Incision Management: The Final Step for Complex Surgical Procedures

Learning Objectives

- Recognize the impact of surgical care complications as it relates to postoperative infections and identify patient populations at risk for surgical site compromise
- Review considerations for steps to take when surgical site disruption occurs with the goal of achieving wound closure
- Explore the role of incision management to reduce the risk of wound infection and dehiscence
- Employ best practice protocols in preventing surgical site infections

Managing Surgical Incisions at Risk for Post-Operative Complications

Goals

- Recognize the importance of infection control protocols for the prevention of SSIs
- Identify patient populations at risk for surgical site compromise
- Describe the appropriate use of NPWT on surgical sites to reduce the risk of wound infection and dehiscence
- Employ early interventions to reduce the risk of readmissions for SSIs

Skin Is Naturally under Tension

- The natural tension from Langer lines cause incisinal edges to retract
- This internal tension within the skin opposes the closure of incisions
- In regions of high movement and in obese patients, tension is increased and sutures or staples experience increased stress

SSI = surgical site infection; NPWT = negative-pressure wound therapy.

Closure Options

Standard Closure Techniques for Surgical Incisions
- Sutures
- Staples
- Tissue adhesives
- Tapes
- Combination of the above

Adjunctive Therapies used over Closure Techniques
- Gauze dressings
- Hydrocolloids
- Growth factors
- Cultured skin
- NPWT

Protocols for Lowering Risk

- Well-established, published guidelines by the CDC and National Institute for Health
  - Preoperative hair removal with clippers
  - Perioperative administration of intravenous antibiotics
  - Surgical team antisepsic techniques
  - Surgical techniques
  - Pre- and post-operative glycemic control
  - Oxygenation, normothermia

Risk Remains Elevated

- Despite advances in surgical technique and perioperative management, SSO/SSI continues to be a major source of morbidity and mortality

High Risk?

- Age >65 years
- Wound infection
- Pulmonary disease
- Peripheral vascular disease
- Hemodynamic instability
- Ostomies
- Hypoalbuminemia
- Systemic infection
- Obesity
- Uremia
- Hyperalimentation
- Asparagine
- Malignancy
- Hypertension
- Length and depth of incision
- Anemia
- Jaundice
- Diabetes – poor control
- Nicotine use
- Type of injury
- Radiation therapy
- Steroid use
- Malnutrition

Risk Factors That May Compromise Healing
Prevalence of Hospital Acquired Infections

- CDC estimates of healthcare-associated infections
  - US – 1.7 million infections
  - US – 99,000 deaths
- 17% to 22% are SSIs
- Patients with multiple comorbidities are at higher risk for surgical site complications
  - Obesity
  - Diabetes
  - Smoking
  - Poor vascularization
  - Poor nutrition


Economic Impact

- Wound complications following surgical procedures can be costly to the healthcare system
- SSIs have been associated with an increased hospital stays that are approximately 9.58 more days and incur an estimated $38,656 more in medical costs
- Postoperative dehiscence can add 9.42 extra days, resulting in additional charges of $40,323 in additional charges


Hospital Infections Now Cost Billions

- $9.8 billion in Hospital Acquired Infection
- JAMA Internal Medicine Sept 2, 2013
- TOP 5 drivers of cost
  - 33.7% SSI ($20,785 per case)
  - 31.6% VAP ($40,144 per case)
  - 18.9% CLABSI ($45,814 per case)
  - 15.4% Cdiff ($11,285 per case)
  - 1% CA-UTI ($896)

A Factor That Can Improve Healing

- Review of Scientific and Clinical Evidence Supporting NPWT over CLOSED incisions
- Incision management system
- Different from a traditional open wound NPWT dressing

What Is Incisional NPWT?
Prevena™ Incision Management System and Incisional NPWT

**Indications**
- Prevena™ Incision Management System is specifically designed for use over clean, closed incisions that continue to drain.

NPWT can also be used to manage clean, closed incisions, and when applied as incisional NPWT, it is functionally equivalent to Prevena™ Incision Management.

