ERAS for Cardiac Surgery!
Really?
Really!

Jonathan Parmet, M.D.
Director of Cardiovascular Anesthesiology
Society Hill Anesthesia Consultants
Goals

• What is ERAS? Or Fast track surgery
• Implementing “On table Extubation” for patients undergoing isolated CABG
What is ERAS

• First described by H. Kehlet 1999 Br J Anesth- a multidisciplinary approach to surgical procedures with the aim of reducing postoperative length of stay, perioperative morbidity/mortality, and attenuating the stress response to surgery.

• Targeted surgical population – colorectal surgery

• Emphasized multimodal non-opioid analgesics and the use of regional anesthetics to accomplish this goal
The state of colorectal surgery prior to ERAS

• Standard colorectal surgery complication rate = 20-30%
  – Ileus
  – Pulmonary dysfunction
  – Pain

• Postoperative length of stay (LOS) 8-12 days

- Implemented standardized enhanced recovery pathway
- Re-evaluated the following:
  - Fasting in preoperative period
  - Intra-operative liberal fluid administration
  - Liberal use of nasogastric tubes
  - Opioid-centric pain management strategies
From Theile: Preop/intraop/ postop pathway prior to ERAS protocol implementation

• Night before surgery mechanical bowel prep (4 l Golytely, erythromycin (1g x 3), neomycin (1g x 3), and metoclopramide (10mg x 3)
• Clear liquids day before surgery
• NPO past midnight
• Liberal intra-operative opioid use
• Low thoracic epidural (bupivacaine and hydromorphone) for open procedures.
• No regional for laparoscopic procedures
Prior to ERAS- postop pathway

• Postoperative fluid NSS or lactated ringers at 125 cc/hr until patient tolerated a diet
  – Clear liquid 1st postop day
• Postoperative pain- PCA fentanyl, morphine, or hydromorphone. PO pain med once tolerate diet
• d/c criteria regular diet, flatus, and pain control
Theile: ERAS protocol

- Expectations reviewed in preoperative visit
- ERAS denoted in EMR
- Night before MBP - Regular diet until 6 pm - clear liquids until 2 hrs before surgery - 20 oz gatorade 2 hrs before anesthesia induction
- Preop - 200 mg Celecoxib, 600 mg Gabapentin, and 975 oral Acetaminophen
Theile: ERAS anesthesia protocol

- Intrathecal morphine (100 µg)
- Subcutaneous unfractionated heparin 5,000 subcutaneous after spinal
- N-methyl-D-aspartate (Mg^{++} 30 mg/kg, ketamine 0.5 mg/kg) ketamine infusion 10 µg/kg/min- opioid sparing effects
- IV lidocaine infusion (40 µg/kg/hr) and 48 hrs postop (1mg/hr)
- Intraop fluid management goal directed
Theile: Postop ERAS

- Pt get out of bed in PACU to be weighed and are out of bed and in chair night of surgery
- Clear liquids given in PACU and night of surgery
- D/c Iv morning after surgery
- Soft diet 1st postoperative day
- Scheduled doses of acetaminophen and celecoxib (q 4h day of surgery, or 6:00 am 1st postop day for open)
Table 3
Compliance with Protocol Elements

