Building an Enhanced Recovery After NeuroSurgery program

Michigan Spine Surgery Improvement Collaborative
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Outline

- What is ERAS?
  - History
  - Literature

- ERAS elements
  - Data
  - Interventions

- Pilot Data & Outcomes

- Future Directions
Outline

❖ What is ERAS?
  • History
  • Literature

❖ ERAS elements
  • Data
  • Interventions

❖ Pilot Data & Outcomes

❖ Future Directions
Defining VALUE in healthcare

VALUE

QUALITY

COST

Outcomes + Patient Experience

Direct Costs + Indirect Costs

https://www.pm360online.com/how-do-you-define-value-in-healthcare/
History of Enhanced Recovery After Surgery (ERAS)

- Pioneered by general surgeon Henrik Kehlet, MD, PhD in Denmark in late 1990s
- “Fast track surgery”
- Identified factors that delay postoperative recovery
  - Pain
  - Gut dysfunction
  - Immobilization
- Combined a series of interventions to reduce perioperative stress and organ dysfunction
What is Enhanced Recovery After Surgery?

ENHANCED RECOVERY AFTER SURGERY

ERAS is a multimodal perioperative care pathway designed to achieve early recovery for patients undergoing major surgery.

ERAS represents a paradigm shift in perioperative care in two ways. First, it re-examines traditional practices, replacing them with evidence-based best practices when necessary. Second, it is comprehensive in its scope, covering all areas of the patient’s journey through the surgical process.

The key factors that keep patients in the hospital after surgery include the need for parenteral analgesia, the need for intravenous fluids secondary to gut dysfunction, bed rest caused by lack of mobility.

The central elements of the ERAS pathway address these key factors, helping to clarify how they interact to affect patient recovery. In addition, the ERAS pathway provides guidance to all involved in perioperative care, helping them to work as a well-coordinated team to provide the best care.
Enhanced recovery after surgery (ERAS) is a surgical care approach that integrates evidence-based protocols to improve surgical outcomes. This approach has been shown to reduce hospital stay, improve patient satisfaction, and decrease complications.

**Introduction**

Enhanced recovery after surgery (ERAS) is a systematic multimodal perioperative care approach that aims to reduce the stress experienced by patients undergoing surgery. ERAS integrates evidence-based practices to optimize perioperative and postoperative care, thereby improving surgical outcomes. This approach has been shown to reduce hospital stay, improve patient satisfaction, and decrease complications.

**Objective**

The objective of this study was to describe the implementation of ERAS in a neurosurgical setting at our institution.

**Methods**

A multidisciplinary team consisting of neurosurgeons, anesthesiologists, nurses, and allied health professionals designed and implemented an ERAS protocol. The protocol included preoperative, intraoperative, and postoperative components that were designed to reduce surgical stress and improve patient outcomes.

**Results**

The implementation of the ERAS protocol resulted in significant improvements in patient outcomes. The mean length of stay decreased from 7 to 5 days, and there was a decrease in the incidence of postoperative complications.

**Conclusion**

The implementation of the ERAS protocol in our neurosurgical practice has resulted in improved patient outcomes. Further research is needed to determine the long-term effectiveness of the protocol and to evaluate its impact on resource utilization and cost savings.

**Key Words:** Cranioectomy, enhanced recovery after surgery

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**THE Enhancing Recovery movement began in Denmark in the 1990s by integrating multidisciplinary programs. Previously known as “enhanced recovery programs,” these initiatives sought to improve surgical outcomes by focusing on preoperative optimization, perioperative care, and early mobilization.**

The Enhancing Recovery After Surgery (ERAS) program is an evidence-based initiative that aims to improve surgical outcomes by implementing a series of evidence-based practices. ERAS protocols are designed to optimize preoperative care, surgical technique, and postoperative management.

**ERAS Protocol Components:**

- **Preoperative Care:** Risk assessment, nutritional support, smoking cessation, and anxiety management.
- **Surgical Technique:** Minimally invasive surgery, optimized anesthesia, and early extubation.
- **Postoperative Care:** Early mobilization, diet and hydration, and early discharge.

**Implementation Challenges:**

- **Patient Cooperativeness:** Engaging patients in their care through education and support.
- **Clinical Practice:** Adapting to institutional workflows and resources.
- **Long-term Outcomes:** Assessing the impact of ERAS on long-term patient satisfaction and quality of life.

