Definition:
Multimodal care pathways designed to reduce the patients’ stress response to surgery, support their physiologic function, and accelerate the return to normal daily function.

Learner Outcomes
1. Identify what key factors contribute to the concept of Enhanced Recovery After Surgery.
2. Define Goal-Directed Fluid Therapy and its effect on patient outcome.
3. Understand how ERAS plays an important role in healthcare delivery today.

Conventional Approach To Patient Care

Healthcare Reimbursement: Then and Now

Enhanced Recovery: Changing How We Do Things
Bruce Weiner, CRNA, MS
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Surgical Complication Rate

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Adverse Event Rate</th>
<th>Average Added LOS (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esophagectomy</td>
<td>55%</td>
<td>12</td>
</tr>
<tr>
<td>Pelvic Exenteration</td>
<td>4%</td>
<td>13</td>
</tr>
<tr>
<td>Pancreatectomy</td>
<td>35%</td>
<td>7</td>
</tr>
<tr>
<td>Colectomy</td>
<td>29%</td>
<td>10</td>
</tr>
<tr>
<td>Gastrectomy</td>
<td>29%</td>
<td>12</td>
</tr>
</tbody>
</table>

Complications Are Costly

Impact of Complications On Length Of Stay

- One Complication: Additional 10.99 days
- Two Complications: Additional 5.18 days
- Three Complications: Additional 2.59 days

Reducing Surgical Stress And Improving Recovery

Opportunities For Improvement

- Broad-based adoption of interventions to improve quality of care, reduce variation in care, post-operative complications and costs.
- ER facilitates transition from traditional to evidence-based practices to improve patient satisfaction and outcomes:
  - Lower pain scores
  - Faster return of bowel function
  - Early mobilization
  - Reduced length of stay
  - Lower cost

History Of ERAS

- 1993 - Henrik Kellet, MD, PhD, Danish Surgeon initiated concept
  - Specific protocols established for colorectal surgery
- 2000 - ERAS collaboration of Northern Europe in 2000
- 2009 - Department of Health in England established ERAS Program for 8 elective procedures
  - Orthopedic
  - Colorectal Surgery
  - GYN
  - Urology
- 2010 - ERAS Society founded
  - [www.erasociety.org](http://www.erasociety.org)
Components of Enhanced Recovery

Preoperative Phase

- Prehabilitation • A comprehensive preoperative program that enhances functional capacity of the individual to enable them to withstand an incoming stressor
- Patient education
  - Provides patients with tools needed to manage stress of surgical experience and become partners in their own recovery
  - Dedicated preoperative counseling
  - Provides realistic expectations for anesthesia, surgery and recovery
- Exercise
  - Strength and aerobic training
  - Incentive spirometry
  - Smoking/ETOH cessation at least 4 weeks preop

Preoperative Phase

- Rethinking NPO after midnight
  - Light meal 6 hrs preop
  - Widely accepted for most patients to have clear liquids 2 hours before anesthetization
  - 250 ml Carbohydrate drink 2 hrs pre-op
  - Decreases risk of hypoglycemia and improves retention of protein and preserves lean body mass
- Venous Thromboembolism (VTE) prophylaxis
  - Sequential compression device (SCD)
  - Low dose unfractionated heparin or LMWH post-operatively
- Bowel Prep?

Mechanisms for Pain Control

Entereq (Alvimopan)

- Entereq 12 mg PO
- Gabapentin 300 mg PO
- Celebrex 400 mg PO
- Acetaminophen 1000 mg IV
- Antiemetics for patients at risk

Entereq 12 mg PO pre-op, than BID

5/7/16
Gabapentin (Neurontin)

- Decreases opioid use
- Structurally similar to GABA, but binds to voltage-gated calcium channels, modulating release of excitatory neurotransmitters
- Side effects include sedation, dizziness, visual disturbances
- Peak plasma level 1-2 hrs, but peak CSF level 6-8 hrs
- 300 mg preferably one hour pre-incision

Celecoxib (Celebrex)

- COX-2 inhibitor
- Contraindicated in Hepatic related procedures
- Dose 400 mg PO

Acetaminophen (Ofirmev)

- Mechanism of Action Undear
- Inhibits prostaglandins centrally, not peripherally like NSAIDS
- Avoid in patients with severe hepatic impairment
- 1 gram IV Q6 hs x 24 hours and then 650 mg PO with start of early oral intake

PONV Prophylaxis

- Ondansetron (Zofran) 4 mg IV
- Dexamethasone (Decadron), 4 mg IV
- Avoidance of N2O
- Aprepitant (Emend) 40 mg PO in patients of risk

Components of Enhanced Recovery

Intraoperative Phase

- Minimally invasive surgery
  - Laparoscopic or minimal open incision
- Regional Anesthesia
  - Mid-thoracic epidural
  - Regional nerve blocks
  - TAP blocks or paravertebral
  - Infiltration with long-acting local anaesthetics
  - Low-dose brief use of sedatives
- Limit systemic opioids and inhalational anesthetics
- Minimizing opioids
  - Infusions
  - Epidural agents
  - Regional anesthesia
  - Tricyclic antidepressants
  - Anticonvulsants
Intraoperative Phase

