Sternal Wound Infections
Diagnosis, Prevention and Treatment

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APACVS 37th Annual Meeting
April 5-8th, 2018
Sternal Wound Infection

Definition- SSWI vs DSWI

SSWI- Superficial Sternal Wound Infection
- Skin
- SC tissue
- Pectoralis Fascia

DSWI- Deep Sternal Wound Infection
- + culture of mediastinal tissue or fluid
- Evidence of mediastinitis
- Chest pain, sternal instability, fever
- Purulent drainage
Sternal Wound Infection

**Diagnosis**

- Positive Culture
- Dehiscence
- Fever
- Pain
- Erythema
- Purulent Drainage
- Instability (click)

Only about 33% are identified pre-discharge in many studies

- Staph Epi- for SWI
- Staph Aureus for DSWI/Mediastinitis
Incidence and Demographics

- 3008 Adults, 291 SSI (9.7%)
- Deep Sternal Wound infections 1.6% (47)
- Post-op Mediastinitis 1.7%
- Superficial Wound complications 6.4%

Preoperative Risk Factor for DSWI/Mediastinitis
- Obesity
- IDDM
- Tobacco
- PVD
- High NYHA class
Sternal Wound Infection

Incidence/Risks/Outcomes

CABGs n=9021

2002-2006

SWI= 0.47% total

DSWI= 0.22%

Mortality

9.1% (vs 1.1% without)

14%

Risks:

- Female
- Preop HTN
- DM
- Obesity
- Prolonged Vent Time
- Re-Exploration for bleeding

Age and Smoking were not a risk factor

Omran et al, Tehran heart Center  BMC ID  2007:112
Table 1: Pre-intra-and postoperative characteristics among patients with and without SWI

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group 1* (n = 9157)</th>
<th>Group 2** (n = 44)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean ± SD)</td>
<td>58.5 ± 9.7</td>
<td>60.1 ± 8.7</td>
<td>0.173</td>
</tr>
<tr>
<td>BMI (mean ± SD)</td>
<td>27 ± 4</td>
<td>28.3 ± 4</td>
<td>0.032</td>
</tr>
<tr>
<td>Female %</td>
<td>25.5</td>
<td>52.3</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Smoking %</td>
<td>39.5</td>
<td>34.1</td>
<td>0.467</td>
</tr>
<tr>
<td>Diabetes %</td>
<td>33.7</td>
<td>59.1</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Hypercholesterolemia %</td>
<td>61</td>
<td>65.9</td>
<td>0.508</td>
</tr>
<tr>
<td>Hypertension %</td>
<td>49.7</td>
<td>90.9</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>PVD %</td>
<td>1.8</td>
<td>2.8</td>
<td>0.666</td>
</tr>
<tr>
<td>Length of preoperative hospital stay (days) (mean ± SD)</td>
<td>8.2 ± 4.9</td>
<td>9.4 ± 6.1</td>
<td>0.098</td>
</tr>
<tr>
<td>CCS (Functional class) (mean ± SD)</td>
<td>2.1 ± 0.8</td>
<td>2.6 ± 0.7</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>LVEF (mean ± SD)</td>
<td>49.1 ± 10.2</td>
<td>50.7 ± 11.2</td>
<td>0.260</td>
</tr>
<tr>
<td>Graft number (mean ± SD)</td>
<td>3.6 ± 0.9</td>
<td>3.6 ± 1</td>
<td>0.928</td>
</tr>
<tr>
<td>Cross clamp time (minute) (mean ± SD)</td>
<td>42.4 ± 41.5</td>
<td>45 ± 16.4</td>
<td>0.686</td>
</tr>
<tr>
<td>Perfusion time (minute) (mean ± SD)</td>
<td>70.1 ± 26</td>
<td>75.2 ± 23.5</td>
<td>0.207</td>
</tr>
<tr>
<td>Re-exploration for bleeding</td>
<td>1%</td>
<td>13.6%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Intubation time (hours) (mean ± SD)</td>
<td>8.9 ± 13.6</td>
<td>54.1 ± 172.1</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Body mass index, BMI; Peripheral vascular disease, PVD; Canadian Cardiovascular Society classification, CCS; left ventricular ejection fraction, LVEF
* Without sternal wound infection
** With sternal wound infection
<table>
<thead>
<tr>
<th>Variables</th>
<th>Odds ratio</th>
<th>95% CI*</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-exploration for bleeding</td>
<td>13.415</td>
<td>4.521–39.802</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Hypertension</td>
<td>10.763</td>
<td>3.297–35.128</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Female</td>
<td>2.707</td>
<td>1.446–5.071</td>
<td>0.0019</td>
</tr>
</tbody>
</table>