**Conclusion:**

The implementation of the ERAS program requires a multidisciplinary approach and ongoing monitoring to ensure sustained improvements in surgical outcomes.
Enhanced Recovery: Improving Patients’ Surgical Experience

Patients are benefiting from this European approach to improve recovery after surgery.

By Kristine Crane, Contributor | Feb. 4, 2013, at 11:06 a.m.

Early mobilization is a key tenet of this approach to recovery, so patients can begin walking much sooner than normal after surgery. (StockPhoto)

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Surgery

Penn Medicine
Four Principles of ERAS

1. The patient is a partner in their own care (where possible).

2. The patient is in the best possible condition preoperatively.

3. The patient has the best possible evidence-based management during and after his/her operation that minimizes surgical and anesthetic harm.

4. The patient experiences the best possible care and rehabilitation enabling them to return to their normal level of activity as soon as possible.

This can only be achieved by an interdisciplinary team working consistently on an iterative process.
No pathway can take the place of sound clinical judgment.
Upon seeking a Surgical Opinion:
- Optimize patient health
- Optimize preoperative haemoglobin levels
- Optimize medical condition(s)
- Shared decision making
- Preoperative health & risk assessments
- Share information with patient and family
- Check understanding of expectations
- Plan for discharge with relevant support and offer an expected length of stay
- Carry out all preoperative therapy instructions (physio, ostomy care)

PREPARING FOR SURGERY

IMMEDIATELY BEFORE SURGERY

DURING SURGERY

EARLY AFTER SURGERY

LATER AFTER SURGERY

RECOVERING AT HOME

Maintain patient safety
- Optimize fluid management, goal directed fluid therapy
- Reduce the impact of postoperative pain
- Postoperative nausea and vomiting management plan in place
- Minimally invasive surgery
- Use of transverse incisions where applicable
- No routine nasogastric tube
- No routine wound drains or central lines
- Follow best practice for urinary catheter insertion to mitigate risk of infection
- If clinically required the best practice for central line insertion and maintenance must be followed

Support and encourage normal fluid and food intake
- Avoidance or early detection and treatment of acute kidney injury and other complications
- Ensure mobility is continued
- Discharge when criteria met

Clear contact plan for re-assessment or reassurance
- Plan for completing all therapy support
- Telephone follow up as agreed locally - suggested days 1, 2, 3 and 7 after discharge following major surgery

2. Optimize fluid hydration
- Complex carbohydrate loading
- NPO for 2 hours pre anesthetic
- Risk assess for all four major infection areas UTI, SSI, Pneumonia & Aspiration and Lines

3. Maintain patient safety through observation and early detection of complications
- Regular oral analgesia to achieve patient comfort for deep breathing and mobility
- Avoidance of systemic opiate-based analgesia where possible or administered topically
- Plans for both step down and rescue analgesia are in place routinely
- Planned mobilization
- Return to normal fluids and diet as soon as tolerated
- Discontinue IV fluids when drinking
- No routine nasogastric tube
- Urinary catheters removed early
- If required the best practice for maintenance and removal of central lines must be followed

ASER Enhanced Recovery Implementation Guide
Enhanced Recovery After Surgery at Pennsylvania Hospital
Outline

- What is ERAS?
  - History
  - Literature

- ERAS elements
  - Data
  - Interventions

- Pilot Data & Outcomes

- Future Directions
Enhanced Recovery After NEUROSurgery: A Patient-Centered Spine Surgery Pathway

Penn Medicine ERAS video

Preop

- Surgical Education & Expectation Management
- Surgical Site Education
- Nutrition Optimization
- Diabetes Management
- Smoking Cessation
- Narcotic/Alcohol use
- Obstructive sleep apnea
- Discharge planning

Periop

- Metabolism Management
- Multimodal Analgesia
- Surgery Checklist
- Early Mobilization
- Wound care Management

Postop

- Clinical team communication
- Wound care Management
- Post acute care resource utilization
**Preop**

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**Periop**

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**Postop**

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Preoperative Surgical Education

- Prepare patients for the increasing physical and psychological demands during and after an operation

- Format: group/individualized education, printed information, audiovisual presentation, combination

- Data:
  - **Reduces fear**
  - **Accelerates functional recovery**
  - **Decreases preoperative anxiety and pain**
  - **Decreases staff phone calls**
  - **Improves pain control**
  - **Increases patient satisfaction**
  - **Decreases LOS**
Engaged Recovery at Penn (ERAP) is a clinical text messaging and patient engagement platform to improve patient compliance to ERAS behaviors, for better patient outcomes and reduced readmissions.

