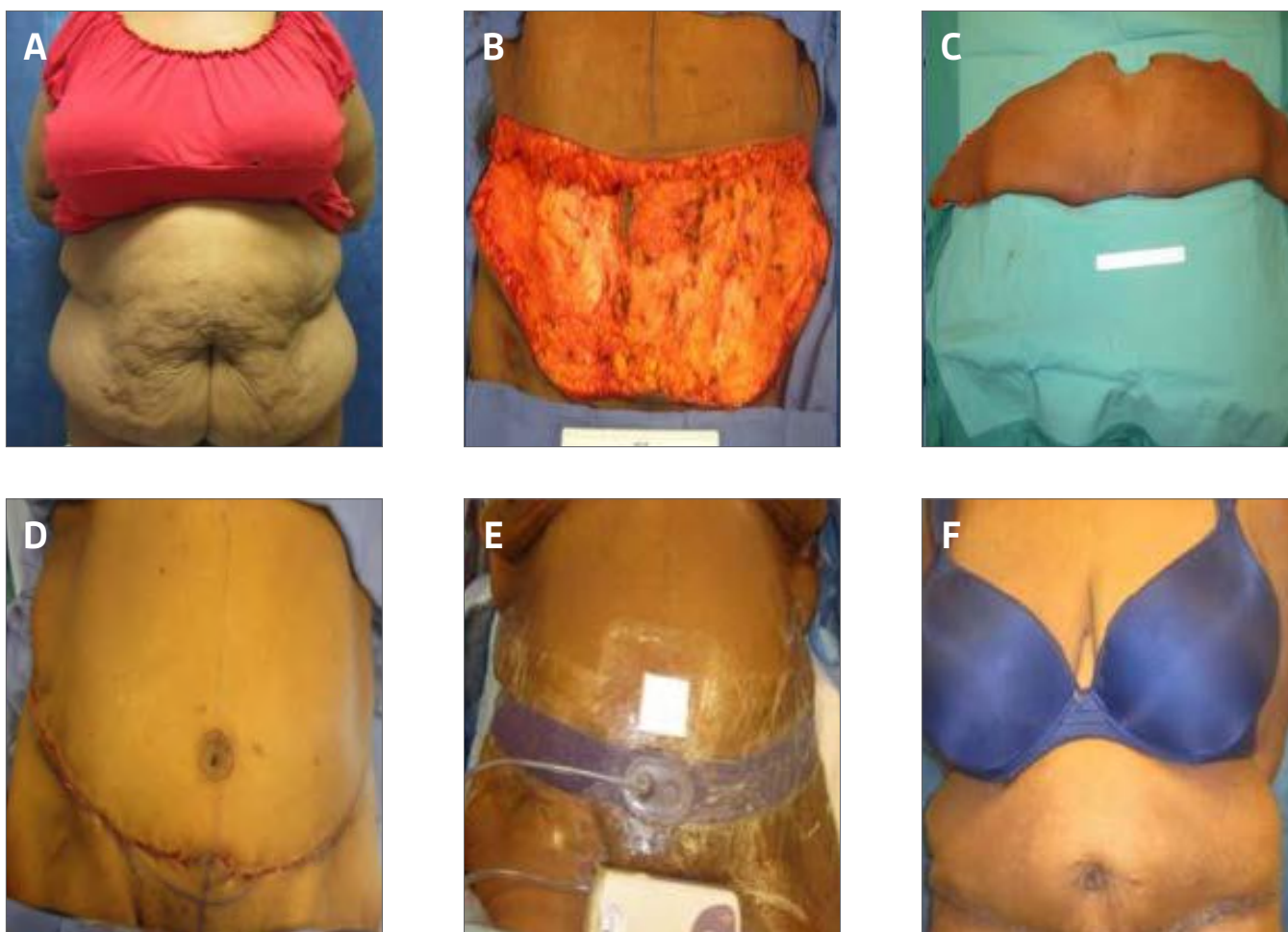
Case Study 5: Panniculectomy (Figure 13)

An obese female presented with end-stage renal disease. She was on dialysis and awaiting a renal transplant. However, the patient's transplant surgeon requested a plastic surgery consultation prior to her renal transplant to evaluate the patient for a panniculectomy for her large, overhanging abdominal pannus (**Figure 13A**) in order to reduce the complexity and risk of the renal transplant procedure.

Post panniculectomy (**Figures 13B and 13C**), PREVENA™ Incision Management System with the CUSTOMIZABLE™ Dressing (KCI, an Acelity company, San Antonio, TX) was placed over the complete closed incision at -125mmHg (**Figures 13D and 13E**). The patient was discharged home on postoperative Day 1 with the dressing in place.

PREVENA™ Therapy was discontinued after 7 days. At postoperative Day 13, the incision remained intact with good reapproximation (**Figure 13F**). The patient did not have any postoperative incision complications.

Figure 13. Panniculectomy for abdominal pannus on an obese female patient. **(A)** Patient with overhanging abdominal pannus. **(B)** Removal of pannus. **(C)** Removed pannus. **(D)** Completely closed incision. **(E)** Application of PREVENA™ Therapy for 7 days. **(F)** Incision at postoperative Day 13.



Patient data and photos courtesy of Dr. Devinder Singh and Dr. Ron Silverman, MD, FACS.

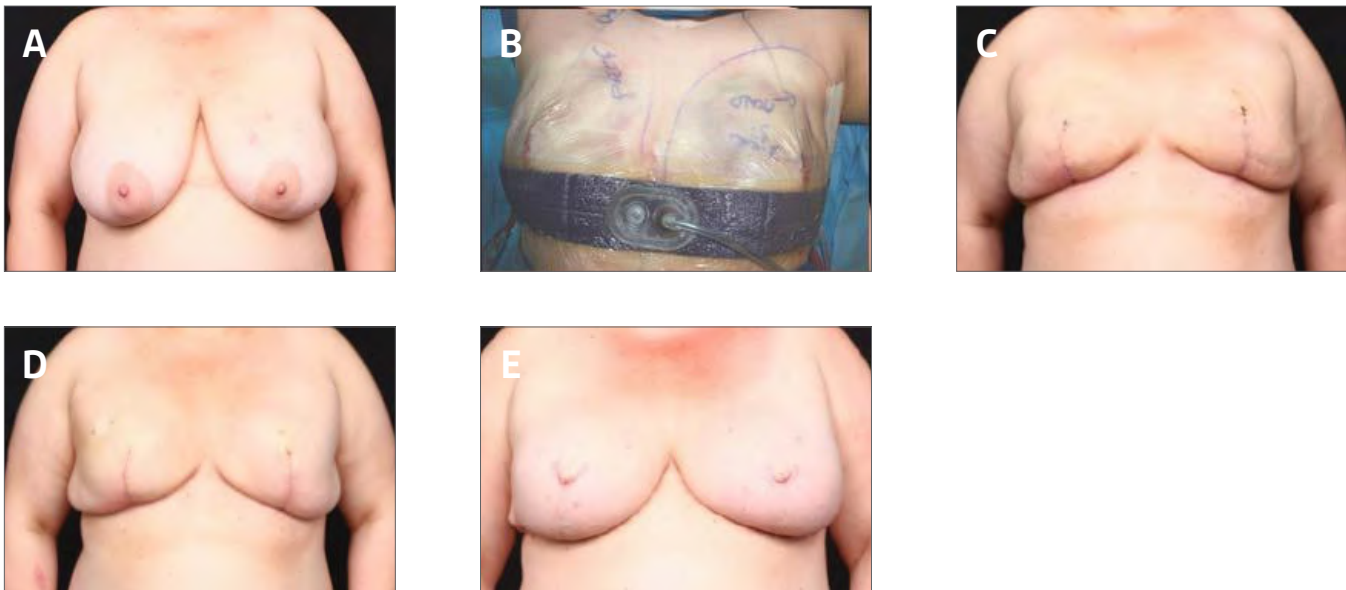
Case Study 6: Breast Reconstruction (Figure 14)

Patient was a 27-year-old female with a history of obesity, preoperative chemotherapy, and axillary dissection of the left breast. Patient (**Figure 14A**) received reduction-pattern mastectomy on both breasts.

Following surgery, the PREVENA™ Incision Management System with the CUSTOMIZABLE™ Dressing (KCI, an Acelyty company, San Antonio, TX) was placed over the complete closed incision at -125mmHg (**Figure 14B**).

PREVENA™ Therapy was discontinued after 5 days, and patient was discharged from the hospital on Day 6. The patient experienced a superficial dehiscence in the left breast in a location where the PREVENA™ Incision Management System did not cover; the dehiscence resolved with local wound care. Both incisions were intact at 4 weeks (**Figure 14C**) and remained intact at 2 months post mastectomy surgery (**Figure 14D**). Patient underwent breast reconstruction with silicone implants, fat injections, and nipple reconstruction with good results at 2 months post reconstruction surgery (**Figure 14E**).

Figure 14. Breast reconstruction on a 27-year-old female patient. **(A)** Patient prior to reduction pattern mastectomy. **(B)** Application of PREVENA™ Therapy following reduction pattern mastectomy. **(C)** 4-weeks post mastectomy surgery. **(D)** 2-months post mastectomy surgery. **(E)** 2-months post breast reconstruction surgery with silicone implants, fat injections, and nipple reconstruction.



Patient data and photos courtesy of Dr. Allen Gabriel.

Case Study 7: Cesarean Section (Figure 15)

Patient was a 30-year-old female, gravid 4, para 3 with a history of late prenatal care. Medical history also included anemia, smoking, pre-pregnancy weight of 250 lbs (BMI = 40.4), and Class III Obesity (BMI = 41.4) (Figure 15A) at time of surgery. Patient underwent a cesarean section (C-section) at 39-weeks gestation.

PREVENA™ Incision Management System with the PEEL & PLACE™ Dressing - 20cm was applied to the incision post C-section (Figure 15B).

PREVENA™ Therapy was discontinued after 7 days (Figures 15C and 15D).

Figure 15. Cesarean section on a 30-year-old female patient. (A) Day 0: Patient prior to surgery. (B) Day 0: Application of PREVENA™ Therapy. (C) Day 7: Dressing prior to removal. (D) Day 7: Surgical incision after dressing removal.



Patient data and photos courtesy of Dr. Lance T. Frye, Oklahoma State University Center for Health Sciences, Oklahoma City, OK.

HEALTH ECONOMICS – POTENTIAL ECONOMIC BENEFIT

Incisional negative pressure wound therapy after high-risk lower extremity fractures⁴

Stannard JP, Volgas DA, McGwin G III, et al. *J Orthop Trauma*. 2012;26(1):37-42.