* Confidence Interval
Sternal Wound Infection

Prevention and Treatment

- Avoid retained blood - dry before closure
- Early extubation
- Early removal of urinary catheter/central line
- I+D of superficial infection with VAC if needed
- Early OP/Definitive Rx for DSWI
  - Debridement of all devitalized tissue/resection
  - Drainage of all infected spaces
  - Abx treatment
  - Closure of sternal space
    - Flaps or closure/Abx irrigation
Staph Aureus Colonization and Sternal Wound Infection

Screening for Staph with nasal swabs (PCR)
Class I Recommendation, Level of Evidence A

Intranasal Treatment
- MSSA >90% decolonization, but
- MRSA only 45-50% effective decolonization

Routine use of Mupirocin- Class I recommendation,
Level of Evidence A

How many of you practice this?
Staph Aureus Preoperative Nasal Colonization Treatment

- 2% Mupirocin for 5 days
  - 45% reduction in SSI if known colonization
  - No MRSA post-sternotomy mediastinitis seen.
- Isolates identical in preop and surgical site cultures in general
Staph Aureus Colonization and Sternal Wound Infection

• A known fact that colonization with Staph A. increases risk of Surgical Site Infection
• Techniques Proposed to Reduce this Risk
  • UD (Universal Decolonization of all Patients)
  • TD (Targeted Decolonization (if culture positive))
  • ND (None)

• Cost Savings:
  UD $426 on average, prevented 19 SSI
  TD $205 on average, prevented 10 SSI
• For 220,000 CABGs done:
  UD would save 102 Million
  TD would save 45 million

<table>
<thead>
<tr>
<th>N</th>
<th>2130 (CABG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWI</td>
<td>5.4% (114)</td>
</tr>
<tr>
<td>HgBA1C w SWI</td>
<td>54 +/- 17mmol/mol</td>
</tr>
<tr>
<td>HgBA1C s SWI</td>
<td>45 +/- 13mmol/mol</td>
</tr>
</tbody>
</table>

HgBA1C > 70mmol/mol (8.6%)
20.6% vs 4.6%

Circ J 2016, 81:36-43
Sternal Wound Infection

Glycemic Control
Results in reduction of SWI and DSWI rates

3065 adult patients, program instituted to simplify glycemic control during an 18 month period

SWI incidence↓ from 2.6% to 1.0% (60% reduction)

Goal Glucose: <110mg/dl for 3 days of control minimum

BG 110-219 mg/dl  2U/hr insulin infusion
BG 220-299  5 U push + 2U/hr
BG 300-400  15U push  + 2U/hr

Hypoglycemia rate was only 0.004%

Cramer et al, Arch Surg 2008 Vol 143
Sternal Wound Infection

Glycemic Control

Simplify and Multidisciplinary Approach

The 1% incidence now is related to co-morbidities such as poorly controlled diabetes preoperatively.
Sternal Wound Infection

IMA and Diabetic Patients

126,235 Diabetic Patients

<table>
<thead>
<tr>
<th></th>
<th>LITA</th>
<th>1.6%</th>
</tr>
</thead>
<tbody>
<tr>
<td>122,465</td>
<td>BITA</td>
<td>3.1%</td>
</tr>
<tr>
<td>3770</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Risk ratio BTA vs. LITA= 1.71

Skeletonized superior to pedicle
If BITA skeletonized the risk is equal to LITA

Sternal Wound Infection
Risks and Prophylaxis: Evidence

**Preoperative Nutritional Status**
Hypoalbunemia $< 3.0\text{gm/ml}$ is a risk factor
Class I/Level B

**Preoperative Glycemic Control**
HgB A1c $>7.5\%$, Glucose $<180-200\text{mg/dl}$
Class I/Level B

**Smoking Cessation**
Class I/Level B
Sternal Wound Infection

Risks and Prophylaxis: Evidence

**Perioperative Antibiotics**
Within 60 minutes, no longer than 48 hours
Cephalosporin  (Vanco not indicated routinely)
Class I/Level A

