Cardiovascular-Thoracic (CVT) Critical Care 2010
Innovative Concepts, Protocols, and Technology to Increase Speed of Recovery, Safety & Patient Comfort

Goal Directed Therapy in the ICU

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Detroit, Michigan
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The Sunshine Act of Medical Transparency

I LOVE NASCAR!.... CAN I HAVE YOUR AUTOGRAPH?

SORRY, KID... I'M A DOCTOR.
Postoperative Sepsis in the United States

Todd R. Vogel, MD, MPH,* Viktor Y. Dombrovskiy, MD, PhD, MPH,* Jeffrey L. Carson, MD,†
Alan M. Graham, MD,* and Stephen F. Lowry, MD, MBA*

Annal of Surgery 2010
<table>
<thead>
<tr>
<th>Groups of Surgical Procedures</th>
<th>Incidence Rates of Sepsis, %</th>
<th></th>
<th>With Sepsis</th>
<th></th>
<th>Without Sepsis</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>95% CI</td>
<td>Rank</td>
<td>Mean</td>
<td>95% CI</td>
<td>Rank</td>
</tr>
<tr>
<td>Esophageal surgery</td>
<td>3.84</td>
<td>3.54, 4.13</td>
<td>1</td>
<td>33.43</td>
<td>30.11, 36.76</td>
<td>4</td>
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<tr>
<td>Pancreatic surgery</td>
<td>3.17</td>
<td>2.98, 3.35</td>
<td>2</td>
<td>31.93</td>
<td>29.31, 34.54</td>
<td>6</td>
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<tr>
<td>Gastric surgery</td>
<td>2.84</td>
<td>2.76, 2.92</td>
<td>3</td>
<td>33.12</td>
<td>31.61, 34.63</td>
<td>5</td>
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<tr>
<td>Small bowel surgery</td>
<td>2.75</td>
<td>2.61, 2.89</td>
<td>4</td>
<td>23.96</td>
<td>21.83, 26.08</td>
<td>11</td>
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<tr>
<td>Gallbladder surgery</td>
<td>1.80</td>
<td>1.70, 1.90</td>
<td>5</td>
<td>18.68</td>
<td>16.64, 20.73</td>
<td>13</td>
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<tr>
<td>Hepatic surgery</td>
<td>1.74</td>
<td>1.59, 1.89</td>
<td>6</td>
<td>36.37</td>
<td>32.48, 40.25</td>
<td>3</td>
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<tr>
<td>Splenic surgery</td>
<td>1.59</td>
<td>1.38, 1.81</td>
<td>7</td>
<td>29.68</td>
<td>24.09, 35.27</td>
<td>9</td>
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<tr>
<td>Adrenal surgery</td>
<td>1.48</td>
<td>1.20, 1.76</td>
<td>8</td>
<td>39.60</td>
<td>29.24, 49.96</td>
<td>2</td>
</tr>
<tr>
<td>Vascular surgery</td>
<td>1.40</td>
<td>1.35, 1.44</td>
<td>9</td>
<td>31.63</td>
<td>30.15, 33.11</td>
<td>7</td>
</tr>
<tr>
<td>Colorectal surgery</td>
<td>1.16</td>
<td>1.12</td>
<td>10</td>
<td>27.30</td>
<td>23.50, 25.49</td>
<td>10</td>
</tr>
<tr>
<td><strong>Cardiac surgery</strong></td>
<td><strong>1.11</strong></td>
<td><strong>1.09, 1.14</strong></td>
<td>11</td>
<td><strong>30.79</strong></td>
<td><strong>29.65, 31.94</strong></td>
<td>8</td>
</tr>
<tr>
<td><strong>Thoracic surgery</strong></td>
<td><strong>0.99</strong></td>
<td><strong>0.95, 1.04</strong></td>
<td>12</td>
<td><strong>45.90</strong></td>
<td><strong>43.83, 47.97</strong></td>
<td>1</td>
</tr>
<tr>
<td>Hernia surgery</td>
<td>0.84</td>
<td>0.78, 0.90</td>
<td>13</td>
<td>22.59</td>
<td>20.18, 25.80</td>
<td>12</td>
</tr>
<tr>
<td>Thyroidectomy</td>
<td>0.49</td>
<td>0.37, 0.61</td>
<td>14</td>
<td>7.30</td>
<td>0.92, 13.69</td>
<td>15</td>
</tr>
<tr>
<td>Breast surgery</td>
<td>0.29</td>
<td>0.23, 0.35</td>
<td>15</td>
<td>16.43</td>
<td>8.81, 24.05</td>
<td>14</td>
</tr>
</tbody>
</table>