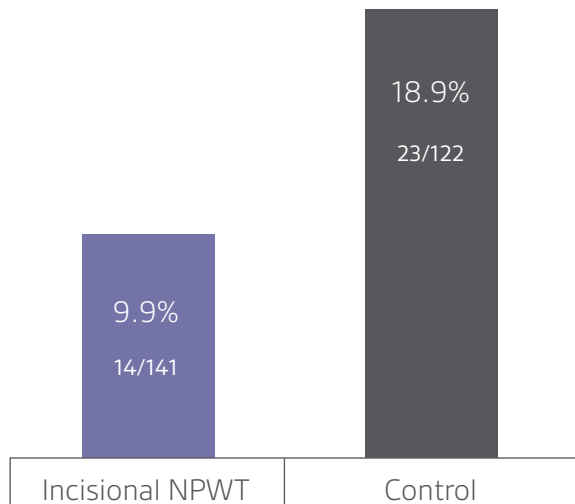
Clinical summary of Stannard study

| | | | |
|------------------|--|------------------|-------------------|
| Study Purpose | To investigate negative pressure wound therapy (NPWT) to prevent wound dehiscence and infection after high-risk lower extremity trauma. | | |
| Study Design | Prospective, randomized multicenter clinical trial | | |
| Subjects | 249 blunt trauma patients with one of three high risk fracture types (tibial plateau, pilon, calcaneus) requiring surgical stabilization | | |
| Treatment | <ul style="list-style-type: none"> Incisional NPWT at -125mmHg, applied equivalently to PREVENA™ Therapy: 130 patients Standard post-operative dressings: 119 patients | | |
| Outcome measures | Acute and chronic wound dehiscence and infection | | |
| Results | | Incisional NPWT* | Control |
| | Patients | 130 | 119 |
| | Fractures | 141 | 122 |
| | Total Infections | 14 | 23 |
| | Percentage Infection | 9.9% | 18.9% $p = 0.049$ |
| | Total Dehiscence | 12 | 20 |
| | Percentage Dehiscence | 8.6% | 16.5% $p = 0.044$ |

*PREVENA™ Therapy is functionally equivalent to the incisional NPWT reported in this study, and the reported clinical outcomes can be applied to PREVENA™ Therapy.

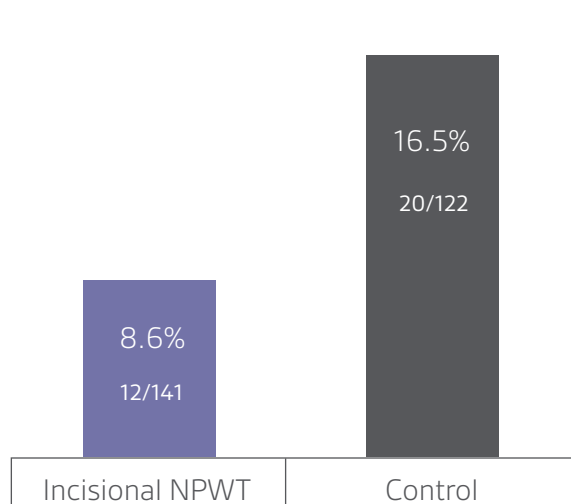
Infection Rate

$p = 0.049$



Dehiscence Rate

$p = 0.044$



Economic analysis of the Stannard clinical study results, using Thompson Cost Data⁷⁶

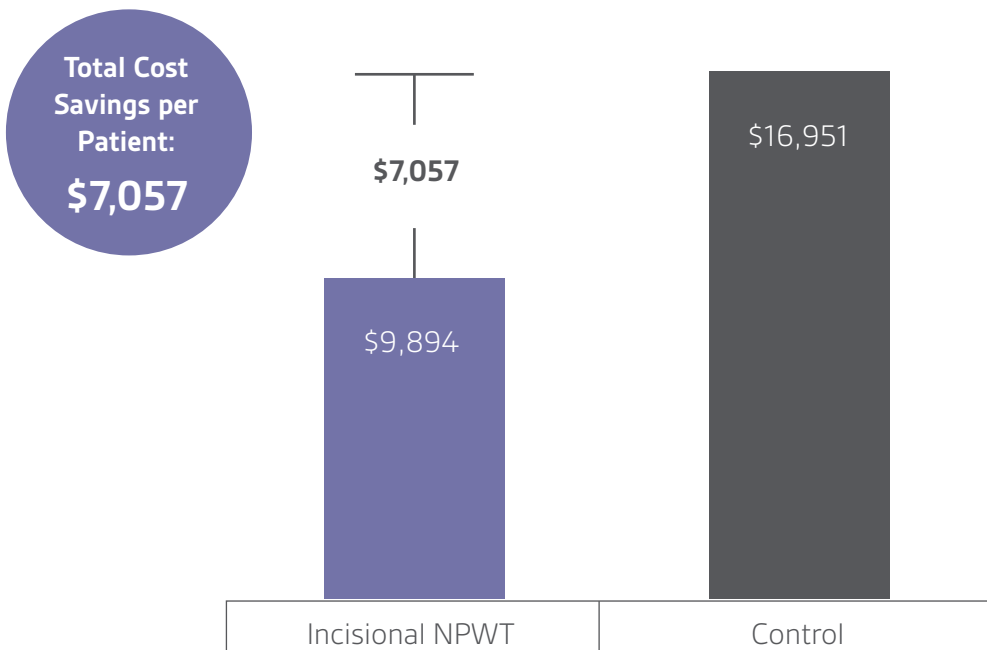
| Orthopedic Incisions | Incisional NPWT | Control |
|---|-----------------|-------------|
| Patients | 130 | 119 |
| Number of Infections* | 14 | 23 |
| Number of Dehiscence* | 12 | 20 |
| Total Infection Cost (Incremental cost of infection = \$64,611 per patient) | \$904,554 | \$1,486,053 |
| Total Dehiscence Cost (Incremental cost of dehiscence = \$26,447 per patient) | \$317,364 | \$528,940 |
| Per Patient Infection Cost (Total Infection Cost / number of patients) | \$6,958 | \$12,488 |
| Per Patient Dehiscence Cost (Total Dehiscence Cost / number of patients) | \$2,441 | \$4,445 |
| Per Patient Cost of Therapy** | \$495 | \$18 |
| Total Cost Per Patient | \$9,894 | \$16,951 |

* Model assumes that patients could only have 1 infection and 1 dehiscence.

** KCI estimate based on price of PREVENA™ PEEL & PLACE™ System and Control therapy (gauze) changed once a day at \$18 a week.

The model uses select study data to provide an illustration of estimates of costs for use of PREVENA™ Therapy or Standard of Care (Control). This model is an illustration and not a guarantee of actual individual costs, savings, outcomes or results. The hospital is advised to use this model as an illustration only to assist in an overall assessment of products and pricing.

Total Cost per Stannard Patient



Prevention of poststernotomy wound infections in obese patients by negative pressure wound therapy³¹

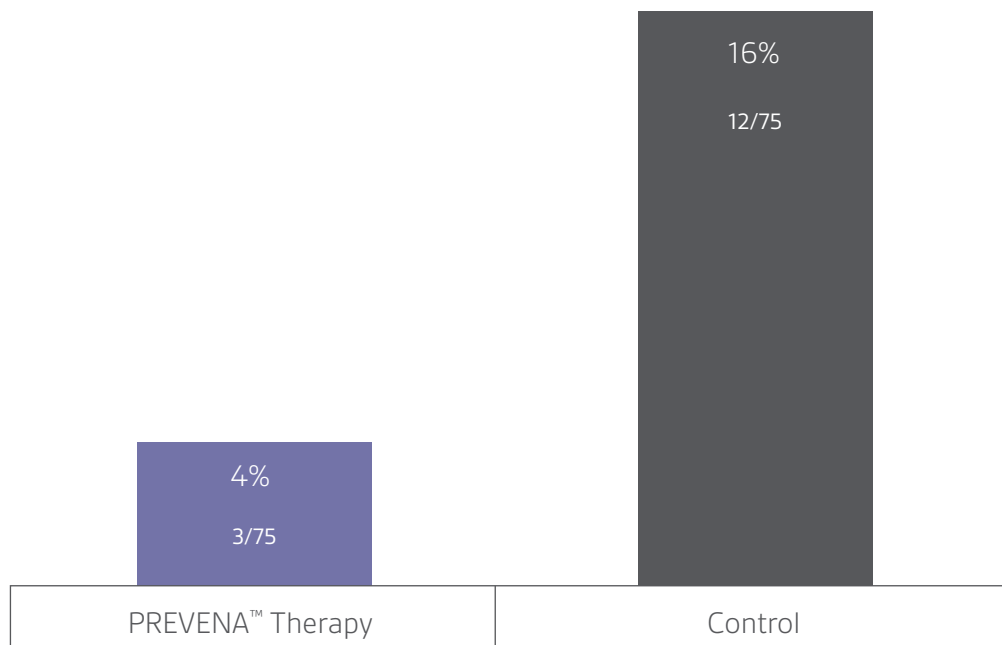
Grauhan O, Navasardyan A, Hofmann M, et al. J Thorac Cardiovasc Surg 2013; 145: 1387 - 92

Clinical summary of Grauhan study

| | | | |
|------------------|---|------------------|-------------------|
| Study Purpose | The majority of wound infections after median sternotomy in obese patients are triggered by the breakdown of skin sutures and subsequent seepage of skin flora. The purpose of this study was to evaluate negative pressure wound dressing treatment for the prevention of infection. We hypothesized that negative pressure wound dressing treatment for 6 to 7 days applied immediately after skin closure reduces the numbers of wound infections. | | |
| Study Design | Prospective, single center clinical trial | | |
| Subjects | 150 patients with a BMI of 30 kg/m ² with cardiac surgery via median sternotomy | | |
| Treatment | <ul style="list-style-type: none"> • PREVENA™ Therapy: 75 patients • Standard post-operative dressings: 75 patients | | |
| Outcome measures | Infection within 90 days | | |
| Results | | PREVENA™ Therapy | Control |
| | Patients | 75 | 75 |
| | Total Infections | 3 | 12 |
| | Percentage Infection | 4% | 16% |
| | | | <i>p</i> = 0.0266 |