**Topical Antibiotics**
To cut edges of sternum on opening and closing
Class I/Level B  (Vanco slurry)

**Bone Wax**
Avoid  Class III/Level B but often used still
Sternal Wound Infection

Intraoperative Risk Factor for DSWI/Mediastinitis
- Bilateral IMA (2.9 vs 3.9%)

Postoperative Risk Factor for DSWI/Mediastinitis
- Prolonged Ventilatory Support
- Air Leak (lung)

Preoperative Risk Factor for SWI
- Obesity
- Age > 75 years

Riddderstolpe et al., Europ Journal of CT Surgery 2001 (20:1168-1175)
Chlorhexidine bathing/shower
Class IIb/Level B

Figure 8 or Bands in high risk patients
Class IIb/Level B

Robicsek Weave if indicated
IIa/B
Sternal Wound Infection

Treatment Options

• Closed Suction
• Abx Catheter Irrigation
• VAC Dressing
• Omental Transposition
• Pectoralis Flaps- “turnover” or “rotation”
• Rectus Abdominus Flap
• Latissimus Dorsi Flap

Early wound exploration, debridement, and sternal fixation as first step to preserve sternum
Wound discharge with fever ± WCC

Intact sternum
- Drain the abscess, Antibiotics, Remove wires, VAC pump
  - Debride, Irrigate, Rewire, primary or delayed wound closure. If tissues under tension
    - Use pectoral flap

Sternal dehiscence
- Viable non infected sternum, low risk patient
  - Debride, Use a myocutaneous flap (one or two stage procedure)
- Necrotic infected sternum, multiple fractures, high risk patients
Sternal Wound Infection

**Rigid Sternal Fixation**
*(mostly for prophylaxis)*

May be used in mild infections, at time of debridement and closure

Contraindicated for treatment of SWI in following:

- Osteoporosis
- Active Infection
- Extreme obesity
- Signs of bone loss
Sternal Wound Infection

VAC - Vacuum Assisted Closure

Introduced in 1997
- Increased peri-sternal blood flow
- Reduces bacterial levels
- Enhances granulation tissue
- Stabilizes chest

VAC Failures:
- > 4cm depth of wound
- Bacteremia
- Exposed bone
- Sternal instability

VAC Risk:
- Bleeding
- Damage to underlying tissues such as heart
- Limit to <3 weeks

Barrier between heart and great vessels and VAC (NPWT)
VAC Therapy Improves Outcomes

22 Studies covering 2467 patients
Non-randomized, meta-analysis

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>VAC</td>
<td>5.2%</td>
</tr>
<tr>
<td>No-VAC</td>
<td>14.4%</td>
</tr>
</tbody>
</table>
Sternal Wound Infection

Immediate versus Delayed One-Stage Treatment

**N= 583 SWI**

497 referred immediately for treatment
LOS= 4.7 days
Mortality= 1%

86 Delayed repairs
LOS= 18 days
Mortality= 4.7%

Take home point – Do Not Delay
Sternal Wound Infection

Early vs. Delayed Referral for One-Stage Debridement and Flaps

<table>
<thead>
<tr>
<th></th>
<th>Immediate</th>
<th>Delayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>N= 583</td>
<td>497</td>
<td>86</td>
</tr>
<tr>
<td>Mechanical vent</td>
<td>4.4% (4days)</td>
<td>46.5% (18.3days)</td>
</tr>
<tr>
<td>Tracheostomy</td>
<td>2.6%</td>
<td>36%</td>
</tr>
<tr>
<td>III/IV Decub</td>
<td>4.8%</td>
<td>23.2%</td>
</tr>
<tr>
<td>Major Dehiscence</td>
<td>0%</td>
<td>14%</td>
</tr>
<tr>
<td>LOS</td>
<td>4.7 days</td>
<td>19.3 days</td>
</tr>
<tr>
<td>Mortality</td>
<td>1%</td>
<td>4.7%</td>
</tr>
</tbody>
</table>

Cabbabe et al, Plast Reconstr Surg 2009 129;1490-4
Sternal Wound Infection

Flap Coverage - Advantages

- Decreased vent dependence
- Decreased need for tracheostomy
- Decreased decubitus
- Decreased LOS
- Decreased mortality