Patients receive text reminders about the critical ERAS behaviors.
Goal: educate patients, caregivers, and secondary sites about wound care in order to help reduce postoperative surgical site infections.

Data:

Prevention of Surgical Site Infection in Spine Surgery

BACKGROUND: Spine surgery is complicated by an incidence of 1% to 9% of surgical site infection (SSI). The most common organisms are gram-positive bacteria and are endogenous, that is brought to the hospital by the patient. Efforts to improve safety have been focused on reducing SSI using a bundle approach. The bundle approach applies many quality improvement efforts and has been shown to reduce SSI in other surgical procedures.

OBJECTIVE: To provide a narrative review of practical solutions to reduce SSI in spine surgery.

METHODS: Literature review and synthesis to identify methods that can be used to prevent SSI.

RESULTS: SSI prevention starts with proper patient selection and optimization of medical conditions, particularly reducing smoking and glycemic control. SSI prevention should start in the preoperative, perioperative, and postoperative phases. The preoperative phase includes antibiotics, skin preparation, and patient selection. The perioperative phase includes minimizing surgical trauma, wound care, and early mobility. The postoperative phase includes wound dressings, antibiotic irrigation, and early mobilization.

CONCLUSION: Significant reduction of SSI is possible, but requires a system of care involving all stakeholders. There are many simple and low-cost components that can be adjusted to reduce SSI. Systematic efforts including understanding of pathophysiology, prevention strategies, and system-wide quality improvement programs demonstrate significant reduction of SSI.

Surgical site infections (SSI) are the most common hospital-acquired infections (HAI) and occur in 1.5% of all surgeries. SSI leads to increased morbidity, reoperation, readmission to the hospital, poorer outcomes, and increased costs. There is growing public awareness, and efforts to reduce infection are ongoing at all levels of care. The United States Center for Disease Control classifies SSI as superficial, deep, or organ space. A superficial infection occurs within 30 days of surgery involving only the skin and subcutaneous tissues and is associated with one of the following: purulent drainage, positive culture obtained aseptically, wound opened by surgeon or designee, or diagnosis as such by surgeon. A deep infection occurs within 30 or 90 days depending upon procedure; a laminectomy is rated at 30 days while fusion at 90 days and involves the fascia and muscles along with one of the following: purulent drainage from deep tissues, a dehiscence or opening by surgeon with positive identification of microorganisms, abscess, or other histologic signs of infection. An organ space infection occurs deep to the muscles and fascia and has the same criteria as deep infection.
Surgical Site Education: ERAS

Penn Neurosurgery

Start
Wash 1: ______________________
Wash 2: ______________________
Wash 3: ______________________
Wash 4: AM of Surgery
Preop

- Surgical Education & Expectation Management
- Surgical Site Education
- Nutrition Optimization
- Diabetes Management
- Smoking Cessation
- Narcotic/Alcohol use
- Obstructive sleep apnea
- Discharge planning

Periop

- Metabolism Management
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- Early Mobilization
- Wound care Management

Postop

- Clinical team communication
- Wound care Management
- Post acute care resource utilization
Most spinal disease occurs in the aging population, which is at an increased risk of protein-energy malnutrition as a result of physiologic/anatomic changes, chronic diseases, poor dietary/psychosocial habits, and habitual use of multiple medications.

The magnitude of a surgical procedure directly impacts caloric and protein requirements.

Pre-operative malnutrition has been shown to present an independent risk factor for unplanned re-admission within 30 days after discharge after elective spine surgery and spinal fusion for degeneration and deformity cases.
Preop

- Surgical Education & Expectation Management
- Surgical Site Education
- Nutrition Optimization
- Diabetes Management
- Smoking Cessation
- Narcotic/Alcohol use
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- Discharge planning

Periop

Metabolism Management
Multimodal Analgesia
Surgery Checklist
Early Mobilization
Wound care Management

Postop

Clinical team communication
Wound care Management
Post acute care resource utilization
Diabetes management

- >25% of US residents over the age of 65 currently have diabetes
- For patients undergoing spinal surgery, diabetes is associated with higher rates of:
  - Infection
  - Pseudarthrosis
  - Perioperative complications
  - Longer length of stay (LOS)
  - 30-day readmission/reoperation rates
- HbA1c
  - Diabetic spine surgery patients have a negative correlation between their recovery rate and preoperative HbA1c level
  - Preoperative HbA1c significantly higher in patients with surgical site infection with diabetes
Diabetes management: ERAS

- Preoperative HbA1c screen for diabetics
- Endocrine referral for glucose > 200mg/dl
- Informed surgical risk counseling

We are requesting that you be referred for consultation and/or treatment for the following: **Diabetes Management**. It is important to evaluate your condition before admission to the hospital in order to best prepare your body for your spine surgery and to help improve your recovery.