Infection Rate³¹

p = 0.0266

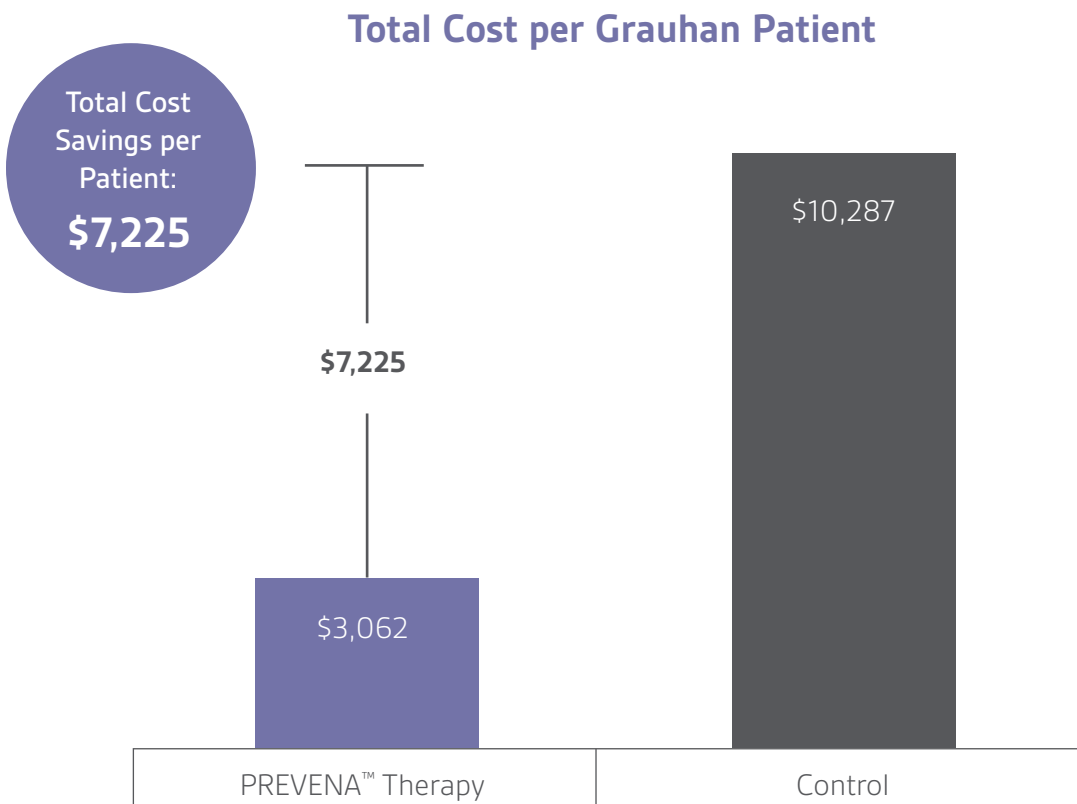


Economic analysis of the Grauhan clinical study results, using Thompson Cost Data⁷⁷

| Sternotomy Incisions | PREVENA™ Therapy | Control |
|---|------------------|------------|
| Patients | 75 | 75 |
| Number of Infections | 3 (4.0%) | 12 (16.0%) |
| Total Infection Cost (Incremental cost of infection = \$64,183 per patient) | \$192,549 | \$770,196 |
| Per Patient Infection Cost (Total Infection Cost / number of patients) | \$2,567 | \$10,269 |
| Per Patient Cost of Therapy* | \$495 | \$18 |
| Total Cost Per Patient | \$3,062 | \$10,287 |

* KCI estimate based on price of PREVENA™ PEEL & PLACE™ System and Control therapy (gauze) changed once a day at \$18 a week.

The model uses select study data to provide an illustration of estimates of costs for use of PREVENA™ Therapy or Standard of Care (Control). This model is an illustration and not a guarantee of actual individual costs, savings, outcomes or results. The hospital is advised to use this model as an illustration only to assist in an overall assessment of products and pricing.



Experience with a new negative pressure incision management system in prevention of groin wound infection in vascular surgery patients³⁶

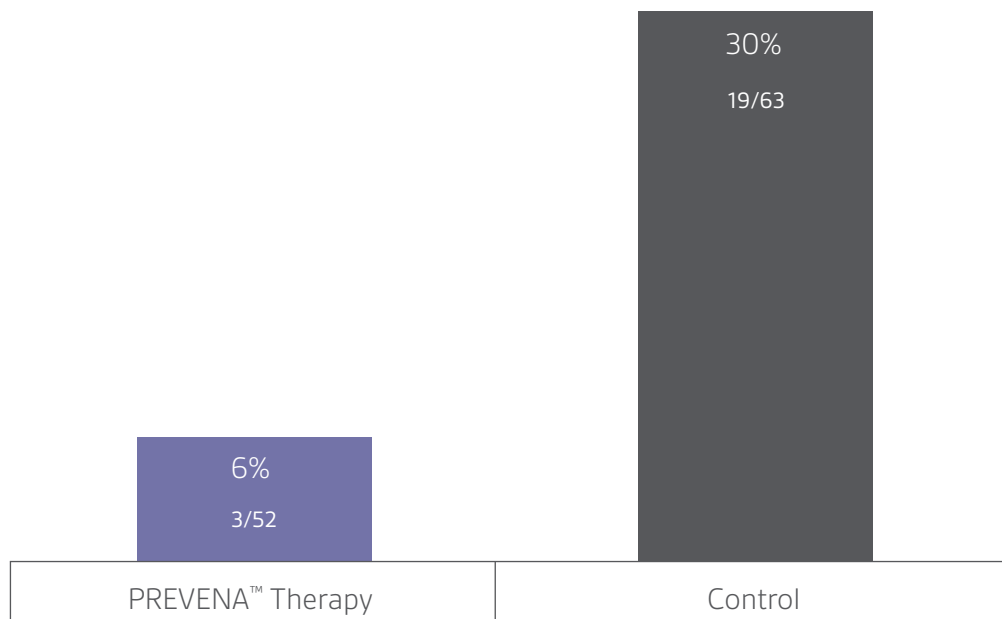
Matatov T, Reddy KN, Doucet LD, et al. J Vasc Surg 2013 January 9.

Clinical summary of Matatov study

| | | | |
|------------------|---|------------------|---|
| Study Purpose | Groin wound infection is an important cause of postoperative morbidity in vascular surgery patients, especially when prosthetic grafts are involved. The objective of this study was to investigate if PREVENA™ Therapy, a negative pressure incision management system, could reduce the risk of groin wound infection in patients after vascular surgery. | | |
| Study Design | Retrospective chart review of consecutive patients at a single center | | |
| Subjects | 90 patients with 115 groin incisions who underwent femoral cutdown for vascular procedures. | | |
| Treatment | <ul style="list-style-type: none"> • PREVENA™ Therapy: 41 patients • Skin adhesive or absorbent dressing: 49 patients | | |
| Outcome measures | Groin wound infection, graded based on Szilgyi classifications. | | |
| Results | | PREVENA™ Therapy | Control |
| | Patients | 41 | 49 |
| | Incisions | 52 | 63 |
| | Total Infections | 3 (all grade I) | 19 (10 grade I; 7 grade II and 2 grade III) |
| | Percentage Infection | 6% | 30% |

Infection Rate³⁶

$p = 0.0011$



Economic analysis of the Matatov clinical study results, using Thompson Cost Data⁷⁸

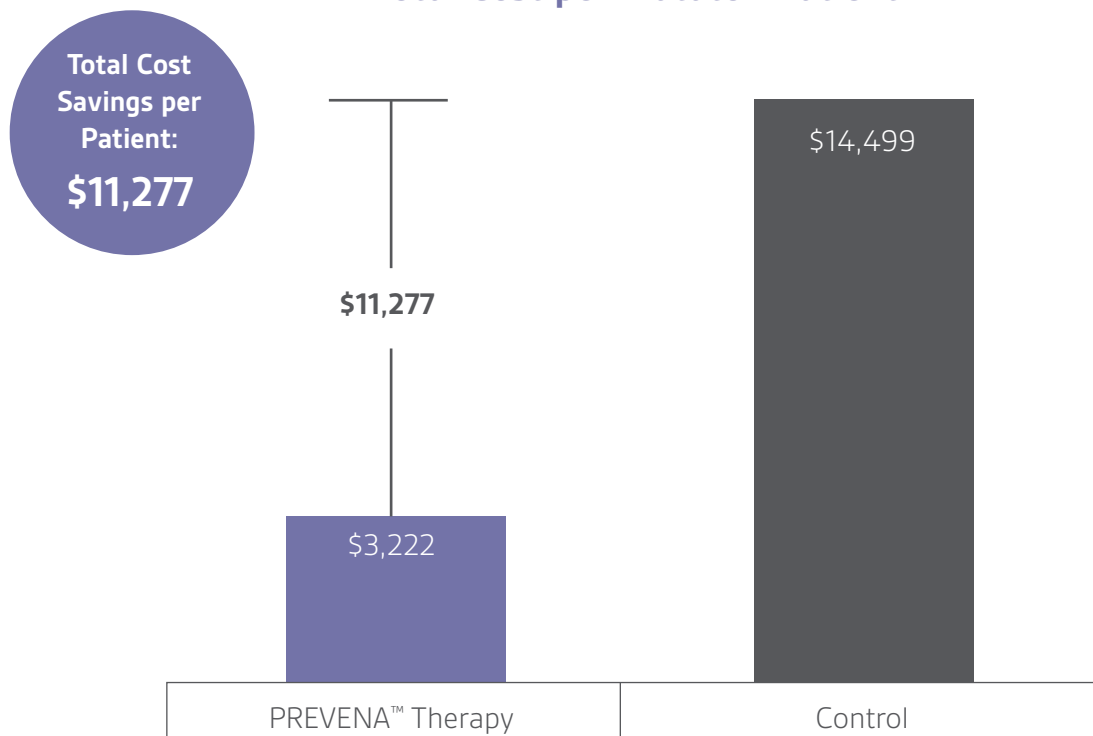
| Groin Incisions | PREVENA™ Therapy | Control |
|---|------------------|-----------|
| Patients | 41 | 49 |
| Incisions | 52 | 63 |
| Number of Infections* | 3 | 19 |
| Total Infection Cost (Incremental cost of infection = \$37,274 per patient) | \$111,822 | \$708,206 |
| Per Patient Infection Cost (Total Infection Cost / number of patients) | \$2,727 | \$14,453 |
| Per Patient Cost of Therapy** | \$495 | \$46 |
| Total Cost Per Patient | \$3,222 | \$14,499 |

* Model assumes that patients could only have 1 infection.

**KCI estimate based on PREVENA™ PEEL & PLACE™ System and non-PREVENA™ Therapy of DERMABOND™ being changed once a week at \$45.83 (\$275/6 for 6 vials), see: <http://www.claflinquip.com/ethicon-high-viscosity-dermabond-topical-skin-adhesive.html?childid=60829#60829>

The model uses select study data to provide an illustration of estimates of costs for use of PREVENA™ Therapy or DERMABOND™ (Control). This model is an illustration and not a guarantee of actual individual costs, savings, outcomes or results. The hospital is advised to use this model as an illustration only to assist in an overall assessment of products and pricing.

Total Cost per Matatov Patient



DERMABOND is a trademark of Ethicon, Inc.