<table>
<thead>
<tr>
<th>Protocol elements</th>
<th>Before ER protocol (n = 98)</th>
<th>After ER protocol (n = 109)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraoperative morphine equivalents, mg, mean ± SD</td>
<td>21.7 ± 10.7</td>
<td>0.5 ± 1.1</td>
<td>0.0001</td>
</tr>
<tr>
<td>Total morphine equivalents, mg, mean ± SD</td>
<td>280.9 ± 395.7</td>
<td>63.7 ± 130.0</td>
<td>0.0001</td>
</tr>
<tr>
<td>Intraoperative net fluid balance, mL, mean ± SD</td>
<td>2,733 ± 1,464</td>
<td>848 ± 953</td>
<td>0.0001</td>
</tr>
<tr>
<td>Total net fluid balance, mL, mean ± SD</td>
<td>4,409 ± 5,496</td>
<td>-182 ± 3,933</td>
<td>0.0001</td>
</tr>
<tr>
<td>Gatorade, n (%)</td>
<td>—</td>
<td>90 (83)</td>
<td>NA</td>
</tr>
<tr>
<td>Ambulate DOS, n (%)</td>
<td>0</td>
<td>84 (77)</td>
<td>0.0001</td>
</tr>
<tr>
<td>Ambulate by POD 1, n (%)</td>
<td>79 (81)</td>
<td>96 (88)</td>
<td>0.178</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Before ER protocol (n = 98)</td>
<td>After ER protocol (n = 109)</td>
<td>p Value</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------------------------</td>
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<td>---------</td>
</tr>
<tr>
<td>Length of stay, d, mean ± SD (median)</td>
<td>6.8 ± 4.7 (5)</td>
<td>4.6 ± 3.6 (3)</td>
<td>0.0002</td>
</tr>
<tr>
<td>Open</td>
<td>7.5 ± 5.3 (6)</td>
<td>5.2 ± 4.4 (4)</td>
<td>0.007</td>
</tr>
<tr>
<td>Laparoscopic</td>
<td>5.5 ± 2.6 (5)</td>
<td>3.8 ± 2.1 (3)</td>
<td>0.003</td>
</tr>
<tr>
<td>Readmission</td>
<td>17 (17)</td>
<td>10 (9)</td>
<td>0.1</td>
</tr>
<tr>
<td>Ileus</td>
<td>27 (28)</td>
<td>18 (17)</td>
<td>0.06</td>
</tr>
<tr>
<td>Unplanned intubation</td>
<td>2 (2)</td>
<td>1 (1)</td>
<td>0.60</td>
</tr>
<tr>
<td>Death</td>
<td>0</td>
<td>0</td>
<td>1.0</td>
</tr>
<tr>
<td>Superficial/deep SSI</td>
<td>10 (10)</td>
<td>4 (4)</td>
<td>0.09</td>
</tr>
<tr>
<td>Organ space SSI</td>
<td>10 (10)</td>
<td>4 (4)</td>
<td>0.09</td>
</tr>
<tr>
<td>Any SSI</td>
<td>20 (20)</td>
<td>8 (7)</td>
<td>0.008</td>
</tr>
<tr>
<td>Thromboembolic event</td>
<td>4 (4)</td>
<td>3 (3)</td>
<td>0.71</td>
</tr>
<tr>
<td>Progressive renal insufficiency</td>
<td>0</td>
<td>0</td>
<td>1.0</td>
</tr>
<tr>
<td>Acute renal failure</td>
<td>0</td>
<td>0</td>
<td>1.0</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>3 (3)</td>
<td>1 (1)</td>
<td>0.35</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>1 (1)</td>
<td>1 (1)</td>
<td>1.0</td>
</tr>
<tr>
<td>Postoperative bleeding</td>
<td>12 (12)</td>
<td>6 (6)</td>
<td>0.13</td>
</tr>
<tr>
<td>Sepsis</td>
<td>1 (1)</td>
<td>2 (2)</td>
<td>1.0</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>1 (1)</td>
<td>3 (3)</td>
<td>0.62</td>
</tr>
<tr>
<td>Unplanned return to OR</td>
<td>7 (7)</td>
<td>5 (5)</td>
<td>0.56</td>
</tr>
<tr>
<td>Any complication</td>
<td>30 (30)</td>
<td>16 (15)</td>
<td>0.007</td>
</tr>
<tr>
<td>Mean 30-d direct cost, mean ± SD</td>
<td>20,435 ± 12,857</td>
<td>13,306 ± 9,263</td>
<td>0.001</td>
</tr>
</tbody>
</table>
Elements of ERAS

