Perioperative Management and Strategies to Decrease Sternal Wound Infection

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Centers for Disease Control and classifications for Sternal Wound Infection (SWI)

• Superficial SWI
  – if only the skin and subcutaneous tissue are involved

• Deep SWI
  – when the infection reaches the sternum but does not involve it

• Osteomyelitis or Mediastinitis
  – when organ/space is involved

Centers for Disease Control and classifications for Mediastinitis

Diagnosis of Mediastinitis requires at least one of these Criterion:

• Organisms cultured from mediastinal tissue
• Evidence of mediastinitis seen during a surgical operation
• One of the following signs or symptoms: fever (>38°C), chest pain or sternal instability and at least one of the following:
  a. purulent discharge from mediastinal area
  b. organisms from blood or discharge from mediastinum
  c. mediastinal widening on x-ray.

Introduction

• Incidence of superficial SWIs after cardiac surgery is 0.5% to 8%
• Morbidity and mortality rate range from 0.5% to 9%
Introduction

- Incidence of mediastinitis after cardiac surgery is 1% to 5%.
- Mortality rate ranges from 10% to 47%
Sternal Wound Infection

- Extends hospital stay
- Leads to additional surgical procedures, vacuum-assisted wound dressing and antibiotic therapy
  - May triple health care costs in cardiac surgery

Risk Factors for SWI

- Reported consistently
  - Obesity
  - Prior cardiac surgery

Risk Factors for SWI

Reported inconsistently

- Diabetes or perioperative hyperglycemia
- Peripheral artery disease
- COPD
- Tobacco use
- Use of bilateral internal mammary arteries
- Prolonged surgical procedure (> five hours)
- Return to the operating room within four days postoperatively
- Prolonged postoperative intensive care
- Large female breast size
Objective

- Analyze the frequency of sternal wound infection before and after changes in infection control policy.
Method

- Retrospective cohort study
  - Control period 2008-2010 (1250 patients)
  - Postintervention period 2012 (439 patients)
- Infection control measures introduced between these periods
  - New hand disinfectants and strict disinfection technique
  - Sternal closure technique
  - Redon catheter discontinuation
  - Safe Surgery Saves Lives (SSSL)
  - Strict post-operative wound care guidelines
  - Post-operative support vests (Posthorax®)

- Sternal wound infections were classified according to the guidelines of the CDC
Hand disinfection technique

- Alcohol based Sterillium® (Bode Chemie GmbH, Hamburg, Germany)
- Chlorhexidine based Hibiscrub® (Mölnycke Health Care, Dietikon, Switzerland)
- Waterless scrub times of 2 minutes were recorded and scrubbing technique was standardized according the Guideline for Hand Hygiene in Health-Care Settings

Comparison of the bactericidal efficacy of five products for surgical hand disinfection with the reference alcohol (n-propanol)

- All achieved a reduction all organisms by 5 logs (RF=5) within 3 mins fulfilling the chemical disinfectants and antiseptics quantitative suspension test

- Sterillium® and Hibiscrub® were the only products that reduced the bacteria counts similar or more than 60% n-propanol immediately and after 3 hrs.

<table>
<thead>
<tr>
<th>Product</th>
<th>Immediate value</th>
<th>P-value</th>
<th>Requirement</th>
<th>3 h Value</th>
<th>P-value</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>n-propanol (60%)</td>
<td>0.83 ± 0.52</td>
<td></td>
<td></td>
<td>0.50 ± 0.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hibiscrub</td>
<td>0.82 ± 0.50</td>
<td>&gt;0.1</td>
<td>Pass</td>
<td>0.53 ± 0.98</td>
<td>&gt;0.01</td>
<td>Pass</td>
</tr>
<tr>
<td>Betadine</td>
<td>0.59 ± 0.47</td>
<td>&lt;0.1</td>
<td>Fail</td>
<td>0.29 ± 0.04</td>
<td>&lt;0.1</td>
<td>Fail</td>
</tr>
<tr>
<td>Derman Plus</td>
<td>-0.2 ± 0.30</td>
<td>&lt;0.1</td>
<td>Fail</td>
<td>-0.01 ± 0.46</td>
<td>&lt;0.1</td>
<td>Fail</td>
</tr>
<tr>
<td>Sterillium</td>
<td>1.45 ± 0.98</td>
<td>&lt;0.01</td>
<td>Pass</td>
<td>0.84 ± 0.93</td>
<td>&lt;0.01</td>
<td>Pass</td>
</tr>
<tr>
<td>Softa Man</td>
<td>1.06 ± 0.68</td>
<td>&lt;0.01</td>
<td>Pass</td>
<td>0.38 ± 0.72</td>
<td>&lt;0.1</td>
<td>Pass</td>
</tr>
</tbody>
</table>