Incisional Negative Pressure Wound Therapy Significantly Reduces Surgical Site Infection in Open Colorectal Surgery³⁸

Bonds AM, Novick TK, Dietert JB, et al. Dis Colon Rectum. 2013;56(12):1403-1408. Note: see sub set data page 1406

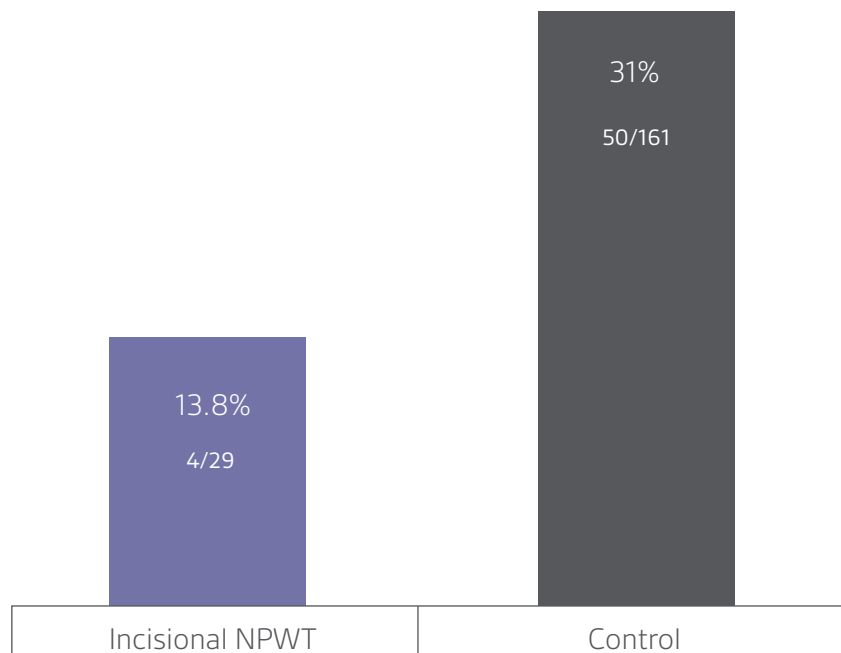
Clinical summary of Bonds study

| | | | |
|------------------|---|------------------|------------------|
| Study Purpose | Surgical site infections in colorectal surgery remain a common problem and are associated with an increase in cost of care and length of stay. This study aims to evaluate the effect of known risk factors and the use of incisional negative pressure wound therapy on surgical site infection rates. | | |
| Study Design | Retrospective chart review at two main hospitals in a single tertiary academic medical center. | | |
| Subjects | 190 non-emergent patients undergoing open colectomy from 2009 and 2011 were studied. | | |
| Treatment | <ul style="list-style-type: none"> • Incisional NPWT at -75mmHg, applied equivalently to PREVENA™ Therapy: 29 • Occlusive dressings: 161 | | |
| Outcome measures | Presence or absence of surgical site infection | | |
| Results | | Incisional NPWT* | Control |
| | Patients | 29 | 161 |
| | Total Infections | 4 | 50 |
| | Percentage Infection | 13.8% | 31% |
| | | | <i>p</i> = 0.036 |

*PREVENA™ Therapy is functionally equivalent to the incisional NPWT reported in this study, and the reported clinical outcomes can be applied to PREVENA™ Therapy.

Infection Rate³⁸

p = 0.036

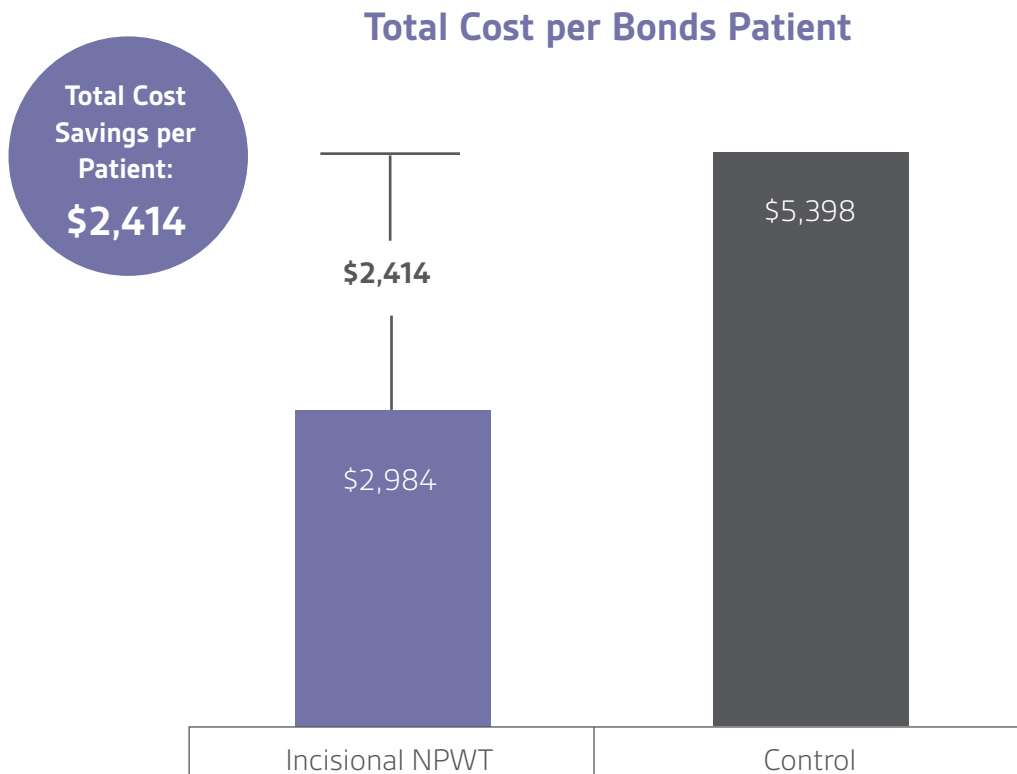


Economic analysis of the Bonds clinical study results, using Thompson Cost Data⁷⁹

| Colorectal Incisions | Incisional NPWT | Control |
|---|-----------------|-----------|
| Patients | 29 | 161 |
| Number of Infections | 4 | 50 |
| Total Infection Cost (Incremental cost of infection = \$17,324 per patient) | \$69,296 | \$866,200 |
| Per Patient Infection Cost (Total Infection Cost / number of patients) | \$2,389 | \$5,380 |
| Per Patient Cost of Therapy* | \$595 | \$18 |
| Total Cost Per Patient | \$2,984 | \$5,398 |

* KCI estimate based on the price of CUSTOMIZABLE™ Dressing System to Control therapy (gauze) changed once a day at \$18 a week.

The model uses select study data to provide an illustration of estimates of costs for use of PREVENA™ Therapy or DERMABOND™ (Control). This model is an illustration and not a guarantee of actual individual costs, savings, outcomes or results. The hospital is advised to use this model as an illustration only to assist in an overall assessment of products and pricing.



SUMMARY

This monograph contains a review of clinical journal and conference literature on the use of closed incision negative pressure therapy (ciNPT) and PREVENA™ Therapy. Additionally, it describes the bench testing, computer modeling, and published scientific studies of proposed biomechanical and physiological mechanisms of the PREVENA™ Incision Management System. Actual patient results are presented as case studies to transition from scientific evidence to clinical experience. Additional clinical research is still needed to fully understand the scientific and medical impact of incisional (ciNPT) and the PREVENA™ Incision Management System in the surgical arena.

Table 1. Comparison of Dressing Materials

| Dressing Component | Incisional V.A.C.® Therapy Dressing Configuration | PEEL & PLACE™ Dressing and CUSTOMIZABLE™ Dressing Configuration |
|-----------------------------------|--|--|
| Skin interface layer | Non-adhering Dressing (petrolatum-coated gauze dressing) | Fabric with 0.019% silver (currently marketed as InterDry™ Ag [Coloplast®, Minneapolis, MN], which is used for skin fold management) |
| Foam bolster (no patient contact) | V.A.C.® GRANUFOAM™ Dressing (polyurethane foam with black pigment) | Same V.A.C.® GRANUFOAM™ Dressing (with black pigment replaced by pigment violet 23) |
| Drape | V.A.C.® Drape (polyurethane film with acrylic adhesive) | Polyurethane film with acrylic adhesive |

Table 2. ASPS Evidence Rating Scale for Therapeutic Studies²⁷

| Level of Evidence | Qualifying Studies |
|-------------------|--|
| I | High-quality, multicenter or single-center, randomized controlled trial with adequate power; or systematic review of these studies |
| II | Lesser-quality, randomized controlled trial; prospective cohort or comparative study; or systematic review of these studies |
| III | Retrospective cohort or comparative study; case-control study; or systematic review of these studies |
| IV | Case series with pre/post test or only post test |
| V | Expert opinion developed via consensus process; case report or clinical example; or evidence based on physiology, bench research or “first principles” |

Table 3. Literature review of the use of NPWT and PREVENA™ Therapy over surgical incisions


| Author | Study Type | Patients | Results/Conclusions |
|--|---|---|--|
| Stannard JP, et al. ⁴ <i>(Journal of Orthopaedic Trauma, 2012)</i> | RCT V.A.C.® Therapy (NPWT) vs. Standard Postoperative Dressings  | <ul style="list-style-type: none"> • 249 patients with 263 calcaneus, pilon and tibial plateau fractures • Randomization: NPWT, 130 patients (141 fractures) vs. Control, 119 patients (122 fractures). | <ul style="list-style-type: none"> • Significant decrease for incidence of dehiscence (12 cases [NPWT] vs. 20 cases [Control]; $p = 0.044$) • Significant decrease for total infections (14 cases [NPWT] vs. 23 cases [Control]; $p = 0.049$) • Incidence of acute infection trended lower with NPWT (1 case) vs. control (5 cases) |

Table 3. Literature review of the use of NPWT and PREVENA™ Therapy over surgical incisions (cont.)