Please call Penn Endocrine Associates and the Diabetes Education Center (listed below) to schedule an appointment at your earliest convenience.

**Endocrine Provider:**
Penn Endocrine Associates at PAH
800 Spruce Street
Philadelphia, PA 19107
215-829-3445

**Diabetes Education/Counseling:**
Barbara Morrison, MSN, RN, CDE, CPN
Diabetes Education Center
Pennsylvania Hospital
Duncan Building, 4th Floor
700 Spruce Street
Philadelphia, PA 19106
215-829-5725

If you have any questions for your neurosurgeon, please contact:
Department of Neurosurgery
235 S. 3rd Street-Entrance on Locust
Philadelphia, PA 19106
Phone: 215-829-4700
Fax: 215-829-8648
Preop

- Surgical Education & Expectation Management
- Surgical Site Education
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Smoking Cessation

- Decreased effectiveness of inflammatory cell function and oxidative bactericidal mechanisms
- Inhibition of reparative cell function
Smoking Cessation: ERAS

- Tobacco cessation correlates with improved spine surgery outcomes

- When to quit and for how long?
  - No definitive data
  - Better results in individuals who quit for >6 months after surgery
  - Preoperative smoking cessation for 4 weeks is associated with a decreased risk of infection, perioperative respiratory, and wound complications
  - Glassman et al: <10% of patients who smoked up until the day of surgery were able to stop postoperatively (Glassman et al. The effect of cigarette smoking and smoking cessation on spinal fusion. Spine (Phila Pa 1976). 2000 Oct 15; 25(20):2608-15.)

- Value of time invested in tobacco cessation?
  - Patients preparing for elective spine procedures may quit at higher rates than the general smoking population (Glassman et al. The effect of cigarette smoking and smoking cessation on spinal fusion. Spine (Phila Pa 1976). 2000 Oct 15; 25(20):2608-15.)
    - 63.8% of smokers quit for at least 1-6 months and 40.4% quit for at least 6 months after spine surgery
    - 90% of this population did not need the aid of nicotine-containing gums or patches or other medications

- Spine surgery patients are more likely to quit if counseled appropriately preoperatively
Narcotic/Alcohol use

- Opioid analgesics have become some of the most frequently prescribed medications in the world
  - Nearly 100% of the total hydrocodone and 83% of oxycodone are consumed in the United States

- Correlations between preoperative opioid use and clinical outcomes in spine surgery patients consistently report opioid use as a negative predictor of outcomes
Preop
- Surgical Education & Expectation Management
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- Nutrition Optimization
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Postop
- Clinical team communication
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- Post acute care resource utilization
Obstructive sleep apnea and spine surgery

- Prevalence of moderate to severe OSA is increasing: 10%-20%  
  - up to 80% of patients remain undiagnosed

- Increased rates of postoperative complications (up to 50% higher complication rates)  
  - increased risk of unplanned admission to the intensive care unit

- Overnight polysomnography remains the gold standard for the diagnosis of OSA  
  - home sleep testing has also been introduced as a validated modality to diagnosis OSA

- The use of a validated and quick screening tool may be beneficial in the preoperative setting
OSA and spine surgery: ERAS

Neurosurgery: Enhanced Recovery After Surgery (ERAS)
Department of Neurosurgery
235 S. DeGraw-Franklin on Locust
Philadelphia, PA 19106
Phone: 215-829-8700  Fax: 215-829-6446

What Does STOP-BANG Mean?
• Snoring
• Tiredness
• Observe stop breathing
• Blood Pressure

High risk:

We are requesting that you be offered for consultation and/or treatment for the following condition:
Obstructive Sleep Apnea. It is important to evaluate your condition before admission to the hospital
in effort to best prepare your body for your spine surgery and to help improve your recovery.

Please call the consulting department listed below to schedule an appointment at your earliest
convenience.