**How Does Incisional NPWT Work?**
1. Removes fluid through the incisional interspaces that may otherwise percolate and work to break down the incision.
2. Acts like a splint for the skin to help resist distracting forces on the incision line.
3. Protects the incision from external contamination for the duration of therapy.

**3D Finite Element Computer Modeling Showed Reduced Lateral Tension**
- Lateral tension around suture line was reduced by approximately 90% before and after Incisional NPWT.

**Bench Study of Appositional Forces**
- In this bench top model, appositional forces were increased with Incisional NPWT therapy.
- Suture line had 51% stronger approximation.
- Staple line had 43% stronger approximation.

*Brand names are included for clarification purposes only. No product promotion should be inferred.*
Porcine Incisions following 5 Days of Incisional NPWT

Data courtesy of Dr. Yaszay.

Immediate Impact
Intermediate Term Impact
Longer Term Impact

Porcine Incisions following 5 Days of Incisional NPWT

Incision after 5 days
Incision following 5 days of treatment with incisional NPWT

Data courtesy of Dr. Yaszay.

Immediate Impact
Intermediate Term Impact
Longer Term Impact

Improved Lymph Flow in a Porcine Model

Increased nanosphere accumulation in lymph nodes suggested incisional NPWT can help improve lymph flow


In a Porcine Study, Incision Apposition Was Increased


Clinical Experience Using Incisional NPWT

- Physicians reported use of NPWT over incisions as early as 2006
- Cardiothoracic
- Orthopedic
- Obstetrician/gynecologist
- Hernia
- Vascular

Cardiothoracic Procedures

Incident Rate of Surgical Site Complications and Use of NPWT Post Surgery
Cardiothoracic Surgical Site Complications

- CABG surgeries
  - 1081 CABG surgeries per million adults per year
- SSI after CABG is serious
  - Infection of the sternum
  - Mediastinitis
  - 50% mortality risk

CABG = coronary artery bypass graft.


Postoperative CABG and mitral valve replacement via sternotomy on a 55-year-old male patient

Case Study: CABG through Median Sternotomy Incision

A. Day 0: Clean closed surgical incision
B. Day 0: Placement of incisional NPWT
C. Day 0: Application of -125 mm Hg pressure
D. Day 5: Surgical incision following removal of incisional NPWT

Retrospective Review

Retrospective study of 20 adult male patients with clean, closed sternotomy incisions
- 10 NPWT; 10 control (standard dressings)
- The NPWT patients were classified as high risk; control patients were not
- Laser Doppler flowmetry measurements
  - When obtained after induction of anesthesia and before surgical incision, there was no difference in baseline sternal perfusion
  - When obtained daily after NPWT for a total of 4 days, the NPWT group had a 100±150% increase, whereas controls dropped -12.7 ±70% (P=0.004)

When the internal mammary artery was harvested for CABG, topical NPWT increased peristernal skin perfusion by 100%, whereas controls perfusion decreased by 26% (P=.04)


Hernia

Case Study Presentation

Intersecting Incisions
Wound complications – trauma, advances in surgery in general, and the stateside care of aging population and increased prevalence of comorbidities lead to increased incidence of abdominal wall hernias. Improvements in surgical techniques have allowed us to achieve primary closure in a high percentage of large abdominal hernia repairs. However, postoperative wound complications remain common. The postoperative application of incisional NPWT along the incision line is a technique that has been used after abdominal wall reconstructions to decrease wound complications. Despite achieving primary closure in a high percentage of large abdominal hernia repairs, postoperative wound complications remain common. The postoperative application of incisional NPWT along the incision line is a technique that has been used after abdominal wall reconstructions to decrease wound complications.

Incisional Negative-Pressure Wound Therapy versus Conventional Dressings Following Abdominal Wall Reconstruction: A Comparative Study

Alexandra Conde-Dino, MD, FACS, Thomas L. Cheng, MD, L. Todd Rutledge, MD, MS, and Paschal T. Doherty, MD

Objective: To compare the rates of wound dehiscence, infection, skin/fat necrosis, and hernia recurrence between patients treated with incisional negative-pressure wound therapy (NPWT) and patients treated with conventional dressings following primary closure of abdominal wall hernias.

