The Portland Diabetic Project: Infection

The Portland Protocol substantially reduces the incidence of hyperglycemia and thereby decreases the incidence of deep sternal wound infection (DSWI).
Hyperglycemia vs Infection
STS 1995

- N = 1500 DM patients
- Prospective collection of perioperative blood glucose levels q 1-2 hours

Hyperglycemia in the first 48 hours post cardiac surgery is an independent predictor of DSWI in diabetics:

Multivariable Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obesity</td>
<td>0.0029</td>
</tr>
<tr>
<td>ITA Graft</td>
<td>0.0183</td>
</tr>
<tr>
<td>Glucose &gt;200</td>
<td>0.0017</td>
</tr>
</tbody>
</table>
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DSWI by glucose Sextile --Current

N= 4775

mg / dl

- < 150: 0.6%
- 150 / 175: 0.6%
- 175 / 200: 1.1%
- 200 / 225: 1.0%
- 225 / 250: 2.1%
- > 250: 3.7%

p=0.001
Is post-operative **hyperglycemia** in patients undergoing open heart surgery associated with an increased incidence of deep sternal wound (mediastinitis) infection rates?

Yes -- increases risk by:

- **2x** @ 175-225 mg/dl
- **4x** @ 225 - 250 mg/dl
- **6x** @ > 250 mg/dl
Do Continuous Intravenous Insulin Infusions (CII) in postoperative cardiac patients substantially reduce the incidence of hyperglycemia and thereby reduce the incidence of deep sternal wound infection?

Total Cardiac Surgery Patients: 14,468

Diabetic Cohort: 17%
Age: 65 + 10 years
Sex: 62% male

n = 2,467

Deep Sternal Wound Infection Rates

- SQI: 2.0%
- CII: 0.8%

Statistical significance: p=0.01
# Demographic Comparison of Groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>SQI (%)</th>
<th>CII (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>54%</td>
<td>67%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Renal insufficiency</td>
<td>3.4%</td>
<td>6.6%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BMI (cm/M²)</td>
<td>28.4</td>
<td>29.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Steroid use</td>
<td>1.9%</td>
<td>3.5%</td>
<td>0.03</td>
</tr>
<tr>
<td>Urgent/emergent</td>
<td>51%</td>
<td>75%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>% IMA</td>
<td>64%</td>
<td>71%</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
## Multivariable Analysis of DSWI

<table>
<thead>
<tr>
<th>Variable</th>
<th>p value</th>
<th>Relative Risk</th>
<th>C.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CII</td>
<td>0.005</td>
<td>0.34</td>
<td>0.14 - 0.74</td>
</tr>
<tr>
<td>BMI</td>
<td>&lt;0.03</td>
<td>1.06</td>
<td>1.00 - 1.12</td>
</tr>
<tr>
<td>ITA graft</td>
<td>0.1</td>
<td>2.0</td>
<td>0.86 - 4.34</td>
</tr>
</tbody>
</table>

Area under the ROC curve = 0.762

n=2353
Hyperglycemia Impairs Immunity

BG > 180 mg/dl

Nonenzymatic Glycation of proteins

Inactivation of IgG
↓ Complement fixation
↑ Collagenase activity

Impairs Leukocyte Functions:

- Delays chemotaxis
- Impairs phagocytosis
- Hinders bacteriocidal activity

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Conclusions: STS 1998

♥ Hyperglycemia in diabetics, not the diagnosis of DM itself, is the causal factor for infection.

♥ The incidence of DSWI in diabetic patients can be normalized to that of the non-DM population through a CII infusion protocol which substantially and safely eliminates hyperglycemia.

♥ The standard utilization of CII in DM patients could dramatically reduce the staggering socioeconomic costs of DSWI in DM patients.

Data Analysis

ICU-CII

DM Pts.
Non-DM
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NO DSWI vs. DSWI: Mean BG

*p<0.01
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### Phased Implementation of the Portland CII Protocol

<table>
<thead>
<tr>
<th>Dates</th>
<th>Location</th>
<th>Target BG (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987 - 1991</td>
<td>SQI &gt; ICU / Tele</td>
<td>150 - 200</td>
</tr>
<tr>
<td>1992 - 1994</td>
<td>ICU only</td>
<td>150 - 200</td>
</tr>
<tr>
<td>1995 - 1998</td>
<td>OR / ICU / Tele</td>
<td>150 - 200</td>
</tr>
</tbody>
</table>

- **DM Pts.**
- **Non-DM**

Year: 87 88 89 90 91 92 93 94 95 96 97

Incidence of DSWI: 0.0% 1.0% 2.0% 3.0% 4.0%
Independent association of Isolated BG Measurements on DSWI

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hgb A-1C</td>
<td></td>
</tr>
<tr>
<td>BG-Preop</td>
<td></td>
</tr>
<tr>
<td>3-BG</td>
<td></td>
</tr>
<tr>
<td>BG-DOS</td>
<td></td>
</tr>
<tr>
<td>BG-POD1</td>
<td></td>
</tr>
<tr>
<td>BG-POD2</td>
<td></td>
</tr>
<tr>
<td>BG-POD3</td>
<td></td>
</tr>
</tbody>
</table>

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DSWI: SQI vs CII 1987 - 2004

N = 5009

p = 0.001
Answer #2

Do Continuous intravenous insulin infusions (CII) in postoperative cardiac patients substantially reduce the incidence of hyperglycemia and thereby reduce the incidence of deep sternal wound infection?

Yes -- Independently lower DSWI by 66%

Would Prevent ~ 3500 DSWI / Year