30.8 - 45.9% Mortality
The Landscape of the Septic Patient

ER or ICU → ICU
Inflammatory Mediators Produce Cardiovascular Insufficiency

- Increased Metabolic Demands: Fever, Tachypnea
- Hypovolemia, Vasodilation & Myocardial Depression
- Microvascular Alterations: Impaired Tissue Oxygen Utilization
- Cytopathic Tissue Hypoxia

Fink, Crit Care Clin, 2002
Oxygen Debt: To Pay or Not to Pay

- full recovery possible
- delayed repayment of O$_2$ debt
- excessive O$_2$ deficit produces lethal cell injury with no-recovery
A Problematic Measurement

“It should be recognized that systemic hypoperfusion usually precedes hypotension”

Rackow, JAMA 1991
A Continuum from Benign to Severe Disease

A clinical response arising from a nonspecific insult, including ≥2 of the following:

- Temperature ≥38°C or ≤36°C
- HR ≥90 beats/min
- Respirations ≥20/min
- WBC count ≥12,000/mm³ or ≤4,000/mm³ or >10% bands
- PaCO2 < 32mmHg
Global Tissue Hypoxia: Diagnostic and Clinical Utility

OXYGEN DEMAND

OXYGEN DELIVERY

OXYGEN BALANCE

Global Tissue Hypoxia

Lactic Acid > 4 mM/L
Shock

Goal Directed

- DO₂
  - PaO₂
  - Hemoglobin
  - Cardiac Output

CNS and Systemic VO₂
- Stress
- Pain
- Hyperthermia
- Shivering
- Work of breathing

Cardiac Optimization
- Preload (CVP, PCWP, SVV)
- Afterload (MAP, SVR)
- Contractility (SV)
- Heart Rate (BPM)
- Coronary Perfusion Pressure

Endpoints of Resuscitation

- SvO₂
- Lactate
- (a-v)CO₂
- Base Deficit
- pH
- StO₂
- VO₂

Microcirculation
Several Randomized Control Trials Show That Increasing $O_2$ Transport is NOT Useful.

The Futility of Past Hemodynamic Optimization Trials: So Why bother?

Hayes et al:
NEJM 1994;330:1717

Alia et al:
Chest 1999, 115:453

24 hours

Global $O_2$ Delivery, Cardiac Output, Mixed Venous $O_2$ Saturation
Optimization Trials
“A Closer Look”

(Boyd, New Horiz, 1996)

(Boyd, New Horiz, 1996)
EARLY GOAL-DIRECTED THERAPY IN THE TREATMENT OF SEVERE SEPSIS AND SEPTIC SHOCK

EMANUEL RIVERS, M.D., M.P.H., BRYANT NGUYEN, M.D., SUZANNE HAVSTAD, M.A., JULIE RESSLER, B.S., ALEXANDRIA MUZZIN, B.S., BERNHARD KNOBLICH, M.D., EDWARD PETERSON, PH.D., AND MICHAEL TOMLANOVICH, M.D., FOR THE EARLY GOAL-DIRECTED THERAPY COLLABORATIVE GROUP*
Suspected infection and document source within 2 h

The high-risk patient: blood pressure < 90 mm Hg after 20-40 mL/kg volume challenge or lactic acid > 4 mmol/L

Antibiotics within 1 h and source control

CVP
- < 8 mm Hg: Crystalloid
- > 8-12 mm Hg: Decrease O₂ consumption

MAP
- < 65 mm Hg: Vasoactive agent(s)
- > 90 mm Hg: Decrease O₂ consumption

ScvO₂
- < 70%: Packed red blood cells to Hct > 30%
- > 70%: Inotrope(s)

Goals achieved
The influence of early hemodynamic optimization on biomarker patterns of severe sepsis and septic shock

Emanuel P. Rivers, MD, MPH; James A. Kruse, MD; Gordon Jacobsen, MS; Kant Shah, MD; Manisha Loomba, MD; Ronny Otero, MD; Ed W. Childs, MD

Crit Care Med, 2007
**IL-8 murine (pg/mL)**

- **EGDT**
- **Standard Therapy**

**Hours after the start of treatment**

- Lactate > 4 mM/L and ScvO2 < 70%
- Lactate > 2 and < 4 mM/L and ScvO2 < 70%
- Lactate < 2 mM/L and ScvO2 > 70%