- No bowel prep
- Limit premedication
- No preoperative fasting
- Clear carbohydrates 2-4 hours prior to surgery
- Standard anesthetic technique
- Thoracic Epidural or TAP or IT narcotic
- High FIO2 (80%)
- Avoid perioperative fluid overload
- Maintain normothermia
- Small transverse incision
- Multimodal Non-opioid analgesia
- Early removal of bladder catheters
- Early postoperative feeding and mobilization
Enhanced recovery for Isolated CABG: Initiating an on table extubation (OTE) program and reducing postoperative length of stay. Abst STS 2019 San Diego California

• Despite the enormity of undergoing cardiac surgery, patients primarily fear postoperative mechanical ventilation

• As of 2018, the Society of Thoracic Surgeons national database reports an On Table Extubation rate of 2.9%

• Only 57% of CABG patients achieve postoperative extubation < 6hrs after ICU arrival

• In 2014 at PAH, we achieved an OTE in 48% of isolated CABG- ICU Postop BiPAP= 50% of OTE patients
PAH CABG: 2014

- **Non-standardized Anesthetic for OTE**
  - Anesthetic 2-4 mg midazolam, 15-20 IV fentanyl, rocuronium or vecuronium
  - Reversal with neostigmine/glyco
  - Some patients received preop intrathecal narcotic

- **ICU concern over the benefit of OTE**
  - Patients over sedated
  - Patients under sedated

- **Non-standardized opioid administration**
  intraoperative and postoperative

- **No standardized perioperative pain management strategy**
PAH CABG: 2015

• Preoperative Clinic surgical team set patient pain expectations
• 1/3 of patients received intrathecal duramorph (0.25 mg, with 5 ug of fentanyl)
• 2015 piloted the use of 1 gm of IV acetaminophen after separation from CPB, and limit dose of Intravenous fentanyl 10-15 cc
• Avoid IV opioids post CPB separation
PAH CABG: 2016-2019

• 2016-2018 increased use of preoperative Intrathecal narcotic administration
• 2016-2018 increased use of preoperative oral gabapentin (300mg) – attempt to limit intraoperative opioids
• 2018 (April)- piloted after induction of general anesthesia - bilateral serratus anterior blocks (0.5% bupivacaine with 1:200,000 epi)
• 2019 (January) scheduled dose of gabapentin for 24 hrs postoperative (100mg), along with 3 doses IV acetaminophen
• 2019 (February)- standard use of Ketamine (0.1 mg/kg/hr) and dexametatomididine (0.1 µg/kg/hr). Limit intraoperative IV opioid to 5 cc or less of IV fentanyl.
PAH CABG: Post CPB

- After protamine administration - 1 gm acetaminophen
- Ketamine infusion turned off
- With chest wires dexametetomidine off
- After chest closure reversal with sugammadex
- After chest closure convert spontaneous respiration
Surgical Technique

• Proximal anastomosis prior to CPB
• CPB - warm beating heart – maintain normothermia
  – Distal anastomosis on cpb with cardiac stabilizer
• LV vent placed
• No Aortic cross clamp i.e. no ischemic arrest
• Low use of post CPB inotropes
OTE by year

Percent OTE in CABG Patients by Year

<table>
<thead>
<tr>
<th>Year</th>
<th>Percent OTE in CABG Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>0.0%</td>
</tr>
<tr>
<td>2013</td>
<td>6.9%</td>
</tr>
<tr>
<td>2014</td>
<td>48%</td>
</tr>
<tr>
<td>2015</td>
<td>60%</td>
</tr>
<tr>
<td>2016</td>
<td>68%</td>
</tr>
<tr>
<td>2017</td>
<td>76.0%</td>
</tr>
<tr>
<td>2018</td>
<td>74.00%</td>
</tr>
<tr>
<td>STS 2017</td>
<td>2.30%</td>
</tr>
</tbody>
</table>

Graph shows a significant increase in OTE from 2012 to 2018, with a notable drop in STS 2017.