Design: Retrospective chart review of patients who underwent primary closure of ventral hernias with incisional NPWT or conventional dressings between 2007 and 2009 at a single surgical center.

Setting: Academic medical center.

Patients: Fifty-six patients with large abdominal wall defects treated with incisional NPWT (n = 23) or conventional dressings (n = 33).

Interventions: Incisional NPWT or conventional dressings following primary closure of abdominal wall defects.

Main Outcome Measures: Incision dehiscence, infection, skin/fat necrosis, and hernia recurrence.

Results: Rates of infection, skin/fat necrosis, seroma, and hernia recurrence were 4%, 9%, 0%, and 4% for group I and 6%, 18%, 12%, 9% for group II, respectively. Rates of infection, skin/fat necrosis, seroma, and hernia recurrence were 4%, 9%, 0%, and 4% for group I and 6%, 18%, 12%, 9% for group II, respectively. This study suggests that incisional NPWT following abdominal wall hernia repair is associated with decreased wound complications compared with conventional dressings.

Conclusions: Incisional NPWT is associated with decreased wound complications compared with conventional dressings following primary closure of abdominal wall hernias. Further research is needed to determine the optimal use of NPWT in the management of abdominal wall hernias.

DOI: 10.1097/SAP.0b013e31824c9073

Conflicts of interest and sources of funding: none declared.

Received October 14, 2011, and accepted for publication, after revision January 30, 2012.
Orthopedic Trauma Surgical Site Complications

- Stabilizing the bone
- Boney fragments within the wound
- 33% to 50% potential infection rates
- Osteomyelitis


Case Study: Right Total Hip Arthroplasty

Postoperative right total hip arthroplasty on a 71-year-old female patient

A. Day 0: Chest closed surgical incision
B. Day 0: Application of incisional NPWT
C. Day 5: Surgical incision following removal of incisional NPWT dressing

Randomized Controlled Trial of Incisional NPWT after Lower Extremity Fractures

- Incisional NPWT vs standard postoperative dressings (control) for patients with calcaneus, pilon, and tibial plateau fractures
- 141 incisional NPWT patients vs 122 control patients


Randomized Controlled Trial Results

<table>
<thead>
<tr>
<th></th>
<th>Incisional NPWT</th>
<th>Control</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>141</td>
<td>122</td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td>14</td>
<td>24</td>
<td>&lt; .02</td>
</tr>
<tr>
<td>Dehiscence</td>
<td>12</td>
<td>21</td>
<td>&lt; .03</td>
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</table>


Vascular Procedures

Incident Rate of Surgical Site Complications Use of NPWT Postsurgery

Potential complications
- Massive hemorrhage
- Systemic sepsis
- Severe limb ischemia
- Septic embolization

From the Society for Vascular Surgery

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

Tim Matatov, MD,* Kerrie N. Balody, MD,† Linda D. Stewart, RN,* Cynthia S. Ellen, MD, MPH,* and Wayne W. Zhang, MD,* Shreveport, La

- Incidence of SSI at the groin after vascular procedures can be as high as 44%
- Morbidity associated with groin infection includes limb loss, sepsis, increased LOS, and increased mortality

Presented at the 2012 Vascular Annual Meeting of the Society for Vascular Surgery

National Nosocomial Infections Surveillance System. by the U.S. Centers for Disease Control and Prevention

Groin Incisions

Intraoperative application of incisional NPWT dressing after femoral-femoral bypass

Results

Incidence and Szilagyi Grades of Infection Based on Total Number of Incisions

<table>
<thead>
<tr>
<th></th>
<th>Prevena Group</th>
<th>Non-Prevena Group</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Szilagyi I</td>
<td>3 (6%)</td>
<td>10 (16%)</td>
<td></td>
</tr>
<tr>
<td>Szilagyi II</td>
<td>0</td>
<td>7 (11%)</td>
<td></td>
</tr>
<tr>
<td>Szilagyi III</td>
<td>0</td>
<td>2 (3%)</td>
<td></td>
</tr>
<tr>
<td>Overall infection</td>
<td>3 (6%)</td>
<td>19 (30%)</td>
<td>.0011</td>
</tr>
</tbody>
</table>