Cabbabe et al, Plast Reconstr Surg 2009, 123:1490-1494
# Sternal Wound Infection

Debridement and Flap Reconstruction vs Traditional Debridement/Rewiring/Closed Drainage

<table>
<thead>
<tr>
<th></th>
<th>Major Comps</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flap Reconstruction</strong></td>
<td>22%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Traditional Approach</strong></td>
<td>92%</td>
<td>33%</td>
</tr>
</tbody>
</table>

Sternal Wound Infection

Muscle Flap Repair

13 year single Institution- 1994-2011

N=10404 patients

130 infections (1.25%) with 12 deaths

118 for Analysis  42% had muscle flaps- longer hospital stay, good outcome
60 day mortality= 12.3%

<table>
<thead>
<tr>
<th>Type</th>
<th>Blood supply</th>
<th>Limitations/adverse events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle flaps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pectoralis turnover flap</td>
<td>IMA and intercostal perforators</td>
<td>Functional arm impairment</td>
</tr>
<tr>
<td>Rotation-advancement pectoralis flap</td>
<td>Thoracoacromial pedicle</td>
<td>Functional arm impairment</td>
</tr>
<tr>
<td>Segmental pectoralis flap</td>
<td>Intercostal blood supply</td>
<td>Functional arm impairment</td>
</tr>
<tr>
<td>Rectus abdominis myocutaneous (RAM) flap</td>
<td>Epigastric arteries</td>
<td>Abdominal wall herniation</td>
</tr>
<tr>
<td>External oblique muscle (EOM) flap</td>
<td>Branches of the intercostals arteries</td>
<td>Only for defects below the 4th costal interspace</td>
</tr>
<tr>
<td>Latissimus dorsi muscle (LDM) flap</td>
<td>Thoracodorsal artery and serratus artery branch</td>
<td>Functional arm impairment</td>
</tr>
<tr>
<td>Non-muscle flaps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Omentum</td>
<td>Gastroepiploic artery</td>
<td>Hernia, reflux, dysphagia</td>
</tr>
<tr>
<td>Fasciocutaneous flaps</td>
<td>Superior epigastric vessels</td>
<td>Abdominal wall impairment</td>
</tr>
<tr>
<td>Split-thickness skin graft</td>
<td>None</td>
<td>Requires a well-vascularized bed</td>
</tr>
<tr>
<td>Rare options</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Osteocutaneous flap</td>
<td>Bone related vessel</td>
<td>Functional (arm) impairment</td>
</tr>
<tr>
<td>Free flaps</td>
<td>Various</td>
<td>Cosmetic impairment</td>
</tr>
</tbody>
</table>
Table 4. Check list prevention of infection in cardiac surgery.

<table>
<thead>
<tr>
<th>Preoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening for Methicillin-resistant S. aureus</td>
</tr>
<tr>
<td>MRSA decolonization</td>
</tr>
<tr>
<td>Hair removal with clippers</td>
</tr>
<tr>
<td>Optimal blood glucose level adjustment</td>
</tr>
<tr>
<td>Dental consult (?)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intraoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timely application of antibiotics</td>
</tr>
<tr>
<td>Antibiotics adapted to preexisting infection</td>
</tr>
<tr>
<td>Adequate surgical hand disinfection</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuing of decolonization</td>
</tr>
<tr>
<td>First dressing change with 24-48 hours</td>
</tr>
<tr>
<td>Regular blood glucose level adjustments</td>
</tr>
<tr>
<td>Termination of perioperative antibiotic prophylaxis at day 1</td>
</tr>
</tbody>
</table>

Note: *Joint mediastinitis register of the German Society for Thoracic and Cardiovascular Surgery (DGTHG), Institute for Quality and Patient Safety (BQS), National Reference Center for Surveillance of Nosocomial Infections (NRZ).*
Conclusions- Prevention:

Preoperative
Nutritional Status
Nasal Swab and/or Decolonization (Mupirocin)
DM control

Intraoperative
Perioperative ABx (48 hours), Vanco paste
Skeletonization of IMA
Dry closure

Post-operative
Glycemic control
Early extubation
Sternal Wound Infection

**Conclusions - Diagnosis and Treatment:**

- Early recognition
- Culture
- Antibiotics
- Re-exploration debridement, secure closure, ABx irrigation

Or

- VAC Dressing

- Immediate muscle flap Closure (pec or omental)
  - or Myocutaneous Flap