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Post OTE use of BiPAP by year

Percent BiPAP in OTE CABG Patients by Year

- 2014: 50%
- *2015: 26%
- 2016: 6%
- 2017: 9%
- 2018: 13%
Post op LOS OTE vs Non OTE

**Postop LOS Days OTE vs. Non-OTE**

- *Postop LOS OTE*: 5.6
- Postop LOS Non-OTE: 9

**Number of Days Postop**

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Establishing a standardized multimodal analgesic Protocol

- Preoperative IT narcotic (n=157)
  - 2015-26%
  - 2016-58%
  - 2017-76%
  - 2018-74%

- Preoperative GABA (n=143)
  - 2016-46%
  - 2017-88%
  - 2018-88%

- Post CPB IV acetaminophen (n=183)
  - 2015-63%
  - 2016-78%
  - 2017-76%
  - 2018-85%
24 hour postoperative Fentanyl requirements at PAH

- *Intrathecal Narc vs No Intrathecal Narc*
  - 67.55 µg vs 138 µg, p=0.004

- Preop Gaba vs No preop Gaba
  - 85 µg vs 112.5 µg p= 0.3

- *Preop Gaba/ Intrathecal Narc vs No Preop Gaba Nointrathecal Narc*
  - 52 µg vs 123µg , p= 0.0019
24 hr Fentanyl requirements by year at PAH in CABG

- 2015 = 115 µg
- 2016 = 89.18 µg
- 2017 = 98 µg
- 2018 = 172 µg *
- 2019 = 60 µg
Intraoperative IV Fentanyl administration from 2015-2019 at PAH

• 2013 – 750- 1000 µg 20 cc
• 2014- 750- 1000 µg 20 cc
• 2015 – 611.19 µg 12 cc
• 2016 – 554.88 µg 11cc
• 2017 – 594.7 µg 12cc
• 2018 – 486.62 µg 9 cc
• January 2019- 350 µg 7 cc
• February – April 2019- 223.33 µg 4.5 cc
ERACS Postoperative Standardized Pain Management at PAH

- Gaba/ Acetaminophen  3 doses postop
- Rescue pain medication- IV dilaudid, po oxycontin, some cases Ketoralac
- > 50 % of CABG patients are now out of bed to chair day of surgery (10% within 1 hr of ICU arrival)
- 10 % of CABG patients ambulate the night of surgery with 50% Ambulating the next day
- LOS 4-5 days with the goal of decreasing to 3 day LOS (STS CABG LOS = 6.9 days)
GABA and ERAS/ERACS Opioid Sparring Anesthesia

- Gaba/acetaminophen the night prior to surgery
- Gaba preop and acetaminophen po - 2 hrs prior to arrival in the hospital
- Scheduled dosing of Gaba/Aceta for 48 hrs in the postoperative period
- Meta-analysis support an opioid sparring effect of perioperative Gaba (pre and postop)
Benefits of Opioid Sparring

- Reduce PONV
- Reduce ileus
- Reduce urinary retention
- Postoperative delirium (Leung J. Anesthesiology 2017; 127:633-44)
- Reduce postoperative opioid administration (Tiippana E. Anesth & Analg 2007;104:1545-56)
- Reduce % of patients that develop postoperative opioid dependence (JAMA April 2018)
Conclusion

• Developing ERACS takes time
• It takes a multispecialty team to effectively implement ERACS and reduce postop LOS
• Institutional culture remains an impediment but can be overcome
• OTE is associated with reducing Postop LOS
  – STS still rates programs on the < 6 hr benchmark
• If more programs adopt OTE/ ERACS significant reduction in health cost for isolated CABG can occur
Thank you

• The cardiac anesthesia/surgical team
  – Darryl H. Berkowitz, MD, Pietro Colonna-Romano, MD
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    Brian Blanchard, CRNP, Katherine Hilliard, PA-C, Theresa Ryan, MSN

• ICU nursing staff

• Society Hill Anesthesia Consultants

• Pennsylvania Hospital of the University of Pennsylvania Health Systems