Mean with standard deviation of 20 subjects.

a The mean is below the reference treatment and assessed not to be significantly lower at P = 0.1.
b The mean is above the reference treatment and assessed to be significantly higher at P = 0.01.
Safe Surgery Saves Lives’ (SSSL) checklist

- Sign In: Identification
- Time Out: Conformation
- Sign Out: To report if the surgery is performed as originally planned, additional unplanned interventions and the occurrence of unexpected complications

➢ Has been shown to result in efficient operation time, a reduction in-hospital complications and mortality within the first 30 days after surgery


Single loop technique Sternal closure

- Sternal closure in the post-intervention period is performed using surgical steel wires in single loop technique compared to the figure-of-eight technique used in the control period
  - easier to perform
  - less tissue damage
  - comparable mechanical support

Discontinuation of redon catheter

- Discontinuation of redon catheter
  - No benefit in reducing wound infection
  - May provide a route of entry for infective organisms

OPSITE Post-Op Visible (Smith & Nephew, Inc.)

• Replaced the normal gauze dressing during the post-intervention period.
  – Made of three layers: low adherent wound contact layer, lattice shaped absorbent pad and a waterproof top layer.

• Applied immediately and left in place for 5 days.

  Provides:
  ➢ barrier to bacteria
  ➢ reduced risk of maceration
  ➢ maintains a dry wound through a highly absorbent pad and breathable film
  ➢ allows uninterrupted monitoring of the wound

Discharge Instruction

• The patient is instructed to apply a waterproof dressing when showering and to keep the wound dry and clean until all wound crusts fall out to prevent maceration.

• Lotions, creams, oils, or powders on incision are strictly avoided until all crusts fall.
Posthorax® vest (Epple. Inc.. Vienna, Austria)

- 2011 the Posthorax® vest was introduced to the clinic to be worn for 6 weeks after surgery
  - Acts as shock absorber due to the cushions present on the front left and right side of the vest
  - Acts as an anteroposterior sternal stabilizer and fixes the two halves of the sternum in place
- Consistent use of the Posthorax® vest has been shown to prevent deep sternal wound infections.
Result

- A total of 1689 patients were included
  - 1250 patients (2008-2010)
  - 439 patients (2012)
## Preoperative Data

<table>
<thead>
<tr>
<th></th>
<th>Control period 2008-2010 (n=1250)</th>
<th>Post-intervention period 2012 (n=439)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>66.42</td>
<td>65.8</td>
<td>ns</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>28.6</td>
<td>27.6</td>
<td>ns</td>
</tr>
<tr>
<td>WBC (10⁹/l)</td>
<td>8.13</td>
<td>7.98</td>
<td>ns</td>
</tr>
<tr>
<td>C reactive protein (mg/ml)</td>
<td>12.32</td>
<td>11.95</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Creatinine (µmol/l)</td>
<td>84.8</td>
<td>87.74</td>
<td>0.043</td>
</tr>
<tr>
<td>Albumin (g/L)</td>
<td>40.55</td>
<td>41.65</td>
<td>ns</td>
</tr>
<tr>
<td>Ejection fraction (%)</td>
<td>53.4</td>
<td>54.6</td>
<td>0.018</td>
</tr>
<tr>
<td>Gender (% Female)</td>
<td>27.4</td>
<td>26.9</td>
<td>ns</td>
</tr>
<tr>
<td>Hypertension (%)</td>
<td>79.5</td>
<td>68.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diabetes (%)</td>
<td>22.8</td>
<td>22.2</td>
<td>ns</td>
</tr>
<tr>
<td>COPD (%)</td>
<td>7.6</td>
<td>8.1</td>
<td>ns</td>
</tr>
<tr>
<td>Euroscore</td>
<td>6.25</td>
<td>5.97</td>
<td>ns</td>
</tr>
</tbody>
</table>
## Correlation between preoperative data and infection