| Author | Study Type | Patients | Results/Conclusions |
|---|--|--|---|
| <p>Stannard JP, et al.³ <i>(Journal of Trauma, 2006)</i></p> | <p>RCT (Interim Analysis) V.A.C.® Therapy (NPWT) vs. Standard Postoperative Dressings</p>  | <ul style="list-style-type: none"> • 44 patients with high-energy trauma wounds with draining hematomas (31 Control and 13 NPWT) • 44 patients with high-energy fractures (24 Control and 20 NPWT) | <ul style="list-style-type: none"> • High-energy trauma wounds: Control group drained a mean of 3.1 days compared to only 1.6 days for NPWT ($p = 0.03$) • High-energy fractures: Control group drained a mean of 4.8 days compared to only 1.8 days for NPWT ($p = 0.02$) |
| <p>Masden, et al.²⁸ <i>(Annals of Surgery, 2012)</i></p> | <p>RCT NPWT vs. Standard dry silver dressings (Control)</p>  | <ul style="list-style-type: none"> • 81 high-risk patients with multiple comorbidities whose closed surgical incisions with treated with: <ul style="list-style-type: none"> ◦ NPWT ($n = 44$) ◦ Control ($n = 37$) • Majority (74/81) of patients underwent lower extremity wound closure post amputation. • All incisions were evaluated on postoperative day 3, at first outpatient visit, and at subsequent visits. Average follow-up period was 113 days. | <ul style="list-style-type: none"> • No differences in demographic, preoperative, and operative variables between groups • Wound complication rates did not achieve statistical significance between the groups: <ul style="list-style-type: none"> ◦ Infection: NPWT, 3/44 (6.8%) vs. Control, 5/37 (13.5%), $p = 0.46$ ◦ Dehiscence: NPWT, 16/44 (36.4%) vs. Control, 11/37 (29.7%), $p = 0.53$ ◦ Reoperation: NPWT, 9/44 (21%) vs. Control, 8/37 (22%), $p = 0.89$ ◦ Overall, 40% of NPWT and 35% of Control groups experienced wound infection, dehiscence, or both |
| <p>Pachowsky M, et al.²⁹ <i>(International Orthopaedics, 2011)</i></p> | <p>RCT PREVENA™ Incision Management System (NPWT) vs. Standard Postoperative Dressings</p>  | <ul style="list-style-type: none"> • 19 patients (10 Control and 9 NPWT) with closed incisions after total hip arthroplasty. • Postoperative seromas were measured in both groups on the fifth and tenth postoperative days. | <ul style="list-style-type: none"> • Significantly decreased development of postoperative seromas in the NPWT group on postoperative day 10 (average volume of 1.97ml) compared to Control (5.08ml) ($p = 0.021$) • A seroma was present in 44% of the NPWT patients and 90% of the Control patients • The NPWT group received significantly fewer days of antibiotics (8.44 ± 2.24 vs. 11.8 ± 2.82 days, $p = 0.005$) • A secretion in the wound after day 5 was reported in fewer patients in the NPWT group (1 vs. 5 patients) |
| <p>Pauser J, et al.³⁰ <i>(International Wound Journal, 2014)</i></p> | <p>RCT PREVENA™ Incision Management System (NPWT) vs. Standard Postoperative Dressings</p>  | <ul style="list-style-type: none"> • 21 patients with femoral neck fractures (FNF) treated with hip hemiarthroplasty (HA) who were randomized to receive either incision NPWT (ciNPT) or standard postoperative dressings (Control) over clean sutured wounds. <ul style="list-style-type: none"> ◦ Control: 10 patients ◦ ciNPT (PREVENA™ Therapy): 11 patients • There were no differences in patient age, coagulation time, postoperative wound size, or wound secretion volume. | <ul style="list-style-type: none"> • Compared to the Control, ciNPT patients had: <ul style="list-style-type: none"> ◦ Reduced seroma volume at postoperative day 5 (0.257 ± 0.75 cm³ vs. 3.995 ± 5.01 cm³, respectively; $p < 0.05$); at postoperative day 10, no difference was reported ◦ Fewer days of wound secretions (0.9 ± 1.0 days vs. 4.3 ± 2.45 days, respectively; $p = 0.0005$) ◦ Fewer dressing changes (5.4 vs. 9.5, respectively; $p < 0.0001$) ◦ Reduced time (and materials) for dressing changes (14.9 ± 3.9 minutes vs. 42.9 ± 11.0 minutes, respectively; $p < 0.0001$) • The authors concluded using ciNPT for closed wounds in the HA setting "might help to reduce complications of prolonged wound healing and postoperative seroma in the wound...and save time needed for wound care." |

Table 3. Literature review of the use of NPWT and PREVENA™ Therapy over surgical incisions (cont.)




| Author | Study Type | Patients | Results/Conclusions |
|---|--|--|---|
| <p>Grauhan O, et al.³¹ <i>(Journal of Thoracic and Cardiovascular Surgery, e-pub 2012)</i></p> | <p>Prospective Comparative Study</p> <p>PREVENA™ Incision Management System (NPWT) vs. conventional sterile wound dressings (Control)</p>  | <ul style="list-style-type: none"> 150 consecutive obese (BMI ≥ 30) patients, whose sternotomy wound incisions were treated with: <ul style="list-style-type: none"> PREVENA™ Therapy (n = 75) Control (n = 75) Primary study endpoint: Wound infection within 90 days Patients allocated to treatment groups by alternating based on time of operation. <ul style="list-style-type: none"> Patients with diabetes assigned "half and half to both groups, with priority." Dressing changes: <ul style="list-style-type: none"> PREVENA™ Therapy: Placed under sterile OR conditions; kept at -125mmHg for the first 6 to 7 postoperative days. Control: Changed on the first or second postoperative day and every 1-2 days thereafter. No significant preoperative patient differences between groups. All patients followed for at least 90 days. | <ul style="list-style-type: none"> PREVENA™ Therapy group, compared to Control group, had significantly fewer <ul style="list-style-type: none"> Wound infections: 3/75 (4%) vs. 12/75 (16%), respectively; $p = 0.0266$; odds ratio, 4.57; 95% confidence interval (CI), 1.23-16.94. Patients whose wound infections had Gram-positive skin flora: 1 vs. 10, respectively; $p = .0090$; odds ratio, 11.39; 95% CI, 1.42-91.36. Timing of wound infection incidence: <ul style="list-style-type: none"> PREVENA™ Therapy group: 71/75 (95%) of the incisions were primarily closed when the dressing was removed in 6 to 7 days. No wound infections occurred after postoperative day 7. Control group: 9/12 wound infections occurred beyond postoperative day 7 and up to day 35. Authors concluded that PREVENA™ Therapy over clean, closed surgical incisions for the first 6 to 7 postoperative days significantly reduced wound infection after median sternotomy for high-risk obese cardiac surgery patients |
| <p>Weir G³² <i>(International Wound Journal, 2014)</i></p> | <p>Prospective Case-Control Pilot Study</p> <p>PREVENA™ Incision Management System (NPWT) vs. conventional postoperative wound dressings (Control)</p>  | <ul style="list-style-type: none"> Eight patients undergoing vascular bypass procedures Patients required bilateral femoral access. PREVENA™ Therapy was placed on one femoral area; contralateral femoral area received standard post-operative dressing (Control). Patients required intra-operative heparin and postoperative anti-coagulation therapy. Patients had at least one of the following risk factors for development of wound complications: obesity, diabetes, hypertension, hypercholesterolemia, smoking within 6 weeks prior to surgery, and HIV/AIDS. | <ul style="list-style-type: none"> Wound complications requiring surgical intervention occurred in three of the control wounds, while no wound complications occurred where PREVENA™ Therapy was applied. The authors suggested that using PREVENA™ Therapy in high-risk patients undergoing vascular surgery potentially reduced wound complications with no observable increase in hemorrhage. |
| <p>Grauhan O, et al.³³ <i>(International Wound Journal, 2014)</i></p> | <p>Prospective Comparative Study</p> <p>PREVENA™ Incision Management System (NPWT) vs. conventional sterile wound dressings (Control)</p>  | <ul style="list-style-type: none"> 3745 cardiac surgery patients undergoing sternotomy <ul style="list-style-type: none"> PREVENA™ Therapy (n = 237) Control (n = 3,508) Primary study endpoint: Wound infection within 30 days Dressing changes <ul style="list-style-type: none"> PREVENA™ Therapy: Applied immediately after skin suturing and remained in place for 6-7 days. Control: Changed on the first or second postoperative day and every 1-2 days thereafter. All patients followed for at least 30 days | <ul style="list-style-type: none"> The PREVENA™ Therapy group had a significantly lower infection rate than the Control group: 3/237 (1.3%) vs. 119/3508 (3.4%), respectively; $p < 0.05$; odds ratio 2.74. In the PREVENA™ Therapy group, 234/237 (98.7%) of the incisions were primarily closed when the dressing was removed 6-7 days after application. The authors concluded using PREVENA™ Therapy for the first 6-7 days over clean, closed surgical incisions reduced the incidence of postoperative wound infections, and the reduced rate in wound infections may be cost effective for patients, hospitals, and health insurance companies. |

Table 3. Literature review of the use of NPWT and PREVENA™ Therapy over surgical incisions (cont.)




| Author | Study Type | Patients | Results/Conclusions |
|--|---|---|--|
| <p>Swift SH, et al.³⁴ <i>(Journal of Reproductive Medicine, 2015)</i></p> | <p>Prospective Comparative Study</p> <p>PREVENA™ Therapy (NPWT)</p>  | <ul style="list-style-type: none"> 319 women at increased risk for infectious morbidity and wound complications after cesarean delivery <ul style="list-style-type: none"> Control: 209 patients NPWT: 110 patients Patients were followed as part of postpartum care or were followed up at 6 weeks postpartum. | <ul style="list-style-type: none"> Compared to the Control, NPWT patients had: <ul style="list-style-type: none"> Fewer postoperative complications (21.0% vs. 6.4%, respectively; $p = 0.0007$) Fewer wound infections (11.5% vs. 2.7%, respectively; $p = 0.008$) Fewer cases of endometritis (6.7% vs. 0.9%, respectively; $p = 0.023$) Approximately the same number of wound separation cases (3.8% vs. 2.7%, respectively; $p = 0.754$) The NPWT group, who were at increased risk for postoperative infections and wound complications, had significant reductions in deep and superficial infectious morbidity after the NPWT system was applied to closed cesarean section incisions. |
| <p>Reddix RN, et al.⁸ <i>(Journal of Surgical Orthopaedic Advances, 2010)</i></p> | <p>Retrospective Review of Patient Records</p> <p>V.A.C.® Therapy (NPWT) vs. Standard Postoperative Dressings (Control)</p>  | <ul style="list-style-type: none"> 66 patients with acetabular fractures treated with standard postoperative care (Control) 235 patients with acetabular fractures treated with NPWT | <ul style="list-style-type: none"> The authors noted that their infection rate of 1.27% represented a significant decrease in comparison to other groups (infection rates of 4.2%,⁵⁶ 4%,⁵⁷ and 5%⁵⁸) of similar size ($p = 0.0282$; reference rate = 4%). Application of NPWT over incisions decreased incidence of perioperative incision complications at the author's institution. |
| <p>Tauber R, et al.³⁵ <i>(Journal of Plastic, Reconstructive and Aesthetic Surgery, 2013)</i></p> | <p>Retrospective Review of Patient Records</p> <p>V.A.C.® Therapy (NPWT) vs. Conventional Compression Dressings (Control)</p>  | <ul style="list-style-type: none"> 24 patients who underwent 45 inguinal lymph node dissections (LNDs) as treatment for penile or urethral cancer <ul style="list-style-type: none"> NPWT: 8 patients (15 LNDs) Control: 16 patients (30 LNDs) | <ul style="list-style-type: none"> NPWT was applied using V.A.C.® WHITEFOAM™ Dressing, and NPWT dressings remained in place for up to 7 days Compared to NPWT, Control patients tended to have: <ul style="list-style-type: none"> Higher levels of maximum drained fluid per day ($p = 0.496$) Longer duration of drainage ($p = 0.632$). More reinterventions (7 vs. 1, respectively; $p = 0.631$). NPWT patients had significantly fewer wound complications ($p = 0.032$) than Control patients: <ul style="list-style-type: none"> 20% vs. 62% incidence of lymphoceles, respectively 7% vs. 45% persistent lymphorrhoea 0% vs. 46% lower extremity lymphoedema Along with shorter hospital stay, the authors commented that NPWT patients benefitted because "... further oncological treatments could be administered without delay." |

Table 3. Literature review of the use of NPWT and PREVENA™ Therapy over surgical incisions (cont.)