**Shock on Admission: A Predictor of Prognosis for Ventilation in the ICU**

*Elisa Estessoro, MD; Francisco Canales, MD; Gabriel Arnaudo Dubin, MD*

Chest, 2005
Use of Mechanical Ventilation
Pre- & Post Sepsis Initiative Implementation

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>Pre-Implementation</th>
<th>Post-Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 hrs</td>
<td>43.0</td>
<td>54.0</td>
</tr>
<tr>
<td>6-72 hrs</td>
<td>37.0</td>
<td>45.0</td>
</tr>
</tbody>
</table>

16.6% RR
p = 0.03

13.9% RR
p = 0.0006
In-Hospital Length of Stay
Pre- & Post- Sepsis Initiative Implementation

Days

PRE-Implementation
21.2

POST-Implementation
15.6

5.6 days (26.4%)

p=0.0006
EGDT after a Decade
NEJM, 2001

The New England Journal of Medicine

EARLY GOAL-DIRECTED THERAPY IN THE TREATMENT OF SEVERE SEPSIS AND SEPTIC SHOCK

EMANUEL RIVERS, M.D., M.P.H., BRYANT NGUYEN, M.D., SUZANNE HAVSTAD, M.A., JULIE RESSLER, B.S., ALEXANDRIA MUZZIN, B.S., BERNHARD KNOBLICH, M.D., EDWARD PETERSON, PH.D., AND MICHAEL TOMLANOVICH, M.D., FOR THE EARLY GOAL-DIRECTED THERAPY COLLABORATIVE GROUP®

November 8, 2001
2778 Before

2997 After

16-18% Mortality Reduction

Absolute Risk Reduction
Does EGDT apply to the CTS Patient?
The Operative Landscape of the CTS Patient

CTS Patient -> CPB -> ICU

Primary Organ Dysfunction -> SIRS -> Recovery
Secondary Organ Dysfunction -> Progressive Organ Dysfunction
Oxygen Debt and Global Tissue Hypoxia

- CPB
- Full recovery possible
- Delayed repayment of O₂ debt
- Excessive O₂ deficit produces lethal cell injury with non-recovery
Systemic Hypoxia as a Stimulus of Inflammation


Systemic hypoxic and inflammatory syndrome: An alternative designation for “sepsis syndrome”

ERNEST BENJAMIN, MD, FCCM; ANDREW B. LEIBOWITZ, MD; JOHN OROPELLO, MD; THOMAS J. IBERTI, MD, FCCM

Critical Care Med, 1992
• No hyperlactemia (NHL).

• Intermediate hyperlactemia (IHL) on ICU admission.

• Late hyperlactemia (LHL) during their ICU stay.
325 patients undergoing CPB:
- 67 patients (20.6%) had an IHL on ICU admission
- 56 patients (17.2%) acquired LHL during their ICU stay.

The 3 groups differed significantly for:
- CPB duration, intraoperative MAP and intraoperative and postoperative use of vasopressor.
Independent risk factors for IHL:
- nonelective surgery
- CPB duration
- intraoperative use of vasopressor.

Logistic regression identified hyperglycemia and epinephrine therapy for LHL as postoperative risk factors.

Receiver operating characteristic curves showed that IHL more accurately predicted ICU mortality than LHL.
ICU mortality:

- 1.5% for No HL

- 3.6% for Late HL

- 14.9% for Intermediate HL (p < 0.0001).
Conclusions

• Hyperlactatemia is common after cardiac surgery.

• A lactate threshold of 3 mmol/L at ICU admission – population at risk of morbidity and mortality
Mixed venous oxygen saturation is a prognostic marker after surgery for aortic stenosis

*Acta Anaesthesiol Scand 2010; 54: 589–595*

J. Holm, R.E. Häkanson, F. Vánky and R. Svedeholm
Department of Cardiothoracic Surgery and Anesthesia, University Hospital, Linköping University, Linköping, Sweden