- Active Warming
- Forced Air Warming
- Fluid Warmers

• Goal-Directed Fluid Therapy

Goal-Directed Fluid Therapy (GDFT)
Minding The Spigot

Wet Or Dry: What’s the Answer

- Too little fluid results in poor tissue perfusion with potential for ischemic injury to vital organs
- Too much fluid results in airway edema, bowel edema, increased lung water and increased risk for heart failure

Complications From Excessive and Insufficient Volume Administration

Classic Method of Fluid Management

- 4-2-1 rule

<table>
<thead>
<tr>
<th>WEIGHT</th>
<th>HOURLY REQUIREMENTS</th>
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</thead>
<tbody>
<tr>
<td>&lt; 10 kg</td>
<td>4 ml/kg</td>
</tr>
<tr>
<td>10-20 kg</td>
<td>40 ml + 2 ml/kg above 10 kg</td>
</tr>
<tr>
<td>&gt; 20 kg</td>
<td>60 ml + 1 ml/kg above 20 kg</td>
</tr>
</tbody>
</table>

- Fluid losses prior to anesthesia
- Maintenance requirements
- Estimated Blood loss (3-1)
- Third space fluid loss during surgery (2-8 cC/kg/hr)

Setting The Record Straight

- No Significant Intravascular Deficit After Fasting
- Basal Insensible Loss Is Approximately 0.5 ml/kg/hr
- Evaporation From Surgical Wound
  - Small incisions: 2 ml/hr
  - Moderate incision with partial exposure of viscera: 8 ml/hr
  - Large incisions with complete exposure of viscera: 12 ml/hr
- Insufflation For Pneumoperitoneum < 1 ml/hr
- Lack Of Evidence Supporting A Non-anatomical Third Space
The Need For Change

• Inconsistency In Interpretation Of Hemodynamics And Clinical Signs In Determining Need For More Fluids
• Conventional Hemodynamic Variables Misleading In Assessing Volume Status
• Lack Of Evidence To Support Use Of CVP

What Is GDF?

• Using a measurement of cardiac output to guide intravenous fluid therapy
• Rivers, et. al. demonstrated improved patient outcome using GDF
• Pearce, et. al. – A correlation with effective GDF and decreased post-operative complications and length of stay.
• Ramsingh, et. al. – Reduction in Complications and Hospital Length Of Stay In High-risk Patients Undergoing Major Abdominal Surgery With SW Guided GDF Therapy

Why is GDFT Important?

• 24.0 Million Anesthetics Worldwide Annually
  • 30% Account For 89% Of Surgical Mortality
• 96 Million Administered To Moderate Risk Patients
  • 30% Have Post-operative Complications
• Postoperative Complications Attributed To Tissue Hypoperfusion

• GOAL: Adequate Tissue Perfusion

Goal Of GDFT

- Optimize Intravascular Fluid Volume
- Optimize Cardiac Output
- Optimize Perfusion Pressure
- Optimize Tissue Oxygen Delivery

The How And What Of Pulse Pressure Variation

Preload Optimization

- Stroke Volume
- Preload
Algorithm for Optimizing SV

Objective For GDFT
- Adequate tissue perfusion: optimal oxygen delivery
  - Maintain intravascular volume
  - Maintain cardiac preload
  - Maintain adequate blood pressure
- Fluid Administration in DGF
  - Combination of fluid administration, boluses and isotopic support
  - Colloids remain intravascular longer than crystalloids
  - Colloids expand plasma volume to a greater extent

Pulse Variability Index Monitoring Systems
- Edwards Vigileo
- LiDCORapid
- Deltex CardioQ
- Ceetah

Components of Enhanced Recovery

Post-operative Phase
- Drains, Tubes and Catheters
  - Drains avoided other than complicated or high-risk cases where risk of bleeding or leakage is high (proximal bypass)
  - Urinary catheters removed within 48 hrs
  - NGT tubes reserved for patients at risk for reflux or aspiration
- Multimodal opioid sparing analgesia
  - Neuraxial administration
  - Acetaminophen
  - NSAIDS after epidural removal
- Early Nutrition and mobilization
  - Oral diet as tolerated
  - Oral nutrition supplements as needed
  - OOB for 6-8 h, 6 m thereafter
  - Postoperative rehab planning
US Implementation

• Slow implementation due to lack of awareness
• Not just a fast-track program that includes minimally invasive surgery and encourages early mobilization and eating
• Slow to adapt all components of the program
• Resistance to change

Adoption Dependent on Team Approach

• Team Leadership
• Patient/Family And Providers
• Staff Education On ER
• Procedure Specific Plans
• Quality Improvement Program Based On Feedback

Protocols

ERAS Success Stories

• Johns Hopkins
  • Reduced LOS 12 days (36.4 percent)
  • Cost savings $9,168
• Duke
  • Reduced LOS 12 days
  • Cost savings to patient $9000, 46.9 percent
• MUSC
  • Reduced LOS 12 days
  • Cost savings $17,420
• UVA
  • Reduced LOS 27 days
  • Cost savings $8,930
  • Complication rate fell from 9% to 5%
• MD Anderson
  • Reduced LOS by 7 days, 2.23 days vs 9.207 days
  • Multifaceted cost savings $21,950,000

Conclusion

• Reduced variation in care
• Significant improvement in patient satisfaction
• Better outcomes
• Reduced healthcare costs
• Faster recovery
• Shortened hospital stay
• Fewer complications