Consulting Department
Penn Sleep Center
Penn Medicine Washington Square
9th Floor
800 Walnut Street
Philadelphia, PA 19107
(215) 829-5027

If you have any questions for your neurosurgeon, please contact:
Department of Neurosurgery
235 S. DeGraw-Franklin on Locust
Philadelphia, PA 19106
Phone: 215-829-8700  Fax: 215-829-6446
Preop

- Surgical Education & Expectation Management
- Surgical Site Education
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Periop

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Postop

- Clinical team communication
- Wound care Management
- Post acute care resource utilization
Preoperative discharge planning

- Health care providers recommend discharge to home, a skilled nursing facility (SNF), or an acute rehabilitation facility on a subjective basis early in the post-operative period.

- The Risk Assessment and Prediction Tool (RAPT) is a valid and reliable method of predicting discharge destinations.

- RAPT helps patients and hospitals plan for post-operative management:
  - >9 highly correlated with discharge to home with services
  - <3 highly correlated with discharge to a rehab
Preop

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Postop

- Clinical team communication
- Wound care Management
- Post acute care resource utilization
Metabolism management

- Clear liquids and gastric secretions move rapidly out of the stomach
  - 50% emptying time of H2O ~12 minutes

- Gastric residual volume ~25 mL in patients fasted overnight prior to surgery = patients who drink clear liquids up to two hours before surgery

- *There is no evidence that restriction of the volume of clear liquids is beneficial*
  - avoids symptoms of dehydration, hypoglycemia, caffeine withdrawal

- Carbohydrate loading
  - (1) fasting depletes energy reserves before surgical stress onset, whereas carbohydrate loading allows maximal glycogen storage and a metabolically “fed” state at the start of surgery
  - (2) insulin resistance is attenuated, and thus insulin’s anabolic actions preserved

- Patients who drink carbohydrate-rich clear liquids until two hours prior to anesthesia may have less thirst, hunger, and anxiety
  - effect on thirst may only last 60 minutes

- Preoperative carbohydrate loading may be safely administered in type 2 diabetes
  - “Patients with gastroparesis may benefit from a longer duration of fasting on a case by case basis”

- Evidence to support carbohydrate-rich drinks is still limited
  - “Preoperative carbohydrate treatment was associated with a small reduction in length of hospital stay when compared with placebo or fasting in adult patients undergoing elective surgery. It was found that preoperative carbohydrate treatment did not increase or decrease postoperative complication rates when compared with placebo or fasting. Lack of adequate blinding in many studies may have contributed to observed treatment effects for these subjective outcomes, which are subject to possible biases.”


**Metabolism management: ERAS**

- **American Society of Anesthesiologists (ASA) guidelines** recommend fasting for at least two hours from clear liquids prior to elective surgery.

- **Patients are instructed to** drink one 20 oz. bottle of non-red Gatorade or Powerade the night before surgery and another 20 oz. two hours prior to arrival time.
Preop

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- Wound care Management
- Post acute care resource utilization
Multimodal Analgesia

- Synergistic actions of nonopioid agents are maximized in postoperative pain management to improve pain control, reduce opioid consumption, and reduce adverse effects of any one particular agent.

- Patients undergoing preemptive analgesia exhibit improvement in immediate post-operative pain, usual activity, depression/anxiety, and self-care at 2 weeks post-operatively.

Comparison of Perioperative Oral Multimodal Analgesia Versus IV PCA for Spine Surgery

Sharul Rajpal, MD,* Debra B. Gordon, RN, MS, FAAN;† Teresa A. Pellino, RN, PhD,‡ Andrea L. Strayer, RN, NP,§ Denise Brost, RN, NP,§ Gregory R. Trost, MD,§ Thomas A. Zideblick, MD, and Daniel K. Resnick, MD$

Study Design: A preintervention and postintervention design was used to examine a total of 200 patients. 

Objective: After successful implementation at our institution of a perioperative oral multimodal analgesia protocol in major joint arthroplasty, a modified regimen was provided to patients undergoing spine procedures.

Summary of Background Data: A proactive, multimodal approach is currently recommended for the management of acute postoperative pain. Inadequate postoperative analgesia can negatively influence surgical outcome and duration of rehabilitation. Routine use of intravenous patient-controlled analgesia (IV PCA) after surgery can result in substantial functional interference, side effects, and lead to untoward events as a result of programming errors.

Methods: A preintervention and postintervention design was used to compare a historical cohort of spine surgery patients who received conventional IV PCA (N = 100) with a prospective group who received a form of perioperative oral multimodal analgesia (N = 100). The new regimen included preoperative and postoperative scheduled extended-release oxycodone, gabapentin, and acetaminophen, intravenous dolasetron and as-needed postoperative short-acting oral oxycodone. Patient surveys and chart audits were used to measure pain intensity, functional interference from pain, opioid consumption, analgesic-related side effects, and patient satisfaction over the first 24 hours postoperatively.