| Author | Study Type | Patients | Results/Conclusions |
|---|---|--|---|
| <p>Matatov T, et al.³⁶ <i>(Journal of Vascular Surgery, 2013)</i></p> | <p>Retrospective Review of Patient Records</p> <p>V.A.C.® Therapy (NPWT) vs. Skin Adhesive or Absorbent (Control)</p>  | <ul style="list-style-type: none"> 90 vascular surgery patients with 115 groin incisions for longitudinal or transverse femoral cut-down <ul style="list-style-type: none"> PREVENA™ Therapy: 41 patients (52 incisions) Control: 49 patients (63 incisions) | <ul style="list-style-type: none"> Used Szilagyi scale to rate degree of infection from grade I (lowest) to grade III (highest) PREVENA™ Therapy was applied intraoperatively and removed after 5-7 days. Mean times of wound evaluation: PREVENA™ Therapy, 7 and 33 days postoperatively vs. Control: 10 and 40 days PREVENA™ Therapy-treated incisions had significantly lower overall rate of infection: 3/52 (6%) vs. 19/63 (30%), $p = 0.0011$ Incidence and severity of infections by group: <ul style="list-style-type: none"> PREVENA™ Therapy: 3 infections, all Szilagyi grade I Control: 19 infections, 10 (16%) Szilagyi grade I, 7 (11%) grade II, and 2 (3%) grade III According to the authors, PREVENA™ Therapy "significantly decreased the incidence of groin wound infection in patients after vascular surgery" |
| <p>Blackham AU, et al.³⁷ <i>(American Journal of Surgery, 2013)</i></p> | <p>Retrospective Review of Patient Records</p> <p>V.A.C.® Therapy (NPWT) vs. standard sterile dressings (Control)</p>  | <ul style="list-style-type: none"> 189 patients underwent 191 surgical procedures for pancreatic, colorectal, or peritoneal surface malignancies <ul style="list-style-type: none"> NPWT: 104 cases Control: 87 cases | <ul style="list-style-type: none"> Patients evaluated as being at risk for development of SSIs were treated with NPWT Compared to Control patients, NPWT patients had significantly: <ul style="list-style-type: none"> More neoadjuvant chemotherapy ($p = 0.024$) More clean-contaminated operations ($p < 0.001$) Longer operation times ($p < 0.001$) Greater intraoperative blood loss ($p < 0.001$) More frequent blood transfusions ($p = 0.002$) NPWT patients had significantly fewer incisional SSIs compared to SSD patients In a subset analysis of clean-contaminated cases, NPWT was associated with significantly fewer: <ul style="list-style-type: none"> Superficial incisional SSIs (6.0% vs. 27.4%, $p = 0.001$) Total SSIs (16.0% vs. 35.5%, $p = 0.011$) Wound openings for any reason (16.0% vs. 35.5%, $p = 0.011$) In this study NPWT decreased incidence of SSIs in surgical oncology patients An RCT is planned to further evaluate the efficacy of incisional NPWT in this patient population. |
| <p>Bonds A, et al.³⁸ <i>(Diseases of the Colon & Rectum, 2013)</i></p> | <p>Retrospective Comparative Study</p> <p>Incisional NPWT vs. standard wound closure with occlusive dressings (Control)</p>  | <ul style="list-style-type: none"> 254 patients undergoing open colectomy <ul style="list-style-type: none"> Incisional NPWT (n = 32) Control (n = 222) Primary study endpoint: presence or absence of SSI Treatment: <ul style="list-style-type: none"> Incisional NPWT: Applied immediately after skin suturing and remained in place at a negative pressure of -75mmHg for 5-7 days. Control: No NPWT; frequency of dressings change per physician discretion. All patients followed; length of follow-up time not specified. | <ul style="list-style-type: none"> The incisional NPWT group had a lower infection rate compared to the Control group: 4/69 (12.5%) vs. 65/254 (29.3%), respectively (OR 0.32, $p < 0.05$). Diabetes mellitus was found to be associated with a higher SSI rate compared to patients without this risk factor: 39.4% vs. 29.7%, respectively (OR 1.98, $p < 0.05$). The authors concluded that using incisional NPWT over clean, standard wound closures appeared to reduce the incidence of SSIs in patients undergoing open colectomy. |

Table 3. Literature review of the use of NPWT and PREVENA™ Therapy over surgical incisions (cont.)




| Author | Study Type | Patients | Results/Conclusions |
|---|--|---|---|
| <p>Soares, et al.³⁹</p> <p>(<i>American Journal of Surgery</i>, 2015)</p> | <p>Retrospective Comparative Study</p> <p>V.A.C.® Therapy (NPWT) vs. standard wound dressings (Control)</p>  | <ul style="list-style-type: none"> 199 patients undergoing ventral hernia repair <ul style="list-style-type: none"> NPWT group (n = 115) Control (n = 84) Patient chart reviews between January 2008 and February 2013. Control group: Standard wound dressings without NPWT; dressings removed on postoperative day 2 and incision exposed to air. NPWT group: NPWT white foam strips were inserted into the subcutaneous spaces of the incision, spaced 6-8cm apart, and extending 1cm above the skin; NPWT applied at -125mmHg continuously; dressing removed on postoperative Day 3. Primary outcome: presence of surgical site infections on or before day 90. All patients were followed for a mean of 8.7 ± 9.9 months. | <ul style="list-style-type: none"> Compared to the Control, NPWT patients had: <ul style="list-style-type: none"> Lower likelihood of surgical site occurrences (17% vs. 42%, respectively; $p = 0.001$) Lower overall SSIs (9% vs. 32%, respectively; $p < 0.001$) Lower rates of major morbidity (32% vs. 52%, respectively; $p = 0.001$) Fewer 90-day reoperations (5% vs. 14%, respectively; $p = 0.02$) The authors concluded that the modified NPWT technique "may decrease the complication rates, making this an acceptable approach in VHR patients with risk factors for SSOs and hernia recurrence." |
| <p>Chadi, et al. ⁴⁰</p> <p>(<i>Diseases of the Colon & Rectum</i>, 2014)</p> | <p>Retrospective Comparative Study</p> <p>V.A.C.® Therapy (NPWT) vs. standard wound dressings (Control)</p>  | <ul style="list-style-type: none"> 59 patients undergoing ventral hernia repair <ul style="list-style-type: none"> NPWT group (n = 27) Control (n = 32) Patient chart reviews between January 2008 and December 2012. Primary outcome: presence of surgical site infections on or before day 30. All patients were followed with the surgeon 4 weeks after discharge. | <ul style="list-style-type: none"> Both groups had similar perioperative risk factors; however, there were increased levels of blood urea nitrogen, more hypertensive patients, and longer mean operative time in the NPWT group. Compared to the Control, NPWT patients had: <ul style="list-style-type: none"> Lower rates of perineal SSIs (15% vs. 41%, respectively; $p = 0.04$) Longer length of stay (11 vs. 8 days, respectively; $p = 0.03$) The authors concluded that NPWT plays a role in decreasing perineal surgical site infection rates following abdominoperineal resection. |
| <p>Mark, et al.⁴¹</p> <p>(<i>Surgical Innovation</i>, 2013)</p> | <p>Retrospective Comparative Study</p> <p>Incisional NPWT vs. conventional sterile wound dressings (Control)</p>  | <ul style="list-style-type: none"> 69 morbidly obese (BMI>45) patients undergoing cesarean section <ul style="list-style-type: none"> Incisional NPWT (n = 21) Control (n = 48) Primary outcome: any postoperative wound complication Treatment: <ul style="list-style-type: none"> Incisional NPWT: Applied over standard surgical incisions and remained in place at a negative pressure of -125mmHg for 2-4 days. Control: No NPWT; standard wound dressings remained in place for 2 days postoperatively. All patients followed for a mean of 6 days following delivery. | <ul style="list-style-type: none"> Incisional NPWT patients, when compared to the Historical Control, had the following risk factors: <ul style="list-style-type: none"> Slightly younger (26.1 vs. 29.5, respectively; $p = 0.04$) More unscheduled cesarean sections (47.6% vs. 22.9%, respectively; $p = 0.04$) Longer length of labor (261 vs. 78 minutes, respectively; $p = 0.02$) Longer length of surgery (76 vs. 64 minutes, respectively; $p = 0.03$) Incision closure with subcuticular sutures rather than staples (95.2% vs. 14.6%, respectively; $p < 0.001$) There were no wound complications in the incisional NPWT group compared to 5 in the Control group: 0/21 (0.0%) vs. 5/48 (10.4%), respectively ($p = 0.15$). The results of this study suggest that using incisional NPWT over clean, closed incisions decreases wound complications in morbidly obese patients undergoing cesarean section. |

Table 3. Literature review of the use of NPWT and PREVENA™ Therapy over surgical incisions (cont.)



| Author | Study Type | Patients | Results/Conclusions |
|---|---|---|---|
| <p>A Gabriel et al⁴² <i>(Plastic and Reconstruction Surgery – Global Open, 2016)</i></p> | <p>Retrospective Review of Patient Records</p> <p>Closed incision negative pressure therapy (ciNPT)</p>  | <ul style="list-style-type: none"> • 13 patients (25 breasts) undergoing postmastectomy reconstruction as part of 2-stage expander/implant breast reconstruction • Treatment: <ul style="list-style-type: none"> o ciNPT: a customizable dressing was applied over the closed incision in the sterile field of the operating room followed by continuous negative pressure at -125 mmHg for an average of 4.3 days o Patients underwent one of 3 types of mastectomies: nipple sparing, reduction-pattern, or skin-sparing o Surgical drains were used with ciNPT (mean drain placement was 8.2 days) o All incisions were closed with absorbable sutures and protected with a sterile dressing. • All patients were followed for 3 months. | <ul style="list-style-type: none"> • Fourteen breasts underwent nipple-sparing mastectomies, 6 breasts had a reduction-pattern mastectomy, and 5 breasts received a skin-sparing mastectomy. • In the nipple-sparing mastectomy group, one breast developed a delayed hematoma on postoperative Day 13 that resolved by the 3-month follow-up visit. • In the reduction-pattern mastectomy group, 3 breasts developed superficial dehiscence that resolved with local wound care. One breast developed flap necrosis that required surgical revision. • No complications were reported in the skin-sparing mastectomy group. • At the 3-month follow-up, 24/25 (96%) breasts achieved complete healing. • The authors concluded that ciNPT with customizable or peel and place dressings "...could be a viable option over closed incisions following immediate postmastectomy reconstruction as part of 2-stage expander/implant breast reconstruction." |
| <p>HJ Cooper et al⁴³ <i>(Journal of Arthroplasty, 2015)</i></p> | <p>Retrospective Review of Patient Records</p> <p>Closed incision negative pressure therapy (ciNPT) vs. antimicrobial dressings (Control)</p>  | <ul style="list-style-type: none"> • 138 patients undergoing hip and knee revision surgery <ul style="list-style-type: none"> o ciNPT (n=30) o Control (n=108) • Primary outcome measures: incidence of wound complications, incidence of total SSIs, and reoperation rate for wound complications • Treatment: <ul style="list-style-type: none"> o ciNPT: Applied after skin suturing and remained in place at a negative pressure of -125 mmHg. o Control: No NPWT; control dressings were applied over standard surgical sutures and remained in place for a minimum of 5 days unless a premature dressing change was required due to saturation. • All patients were followed for 90 days. | <ul style="list-style-type: none"> • Compared to the Control, ciNPT resulted in: <ul style="list-style-type: none"> o Fewer overall wound complications (6.7% vs. 26.9%, respectively; $p=0.024$) o Fewer total SSIs (3.3% vs. 18.5%, respectively; $p=0.045$) o A trend toward fewer reoperations (3.3% vs. 13.0%, respectively; $p=0.191$) • The authors' findings suggest that "...ciNPT may decrease wound complications and SSIs in patients undergoing revision hip and knee surgery." |