Another Case Study

Massive Localized Lymphedema
Results

Observations

- Mechanical stabilization (immediate reduced lateral tension/ increased appositional strength)
- Physical protection of wound
- Early increase in wound-breaking strength
- Narrower zone of scar histologically
- Reduction in edema
- Increased blood flow
- Suggested increase in lymph flow
- Reduction in hematoma/seroma

Managing Surgical Incisions at Risk for Post-Operative Complications

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Clinical Cases

NOTE: As with any case study, the results and outcomes experienced by the following patients 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 1

Chest Defect

Tight Closure of Donor Site
Tight Closure of Donor Site

Flap on Chest Wall

Application of Incisional NPWT

Post Dressing Removal POD #7

Follow-up at POD 24
We report on postoperative outcomes with a customizable dressing over closed incisions in 13 patients who received immediate postoperative breast reconstruction.

### Patient Demographics

<table>
<thead>
<tr>
<th>Category</th>
<th>N = 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Breasts</td>
<td>25</td>
</tr>
<tr>
<td>Average age (range)</td>
<td>44.72 years (27-62 years)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male (%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Female (%)</td>
<td>13 (100%)</td>
</tr>
<tr>
<td>Average BMI (range)</td>
<td>29.36 (20-44)</td>
</tr>
<tr>
<td>Comorbidities</td>
<td></td>
</tr>
<tr>
<td>Preoperative chemotherapy</td>
<td>2</td>
</tr>
<tr>
<td>Obesity</td>
<td>4</td>
</tr>
<tr>
<td>Axillary dissection</td>
<td>1</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1</td>
</tr>
<tr>
<td>None</td>
<td>9</td>
</tr>
</tbody>
</table>

### Results

**Surgical Incision Management**

<table>
<thead>
<tr>
<th>Mastectomy Type</th>
<th>Average Number of Days with Surgical Incision Management (range)</th>
<th>Average Number of Days with Drain (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction pattern</td>
<td>4.33 (3-5)</td>
<td>8.50 (7-12)</td>
</tr>
<tr>
<td>Nipple sparing</td>
<td>4.71 (3-5)</td>
<td>7.93 (6-10)</td>
</tr>
<tr>
<td>Skin sparing</td>
<td>3.00 (3)</td>
<td>8.60 (8-9)</td>
</tr>
<tr>
<td>Total for all patients</td>
<td>4.28 (3-5)</td>
<td>8.20 (6-12)</td>
</tr>
</tbody>
</table>

Use of Capsular Incision in Normal Prostatic Tissue (ciNPT)?

- **Closed incisions**
  - Primary use
    - To avoid SSI
  - Secondary use
    - To avoid SSI

### Case 3

Necrotizing fasciitis following tubal ligation

POD 1 following debridement
Application of Incisional NPWT

3 weeks
Post Delayed Primary Closure

4 months
Post Delayed Primary Closure

Case 4
Contraindications

- Necrotic tissue with eschar
- Untreated osteomyelitis
- Malignancy in the wound
- Exposed blood vessels, organs, or nerves
- Non-enteric or unexplored fistulas

Where Does ciNPT Fit in My Practice?

- Closed incisions
  - At risk for seroma formation
  - Large undermining
  - High BMI
  - Use of biologics/synhetics
  - At risk for dehiscence
  - Tight closure
  - Repeated incisions through the same scar
  - Risk factors:
    - DM, high BMI, smoker, his radiation, soap, immuno-suppressed
Conclusion

**Improved surgical outcomes** in the high risk group of patients can be achieved with the addition of **NPWT** when well-planned and executed operative procedures are carried out based on **sound surgical principles**

NPWT
NPWT instillation
ciNPT

Thank You