### Table 1

Pre-operative characteristics in patients with $\text{SvO}_2 \geq 55\%$ and $\text{SvO}_2 < 55\%$.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>$\text{SvO}_2 \geq 55%$</th>
<th>$\text{SvO}_2 &lt; 55%$</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>69 ± 10</td>
<td>72 ± 11</td>
<td>0.07</td>
</tr>
<tr>
<td>Female gender</td>
<td>47%</td>
<td>68%</td>
<td>0.02</td>
</tr>
<tr>
<td>BSA</td>
<td>1.86 ± 0.19</td>
<td>1.79 ± 0.17</td>
<td>0.04</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>11%</td>
<td>13%</td>
<td>0.77</td>
</tr>
<tr>
<td>Hypertension</td>
<td>28%</td>
<td>29%</td>
<td>0.84</td>
</tr>
<tr>
<td>COPD</td>
<td>9.0%</td>
<td>6.5%</td>
<td>1.0</td>
</tr>
<tr>
<td>NYHA class III/IV</td>
<td>56%</td>
<td>77%</td>
<td>0.02</td>
</tr>
<tr>
<td>Plasma-creatinine (µmol/l)</td>
<td>100 ± 25</td>
<td>106 ± 30</td>
<td>0.22</td>
</tr>
<tr>
<td>Hemoglobin (g/l)</td>
<td>134 ± 13</td>
<td>128 ± 12</td>
<td>0.008</td>
</tr>
<tr>
<td>LVEF (\leq 0.50)</td>
<td>6.0%</td>
<td>6.3%</td>
<td>1.0</td>
</tr>
<tr>
<td>Emergent/urgent procedure</td>
<td>6.3%</td>
<td>13%</td>
<td>0.15</td>
</tr>
<tr>
<td>EuroSCORE</td>
<td>5.4 ± 2.0</td>
<td>6.5 ± 2.4</td>
<td>0.003</td>
</tr>
</tbody>
</table>

BSA, body surface area; COPD, chronic obstructive pulmonary disease; NYHA, New York Heart Association classification; LVEF, left ventricular ejection fraction; EuroSCORE, additive EuroSCORE.
Mixed venous oxygen saturation is a prognostic marker after surgery for aortic stenosis

*Acta Anaesthesiol Scand* 2010; 54: 589–595

J. Holm, R.E. Håkanson, F. Váňky and R. Svedjeholm
Department of Cardiothoracic Surgery and Anesthesia, University Hospital, Linköping University, Linköping, Sweden
The best cutoff for mortality related to cardiac failure was \textbf{SvO2 53.7\%}, with a sensitivity of 1.00 and a specificity of 0.94. The negative predictive value was 100%.

\textit{ROC Curve}

\textbf{AUC} = 0.97 (95\% CI 0.96-1.00) \textbf{p}=0.001
The best cutoff for all-cause mortality was SvO2 of 58.1%, with a sensitivity of 0.75 and a specificity of 0.84. The negative predictive value was 99.4%.
Mixed venous oxygen saturation is a prognostic marker after surgery for aortic stenosis

*Acta Anaesthesiol Scand* 2010; 54: 589–595

J. Holm, R.E. Håkanson, F. Vánky and R. Svedjeholm
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Mixed venous oxygen saturation is a prognostic marker after surgery for aortic stenosis


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Department of Cardiothoracic Surgery and Anesthesia, University Hospital, Linköping University, Linköping, Sweden

- SvO$_2$ on admission to the ICU after surgery for aortic stenosis demonstrated excellent sensitivity and specificity:
  - For post-operative morbidity (stroke)
  - Mortality related to procedure-associated cardiac failure
  - A marker of badness.
A Prospective, Randomized Study of Goal-Oriented Hemodynamic Therapy in Cardiac Surgical Patients

Pekka Pölönen, MD*, Esko Ruokonen, MD, PhD*, Mikko Hippeläinen, MD, PhD†, Mikko Pöyhönen, MD, PhD*, and Jukka Takala, MD, PhD*

Critical Care Research Program, *Departments of Anesthesia and Intensive Care, and †Surgery, Kuopio University Hospital, Kuopio, Finland

(Anesth Analg 2000;90:1052–9)