Table 3. Literature review of the use of NPWT and PREVENA™ Therapy over surgical incisions (cont.)


| Author | Study Type | Patients | Results/Conclusions |
|--|---|---|--|
| <p>VS Reddy⁴⁴ <i>(Cureus, 2016)</i></p> | <p>Retrospective Review of Patient Records</p> <p>Closed incision negative pressure therapy (ciNPT)</p>  | <ul style="list-style-type: none"> • 27 patients undergoing cardiothoracic surgery • Patient risk factors included: obesity (27/27, 100%), diabetes (25/27, 92.6%), hypertension (16/27, 59.3%) and ≥5 comorbidities (20/27, 74%). • Treatment: <ul style="list-style-type: none"> ◦ ciNPT: Applied after immediately after skin suturing and remained in place at a negative pressure of -125 mmHg for a mean duration of 5.6±0.9 days. ◦ All patients received antibiotics prior to surgery (-30 minutes), during surgery (4 hours), and up to 24 hrs postoperatively. • All patients were evaluated within the first 30 days postoperatively; mean follow-up was 6.7±3.1 weeks. | <ul style="list-style-type: none"> • Within the first 30 days post-surgery, ciNPT resulted in: <ul style="list-style-type: none"> ◦ A majority of patients with intact incisions with good approximation and no major sternal complications (21/27; 77.8%) ◦ Two patients experienced minor dehiscences and 4 patients had superficial cellulitis that were treated and resolved. • All patients had intact incisions at the final follow-up visit. • The author concluded that in these cardiac patients "...ciNPT over closed sternal incisions resulted in favorable outcomes within 30 days of surgery." |

Table 3. Literature review of the use of NPWT and PREVENA™ Therapy over surgical incisions (cont.)






| Author | Study Type | Patients | Results/Conclusions |
|---|---|---|---|
| Reddix RN, et al. ⁷ <i>(American Journal of Orthopedics, 2009)</i> | Retrospective Review of Patient Records V.A.C.® Therapy (NPWT)  | <ul style="list-style-type: none"> 19 morbidly obese patients (BMI>40) with acetabular fractures | <ul style="list-style-type: none"> NPWT was applied postoperatively No reported complications among 19 obese patients |
| Condé-Green A, et al. ⁵² <i>(Annals of Plastic Surgery, 2013)</i> | Retrospective Review of Patient Records V.A.C.® Therapy (NPWT) vs. Standard Gauze Dressings (Control)  | <ul style="list-style-type: none"> 56 patients were treated with either incisional NPWT (n = 23) or gauze dressings (n = 33) after abdominal wall reconstruction to repair large ventral hernias | <ul style="list-style-type: none"> Overall wound complications rates significantly favored the incisional NPWT group vs. Control: 22% vs. 63.6%, respectively (p = 0.020) Skin dehiscence rate was also significantly lower for incisional NPWT group: 9% vs. 39%, (p = 0.014) Rates for other wound complications (infection, skin and fat necrosis, seroma, and hernia recurrence) were also lower for the NPWT group. According to authors, study results suggest that incisional NPWT "significantly improves rates of wound complication and skin dehiscence when compared to conventional dressings." |
| Colli A, et al. ⁴⁵ <i>(Journal of Cardiothoracic Surgery, 2011)</i> | Case series PREVENA™ Therapy (NPWT)  | <ul style="list-style-type: none"> 10 patients with closed sternal incisions and mean Fowler risk score of 15.1 following cardiac surgery | <ul style="list-style-type: none"> Wounds and surrounding skin showed complete wound healing with absence of skin lesions following dressing removal No infections occurred during 30 day follow-up time No device-related or other complications were observed with PREVENA™ Therapy |
| Stannard, et al. ⁴⁶ <i>(Ostomy Wound Management, 2009)</i> | Case series V.A.C.® Therapy (NPWT)  | <ul style="list-style-type: none"> Incisional NPWT was used for 4 patients: <ul style="list-style-type: none"> 1 with coronary artery bypass grafting, 1 with a transmetatarsal amputation 2 with abdominal hysterectomies | <ul style="list-style-type: none"> Patient comorbidities included obesity, diabetes, hypertension, and peripheral artery disease. Three patients healed without complication; one patient with an abdominal hysterectomy experienced superficial skin separation (3mm – 5mm) after staple removal. Authors also shared practical tips, including a patient grading scale to help identify patients who could benefit from incisional NPWT or PREVENA™ Therapy.⁴³ |
| Gomoll AH, et al. ⁶ <i>(Journal of Orthopaedic Trauma, 2006)</i> | Case Series V.A.C.® Therapy (NPWT)  | <ul style="list-style-type: none"> 35 patients with foot and ankle trauma, revision hip arthroplasty, proximal femoral and tibial fracture fixation | <ul style="list-style-type: none"> Average time of NPWT use was just over 3 days Use of NPWT saved an average of 4 conventional dressing changes and reduced risk of external contamination No infections had occurred in high-risk patients 3 months post operation. |

Table 3. Literature review of the use of NPWT and PREVENA™ Therapy over surgical incisions (cont.)




| Author | Study Type | Patients | Results/Conclusions |
|--|---|--|---|
| <p>Bollero D, et al.⁴⁷ <i>(International Wound Journal, 2015)</i></p> | <p>Case Series PREVENA™ Therapy</p>  | <ul style="list-style-type: none"> • 8 patients undergoing surgical excision of wide pathological scars | <ul style="list-style-type: none"> • First use of PREVENA™ Therapy after pathological scar excision • Scar sites were located in body areas with skin stretch during flexion/extension movements. • PREVENA™ Incision Dressing was applied intraoperatively and maintained for 8 days at -125mmHg • 7 of 8 patients completed treatment successfully • 1 patient discontinued treatment after 1 day because scar was close to pubic area and, despite shaving, it was not possible to achieve and maintain an air-tight seal. • The authors concluded that "Easy intraoperative application and postoperative management, associated with good compliance of patients, make PREVENA™ [Therapy] a safe home-care device."⁴⁴ |
| <p>Maclin M and Guerra O⁴⁸ <i>(Negative Pressure Wound Therapy, 2014)</i></p> | <p>Small Case Series V.A.C.® Therapy (NPWT)</p>  | <ul style="list-style-type: none"> • 3 patients undergoing panniculectomy with ventral hernia repair. • Channel drains were placed vertically through a closed incision and in contact with NPWT white foam dressing strips ('French Fries'). • NPWT was applied to the incision line for 7-10 days; subsequent NPWT was applied only to French Fry portal sites. • Patient co-morbidities included obesity, diabetes, hypertension, emphysema, hypercholesterolemia, ulcerative colitis, and post gastric bypass. | <ul style="list-style-type: none"> • Wound incisions healed without complications for two patients. Superficial partial thickness necrosis at the T-junction occurred with one patient's incision; however, this healed with local wound care. • NPWT allowed for superficial control of the incision line while the French Fry portal sites contributed to deep control by compressing undermined deep dead spaces. • The authors concluded that the "use of NPWT helped to address and minimize serious complications in these high-risk patients". |
| <p>Vargo D⁵³ <i>(American Journal of Surgery, 2012)</i></p> | <p>Retrospective review Incisional NPWT (V.A.C.® Therapy)</p>  | <ul style="list-style-type: none"> • 30 high-risk patients undergoing abdominal surgery whose incisions were treated with incisional NPWT. Published historical data were used as the control group (n = 30). • All patients received antibiotics. Incisional NPWT was applied at -75mmHg continuously for an average of 5.6 days (range 5-7 days). • Primary outcome: wound infection rate • Secondary outcomes: device safety and overall surgical site complication rate • Follow-up period: Wounds were assessed at the time of dressing removal and at 2 weeks and 4 weeks post-surgery. | <ul style="list-style-type: none"> • No ischemia, skin necrosis, or wound infections were identified in the incisional NPWT group. • Compared to the control, incisional NPWT patients had a lower overall complication rate (6% vs. 20%, respectively; $p < 0.05$). • The authors concluded that the "negative-pressure wound therapy applied to a closed high-risk surgical wound is safe, with no evidence of skin necrosis and decreased wound infection rate." |

Table 3. Literature review of the use of NPWT and PREVENA™ Therapy over surgical incisions (cont.)



| Author | Study Type | Patients | Results/Conclusions |
|---|--|--|---|
| Haghshenasskashani A, et al. ⁵⁴ <i>(British Journal of Diabetes & Vascular Disease, 2011)</i> | Case study PREVENA™ Therapy (NPWT)  | <ul style="list-style-type: none"> 1 patient with distal lower limb incision site treated with PREVENA™ Incision Management System following popliteal-tibial bypass grafting | <ul style="list-style-type: none"> The incision did not become oedematous or deteriorate at any time, even after the PREVENA™ Incision Dressing was removed Ongoing tissue healing was maintained without complication Patient discharged on day 12 after regaining full mobility and removal of sutures. |
| Dutton M and Curtis K ⁵⁵ <i>(Journal of Wound Care, 2012)</i> | Case study V.A.C.® Therapy (NPWT)  | <ul style="list-style-type: none"> 53-year old male presented with a laparotomy surgical site breakdown NPWT dressings were used in a splinting technique to help prevent laparotomy wound breakdown | <ul style="list-style-type: none"> Obesity, malnutrition, fistula, and previous surgeries in the area of wound breakdown were factors that increased the likelihood of wound complications for this patient. Authors placed 3 horizontal strips of foam dressing over the foam-dressing covered vertical incision as a way to splint the wound, drawing wound edges together and helping support the weight of the pannus After 7 days of incisional NPWT, there was only a small, superficial breakdown at the distal end of the incision. No further complications were reported during follow-up visits 4 and 6 weeks later. |

Table 4. Patient Risk Factors⁶⁴⁻⁶⁶

| | |
|--|---|
| <ul style="list-style-type: none"> Age > 65 Wound infection Pulmonary disease Vascular disease Hemodynamic instability Ostomies Hypoalbuminemia Systemic infection Obesity Uremia Hyperalimantation Ascites | <ul style="list-style-type: none"> Malignancy Hypertension Length and depth of incision Foreign body in the wound Anemia Jaundice Diabetes – poor control Active smoker Type of injury Radiation therapy Steroid use |
|--|---|