<table>
<thead>
<tr>
<th></th>
<th>No infection (n=1595)</th>
<th>Pre-sternal infection</th>
<th>Deep sternal infection (n=47)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>66</td>
<td>65.8</td>
<td>65.4</td>
<td>ns</td>
</tr>
<tr>
<td><strong>BMI kg/m²</strong></td>
<td>28.38</td>
<td>27.6</td>
<td>27.9</td>
<td>ns</td>
</tr>
<tr>
<td><strong>WBC 10⁹/l</strong></td>
<td>8.09</td>
<td>7.98</td>
<td>8.43</td>
<td>ns</td>
</tr>
<tr>
<td><strong>CRP mg/ml</strong></td>
<td>12.2</td>
<td>11.95</td>
<td>15.65</td>
<td>ns</td>
</tr>
<tr>
<td><strong>Creatinine µmol/l</strong></td>
<td>78</td>
<td>87.74</td>
<td>88.5</td>
<td>ns</td>
</tr>
<tr>
<td><strong>Albumin (g/L)</strong></td>
<td>41.2</td>
<td>41.65</td>
<td>40.94</td>
<td>ns</td>
</tr>
<tr>
<td><strong>EF%</strong></td>
<td>53.4</td>
<td>54.6</td>
<td>50.2</td>
<td>ns</td>
</tr>
<tr>
<td><strong>Gender (% Female)</strong></td>
<td>27</td>
<td>27.7</td>
<td>36.2</td>
<td>ns</td>
</tr>
<tr>
<td><strong>Hypertension (%)</strong></td>
<td>76.5</td>
<td>78.8</td>
<td>76.6</td>
<td>ns</td>
</tr>
<tr>
<td><strong>Diabetes (%)</strong></td>
<td>22.2</td>
<td>36.2</td>
<td>25.2</td>
<td>ns</td>
</tr>
<tr>
<td><strong>COPD (%)</strong></td>
<td>7.5</td>
<td>8.5</td>
<td>7.7</td>
<td>ns</td>
</tr>
<tr>
<td><strong>Euro score</strong></td>
<td>6.25</td>
<td>5.97</td>
<td>6.87</td>
<td>ns</td>
</tr>
</tbody>
</table>
Types of surgery performed

![Bar chart showing the percentage of patients for different procedures during control and intervention periods.](chart.png)
Use of BIMA

![Bar chart showing the use of BIMA from 2008-2010 and 2012 with a p-value of 0.006.]
Intra- and post-operative data
Correlation between intra- and post-operative parameters with sternal infection

<table>
<thead>
<tr>
<th></th>
<th>No Infection (n=1595)</th>
<th>Pre-sternal infection</th>
<th>Deep sternal infection (n=47)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical time (min)</td>
<td>278</td>
<td>329</td>
<td>327</td>
<td>0.017</td>
</tr>
<tr>
<td>Intubation time (h)</td>
<td>27.1</td>
<td>20.87</td>
<td>48.53</td>
<td>0.001</td>
</tr>
<tr>
<td>CKMB peak (µg/L)</td>
<td>56.85</td>
<td>53.7</td>
<td>56.7</td>
<td>ns</td>
</tr>
<tr>
<td>Creatinine peak (µmol/L)</td>
<td>85</td>
<td>119</td>
<td>124</td>
<td>ns</td>
</tr>
<tr>
<td>PRBC</td>
<td>3.22</td>
<td>3.79</td>
<td>7.98</td>
<td>0.04</td>
</tr>
<tr>
<td>Noradrenalin (µg/min)</td>
<td>9.77</td>
<td>7.53</td>
<td>12.5</td>
<td>0.016</td>
</tr>
<tr>
<td>Re-thoracotomy</td>
<td>6.4</td>
<td>10.9</td>
<td>13.3</td>
<td>ns</td>
</tr>
<tr>
<td>BIMA (%)</td>
<td>24.7</td>
<td>43.9</td>
<td>25.9</td>
<td>0.021</td>
</tr>
</tbody>
</table>
Conclusion

Despite the higher BIMA and noradrenaline use in 2012 multidisciplinary strategies resulted in fewer sternal infections:

- New hand disinfectants and strict disinfection technique
- Sternal closure technique
- Redon catheter discontinuation
- Safe Surgery Saves Lives (SSSL)
- Strict post-operative wound care guidelines
- Post-operative support vests (Posthorax®)
Conclusion

- Responsibility to educate new rotating resident surgeons on the changes implemented to reduce sternal infections

- Institutional guidelines to help in maintaining standards
Conclusion

Process Optimization