Table 1. Clinical Data of the Study Groups

<table>
<thead>
<tr>
<th></th>
<th>Control group (n = 197)</th>
<th>Protocol group (n = 196)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>60.9 ± 9.3</td>
<td>60.0 ± 8.5</td>
</tr>
<tr>
<td>Sex (female), n (%)</td>
<td>54 (27.4)</td>
<td>47 (24.0)</td>
</tr>
<tr>
<td>EF (%)</td>
<td>63 ± 14</td>
<td>64 ± 15</td>
</tr>
<tr>
<td>Diabetes, n (%)</td>
<td>21 (10.7)</td>
<td>26 (13.3)</td>
</tr>
<tr>
<td>NYHA class</td>
<td>3.2 ± 0.8</td>
<td>3.1 ± 0.7</td>
</tr>
<tr>
<td>Operation</td>
<td></td>
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<tr>
<td>CABG, n (%)</td>
<td>138 (70.1)</td>
<td>150 (76.5)</td>
</tr>
<tr>
<td>Others, n (%)</td>
<td>59 (30.0)</td>
<td>46 (23.5)</td>
</tr>
<tr>
<td>TIA/stroke, n (%)</td>
<td>16 (8.1)</td>
<td>16 (8.2)</td>
</tr>
<tr>
<td>COPD, n (%)</td>
<td>13 (6.6)</td>
<td>5 (2.6)</td>
</tr>
<tr>
<td>Operation time (min)</td>
<td>251 ± 78</td>
<td>242 ± 68</td>
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<tr>
<td>Perfusion time (min)</td>
<td>141 ± 51</td>
<td>134 ± 44</td>
</tr>
<tr>
<td>X-clamp time (min)</td>
<td>120 ± 42</td>
<td>116 ± 38</td>
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<tr>
<td>Anastomosis (n)</td>
<td>4 ± 2</td>
<td>4 ± 2</td>
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</tbody>
</table>
Enrollment and randomization of the patients
- day before surgery

Control group, n = 197
standard clinical care, see text

Protocol group, n = 196
interventions in addition to standard clinical care, see text

after CPB baseline

Hemodynamic and oxygen transport measurement
timepoint

ICU arrival

ICU 2 hrs

ICU 6 hrs

ICU 8 hrs

after CPB baseline

ICU arrival

ICU 2 hrs

ICU 6 hrs

ICU 8 hrs

Interventions in the protocol group:
dobutamine infusion at 18 microgram/min

SvO₂ > 70, Lact ≤ 2.0

Organ dysfunctions:
on the first postoperative morning and on the hospital discharge
<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>Off CBP</th>
<th>ICU arrival</th>
<th>ICU 2 h</th>
<th>ICU 6 h</th>
<th>ICU 8 h</th>
<th>Time</th>
<th>Group-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>DO$_2$ (mL · min$^{-1}$ · m$^{-2}$)</td>
<td>Control</td>
<td>339 ± 82</td>
<td>400 ± 83</td>
<td>445 ± 112</td>
<td>455 ± 97†</td>
<td>465 ± 94†</td>
<td>P &lt; 0.001</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>Protocol</td>
<td>343 ± 84</td>
<td>395 ± 86</td>
<td>461 ± 104</td>
<td>489 ± 115</td>
<td>508 ± 106</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VO$_2$ (mL · min$^{-1}$ · m$^{-3}$)</td>
<td>Control</td>
<td>76 ± 22 ‡</td>
<td>113 ± 22</td>
<td>127 ± 29</td>
<td>134 ± 26</td>
<td>128 ± 22</td>
<td>P &lt; 0.005</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Protocol</td>
<td>82 ± 28 ‡</td>
<td>113 ± 21</td>
<td>127 ± 28</td>
<td>140 ± 27</td>
<td>131 ± 22</td>
<td>P &lt; 0.001</td>
<td></td>
</tr>
<tr>
<td>O$_2$ER (%)</td>
<td>Control</td>
<td>24 ± 8</td>
<td>29 ± 6</td>
<td>29 ± 6</td>
<td>29 ± 5</td>
<td>28 ± 5†</td>
<td>P &lt; 0.001</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>Protocol</td>
<td>25 ± 9</td>
<td>29 ± 6</td>
<td>28 ± 6</td>
<td>28 ± 5</td>
<td>26 ± 4</td>
<td>P &lt; 0.001</td>
<td></td>
</tr>
<tr>
<td>SVO$_2$ (%)</td>
<td>Control</td>
<td>74 ± 8</td>
<td>67 ± 6</td>
<td>67 ± 6</td>
<td>68 ± 5</td>
<td>69 ± 5†</td>
<td>P &lt; 0.001</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>Protocol</td>
<td>73 ± 9</td>
<td>67 ± 7</td>
<td>68 ± 6</td>
<td>69 ± 5</td>
<td>71 ± 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lactate (mmol/L)</td>
<td>Control</td>
<td>1.53 ± 0.39</td>
<td>1.13 ± 0.39</td>
<td>1.06 ± 0.44</td>
<td>1.22 ± 0.39</td>
<td>1.27 ± 0.39</td>
<td>P &lt; 0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Protocol</td>
<td>1.71 ± 0.6</td>
<td>1.17 ± 0.47</td>
<td>1.02 ± 0.46</td>
<td>1.17 ± 0.65</td>
<td>1.17 ± 0.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔPCO$_2$ (kPa)</td>
<td>Control</td>
<td>0.36 ± 0.20</td>
<td>0.60 ± 0.23</td>
<td>0.73 ± 0.19</td>
<td>0.79 ± 0.24</td>
<td>0.79 ± 0.23</td>
<td>P &lt; 0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Protocol</td>
<td>0.55 ± 0.26</td>
<td>0.60 ± 0.19</td>
<td>0.70 ± 0.20</td>
<td>0.75 ± 0.20</td>
<td>0.77 ± 0.27</td>
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</tr>
</tbody>
</table>
• Outcomes:
  – ↓ median hospital stay
    (6 vs 7 days, \( P < 0.05 \))
  – ↓ morbidity at the time of hospital discharge
    (1.1% vs 6.1%, \( P < 0.01 \))