Table 5A. Biomechanical properties of the PREVENA™ Incision Management System

| Property Demonstrated | Study Description | Nonclinical Results |
|--|--|---|
| Helps hold closed incision edges together | <ul style="list-style-type: none"> <i>In vitro</i> simulated incision model⁶⁹ <ul style="list-style-type: none"> Measured force needed to separate sutured and stapled incision edges 10mm Compared sutures plus PREVENA™ Therapy to sutures only and staples plus PREVENA™ Therapy to staples only | <ul style="list-style-type: none"> Sutures plus PREVENA™ Therapy resisted separation 51% better than sutures only (92.9 ± 2.6N vs. 61.7 ± 0.3N, respectively; (p<0.05) Staples plus PREVENA™ Therapy resisted separation 43% better than staples only (98.8 ± 0.0 N vs. 69.3 ± 0.4N, respectively; (p<0.05) |
| May help realign and reduce tensile forces across the incision | <ul style="list-style-type: none"> Finite element computer model 1⁶⁹ <ul style="list-style-type: none"> Evaluated tensile forces in a cross-section of a simulated incision closed with sutures Compared sutures only to sutures plus PREVENA™ Therapy | <ul style="list-style-type: none"> Sutures only: tensile loads concentrated at sutures Sutures plus PREVENA™ Therapy: tensile loads realigned and more evenly spread across a simulated incision |
| | <ul style="list-style-type: none"> Finite element computer model 2⁶⁹ <ul style="list-style-type: none"> Simulated a sutured incision with lateral tension Evaluated strain levels with and without PREVENA™ Therapy | <ul style="list-style-type: none"> High lateral strain areas normally surround the incision line PREVENA™ Therapy led to reduced lateral strain around the suture lines of the incision |

Table 5B. Physiological Properties of PREVENA™ Incision Management System

| Property Demonstrated | Study Description | Nonclinical Results |
|-----------------------------|---|---|
| May help improve fluid flow | <ul style="list-style-type: none"> <i>In vivo</i> porcine model was developed to evaluate effect of negative pressure (PREVENA™ Therapy) on hematoma/seroma formation, fluid removal into the canister, and lymph system involvement⁷⁰ <ul style="list-style-type: none"> Two sets of contralateral subcutaneous voids with overlying sutured incisions were created on the ventral sides of each of 8 swine. Uniquely labeled 30 and 50nm nanospheres were introduced into each subcutaneous void. Incisions were assigned to PREVENA™ Therapy or standard of care (SOC) (3M™ Tegaderm™ Dressing) over sutures for 4 days. After therapy, the hematoma/seroma in each defect was weighed (with differences averaged for each animal), fluid levels in the canister were monitored, 5 pre-identified lymph nodes were harvested, and 5 key organs were biopsied. | <ul style="list-style-type: none"> Hematoma/seroma mass significantly reduced (63%) for PREVENA™ Therapy vs. SOC (mean 15 ± 3g vs. 41 ± 10g, respectively; p = 0.002) No fluid found in PREVENA™ Canister Lymph nodes had ~60 µg (~50%) more 30- and 50-nm nanospheres from PREVENA™ Therapy-treated incisions compared to Control sites (p = 0.04 and p = 0.05, respectively). Nanosphere incidence significantly greater from PREVENA™ Therapy sites versus Control sites in lungs, liver and spleen (p<0.05); no nanospheres found in kidney biopsies. According to the authors, in this scientific model, application of PREVENA™ Therapy significantly decreased hematoma/seroma levels without fluid collection in the canister, which may be explained by increased lymph clearance.⁷⁰ |
| | <ul style="list-style-type: none"> <i>In vivo</i> porcine incision model compared PREVENA™ Therapy to standard dry dressings (Control)⁷¹ <ul style="list-style-type: none"> In 8 mature mini-pigs, the two dressings were applied to adjacent sutured incisions over the spine. After 3 or 5 days, incisions were assessed using scar scale rating, biomechanical testing (e.g., failure load, failure energy, and stress), and histological analysis. | <ul style="list-style-type: none"> PREVENA™ Therapy incisions had a significantly improved scar scale height grade (p<0.026) <ul style="list-style-type: none"> The representative Control incision showed inflammation, edema and swelling around the incision (Figure 8A) The representative PREVENA™ Therapy incision line was barely visible (Figure 8B) Control group scores were lower for failure load (4.9 ± 4.0 vs. 16.5 ± 14.6N), energy absorbed (8.0 ± 9.0 vs. 26.9 ± 23.0 mJ), and ultimate stress (62 ± 53 vs. 204 ± 118 N/mm²). Histology showed no differences in incision scar width between the two groups. In this porcine study, authors noted, "a trend toward improved early healing strength and in a significantly improved incision appearance," for incisions treated with PREVENA™ Therapy. |

Table 5B. Physiological Properties of PREVENA™ Incision Management System (cont.)

| Property Demonstrated | Study Description | Nonclinical Results |
|-----------------------------------|---|--|
| Helps facilitate incision healing | <ul style="list-style-type: none"> <i>In vivo</i> porcine model used to assess whole-genome microarrays to gain insight in the biological processes of closed incision management (CIM).⁷² <ul style="list-style-type: none"> Total RNA was isolated from the tissue Quality and quantity of RNA were determined using the Experion™ Automated Electrophoresis System (Bio-Rad, Hercules, CA). | <ul style="list-style-type: none"> Genomic pathway analysis via PANTHER™ (Gen-Probe™, San Diego, CA) indicated: <ul style="list-style-type: none"> Increased integrin signaling in CIM-treated incisions as compared to SOC-treated incisions (normalized to naïve) Decreased inflammation mediated by key chemokine and cytokine marker expression in CIM-treated incisions compared to SOC-treated incisions (normalized to naïve) CIM affects gene expression differently than SOC |
| | <ul style="list-style-type: none"> <i>In-vivo</i> porcine model used to compare the biomechanics of CIM-treated incisions to SOC-treated controls 40 days post-surgery.⁵⁷ <ul style="list-style-type: none"> Three adult female Yucatan swine (65-75 kg) received eight 6-cm long full-thickness dorsal incisions. Incisions were closed with 2-0 Prolene sutures using a simple interrupted pattern. Contralateral incisions received SOC (ABD Pads) or CIM for 5 days, then SOC for 5 days. Sutures were removed on Day 10, and covered with Tegaderm™ dressing (3M; St. Paul, MN) for an additional 5 days. The incisions were left untreated until term (Day 40). Mechanical testing: Tissue surrounding the incision scar was trimmed to a 10cm x 1cm strip including the epidermis, dermis, subdermal fat layer, and subcutaneous fat layer. Gene Expression: 4-mm tissue biopsies were collected on days 6, 20, and 40. Histomorphometric testing: Incision site and four strips of naïve skin from each of 5 animals were excised for processing. | <ul style="list-style-type: none"> At 40 days post-surgery, mechanical properties (strain energy density, peak strain) were higher and the width of the healed area was narrower in CIM-treated incisions versus SOC (Table 7) At 5 days post-surgery, fewer genes were differentially expressed and showed reduced upregulation of genes associated with inflammation, hypoxia, retardation of re-epithelialization, impaired wound healing, and scarring in CIM-treated incisions versus SOC. These data suggest that surgical incision management with CIM, provided by the PREVENA™ Incision Management System, may improve the quality of the healed wound and reduce the likelihood of wound dehiscence. |
| | <ul style="list-style-type: none"> <i>In vitro</i> viral penetration study⁷⁵ confirmed that PREVENA™ Incision Dressing protects the incision from external contamination <ul style="list-style-type: none"> Test squares were cut from the polyurethane film and clamped into a penetration test cell. A 60ml bacteriophage suspension was introduced into top side of test cell (5 min). Film was monitored for penetration before and after 2 PSIG pressure was applied for 1 min. | <ul style="list-style-type: none"> Both biological assay (Table 8) and visual inspection showed no penetration. These results indicate that the exterior drape of the PREVENA™ Incision Management System may be a microbial barrier to viral contamination (as small as 27nm) and bacterial sources. |

Table 6. Appositional Model Results Measured the Amount of Force Needed to Separate Closed Incision Edges by 10mm⁶⁹

| | Maximum Tension Measured (N) | Percentage Increase in Appositional Forces |
|--|------------------------------|--|
| Sutures Only | 61.7 ± 0.3 | 51% |
| Sutures and PREVENA™ Incision Dressing | 92.9 ± 2.6* | |
| Staples Only | 69.3 ± 0.4 | 43% |
| Staples and PREVENA™ Incision Dressing | 98.8 ± 0.0* | |

*(p<0.05)

Table 7. Characteristics of Clean, Closed Surgical Incisions in Yucatan Swine 40 Days Post-Surgery⁵⁷

| Mechanical Property | Naïve | SOC (<i>p</i> -value) ^a | PREVENA™ Therapy (<i>p</i> -value) ^a | Percentage Difference (between PREVENA™ Therapy and SOC) | <i>p</i> -value (Difference between PREVENA™ Therapy and SOC) |
|--|-------------|--|--|---|--|
| Strain Energy Density (N/mm ²) | 0.37 ± 0.05 | 0.15 ± 0.02 (<0.0001) | 0.21 ± 0.04 (0.0097) | 40 | 0.0373 |
| Peak Strain (unitless) | 0.26 ± 0.01 | 0.18 ± 0.01 (0.0005) | 0.23 ± 0.02 (0.1512) | 28 | 0.0455 |
| Peak Stress (N/mm ²) | 3.1 ± 0.3 | 2.0 ± 0.2 (0.0233) | 2.4 ± 0.3 (0.1845) | NS | 0.2703 |
| Elastic modulus (N/mm ²) | 17 ± 1 | 17 ± 1 (1.000) | 17 ± 2 (1.000) | NS | 1.000 |
| Sample size (<i>n</i>) | 12 | 10 | 9 | NA | NA |

Data are shown as mean ± standard error; NS not significant, NA not applicable; ^a *p*-values in parentheses are for difference from naïve

Table 8. Bacteriophage concentrations from penetration study⁷⁵

| Dressing Area | Concentrations |
|------------------------|----------------------------|
| Top Side/Pre-Pressure | 8.7x10 ⁸ PFU/ml |
| Top Side/Post-Pressure | 9.4x10 ⁸ PFU/ml |
| Bottom Side Assay | <1 PFU/ml |

* According to Nelson Labs, an assay titer value of <1 Plaque Forming Units (PFU)/ml is reported for assay plates showing no growth.

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PREVENA™

INCISION MANAGEMENT SYSTEM

Follow local institutional protocols for infection control and waste disposal procedures. Local protocols should be based on the applicable federal, state and/or local government environmental regulations.

NOTE: Specific indications, contraindication, warnings, precautions and safety information exist for the PREVENA™ Incision Management System. Please consult the PREVENA™ Incision Management System or PREVENA PLUS™ Incision Management System Clinician Guide Instructions for Use prior to application. Rx only.

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