• Increasing \( \text{DO}_2 \) to achieve normal \( \text{SvO}_2 \) values and lactate during the immediate postoperative period decreases costs.
Early goal-directed therapy in moderate to high-risk cardiac surgery patients

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### Table 1: Demographic data of both groups

<table>
<thead>
<tr>
<th></th>
<th>Control group (n = 14)</th>
<th>EGDT group (n = 13)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>62.2 ± 7.5</td>
<td>58.1 ± 9.1</td>
<td>0.87</td>
</tr>
<tr>
<td>Male: female ratio</td>
<td>11:3</td>
<td>10:3</td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>160.7 ± 10.5</td>
<td>161.6 ± 8.0</td>
<td>0.16</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>67.1 ± 8.4</td>
<td>68.6 ± 8.1</td>
<td>0.89</td>
</tr>
<tr>
<td>EuroSCORE</td>
<td>4.3 ± 1.1</td>
<td>4.3 ± 1.1</td>
<td>0.71</td>
</tr>
<tr>
<td>CPB (min)</td>
<td>98.3 ± 6.7</td>
<td>99.0 ± 7.9</td>
<td>0.68</td>
</tr>
<tr>
<td>AOXCL (min)</td>
<td>53.8 ± 5.8</td>
<td>54.0 ± 7.5</td>
<td>0.52</td>
</tr>
<tr>
<td>Average number of grafts</td>
<td>3.1 ± 0.3</td>
<td>3.2 ± 0.4</td>
<td>0.49</td>
</tr>
</tbody>
</table>

P < 0.05 significant. CPB: Cardiopulmonary bypass, AOXCL: Aortic cross clamp, EGDT: Early goal-directed therapy
<table>
<thead>
<tr>
<th>Outcome Description</th>
<th>Control Group (n = 14)</th>
<th>EGDT Group (n = 13)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average extra volume used</td>
<td>80 ± 80</td>
<td>330 ± 160</td>
<td>0.043*</td>
</tr>
<tr>
<td>Number of times the inotropic agents were changed</td>
<td>0.4 ± 0.7</td>
<td>3.4 ± 1.5</td>
<td>0.026*</td>
</tr>
<tr>
<td>Duration of ventilatory support (h)</td>
<td>20.7 ± 7.1</td>
<td>13.8 ± 3.2</td>
<td>0.304</td>
</tr>
<tr>
<td>Duration of use of inotropic agents (days)</td>
<td>3.8 ± 1.6</td>
<td>1.6 ± 0.9</td>
<td>0.136</td>
</tr>
<tr>
<td>Length of ICU stay (days)</td>
<td>4.9 ± 1.8</td>
<td>2.6 ± 0.9</td>
<td>0.142</td>
</tr>
<tr>
<td>Length of hospital stay (days)</td>
<td>8.8 ± 2.1</td>
<td>5.8 ± 1.2</td>
<td>0.161</td>
</tr>
</tbody>
</table>

*P < 0.05 significant
EGDT in the CTS Patients

• A systematic approach to detection and resolution global tissue hypoxia.
  – Post op surgery
  – Secondary sepsis
• Generally shown to be effective in decreasing:
  – Morbidity
  – Mortality
  – Health care resource consumption