Results: Patients who received the new perioperative multimodal oral regimen had significantly less opioid consumption ($P < 0.001$), lower ratings of Least Pain ($P < 0.01$), and experienced less nausea ($P < 0.001$), drowsiness ($P < 0.05$), interference with walking ($P < 0.05$), and coughing and deep breathing ($P < 0.05$) compared with the IV PCA group.

Conclusions: This quality improvement study shows the safety and significant advantages of a multimodal perioperative oral analgesic regimen compared with standard IV PCA after spine surgery.

Key Words: postoperative pain, gabapentin, oxycodone, IV PCA, spine surgery, quality improvement

(Original Article 139-145)

Inadequate postoperative pain control has adverse physiologic effects, including delayed return of normal respiratory and gastrointestinal function. Unrelieved pain increases the stress response in a way that affects the immune system, leading to delays in healing and is a known risk factor for the development of chronic pain syndromes.

The use of intravenous patient-controlled analgesia (IV PCA) is a popular approach that has supplanted the use of as-needed (PRN) intramuscular injections for the management of pain after major surgery. Although studies suggest strong patient preference for IV PCA over earlier routine PRN intramuscular delivered analgesia, meta-analysis of patients using IV PCA reported only marginally superior analgesia. A systematic review by Ballantyne et al found a pain control difference of only 3.6 mm on a 0 to 100-mm visual analog scale when compared with conventional postoperative analgesia.

Another meta-analysis found no differences in pain intensity or pain relief between IV PCA and conventional postoperative opioid analgesia. A Cochrane review concluded that despite greater patient satisfaction, patients receiving IV PCA consumed slightly higher amounts of opioid with little benefit in analgesia, experienced more pruritus, and found no differences in length of stay compared with conventional analgesia. Ironically, although PCA pumps offer several safety features to prevent the administration of excessive amounts of opioids, medication errors involving PCA pumps continue to occur secondary to human programming errors. When error occurs with IV PCA therapy, the chance of untoward events increases more than 3.5 times compared with other medication errors. PCA pump programming errors have been linked to patient death.

Whereas no single technique or analgesic regimen has been shown to completely eliminate postoperative pain, the use of multimodal analgesia, that is, combining...
Neurosurgery ERAS Pain Management Protocol

- Set realistic expectations and provide patient education about achieving optimal analgesia

**Education**

**IV/Oral Analgesia**

**Local Anesthetic**

**Other Adjuncts**

**Rescue Analgesia**

**Gabapentin**

**NSAIDs**

**Opioids**

**Acetaminophen**

**Bupivacaine**

**Dexamethasone**

**Muscle relaxers**

**IV Opioids**
Neurosurgery ERAS Multimodal Pain Management

- **Reduction of routine use of IV patient controlled analgesia use**
  - Greater patient satisfaction with PCA
  - Human PCA programming errors

- **Gabapentin 600mg x 1 in preoperative holding area** (Pandey CK et al. Evaluation of the optimal preemptive dose of gabapentin for postoperative pain relief after lumbar disectomy: a randomized, double-blind, placebo-controlled study. J Neurosurg Anesthesiol 2005; 17:65.)

- **Acetaminophen 975mg PO q6h (hold for liver disease)** (McDaid C et al. Paracetamol and selective and non-selective non-steroidal anti-inflammatory drugs (NSAIDs) for the reduction of morphine-related side effects after major surgery: a systematic review. Health Technol Assess 2010; 14:1)

- **Opioids**
  - IV: Morphine 1-2 mg q2h PRN/Hydromorphone 0.2-0.4 mg PRN until POD 1
  - Oxycodone 5-10 mg q4h PRN/Hydromorphone 2-4 mg q4h PRN

- **NSAIDs**
  - Ketorolac 15mg IV q6h PRN - hold for patients with impaired renal function or fusion patients unless approved by surgeon

- **Muscle relaxants**
  - Diazepam 5mg PO q8h PRN/
  - Cyclobenzaprine 10mg PO q8h PRN

*Individualized pain management protocol for chronic users*
**Preop**

- Surgical Education & Expectation Management
- Surgical Site Education
- Nutrition Optimization
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- Discharge planning

**Periop**

- Metabolism Management
- Multimodal Analgesia
- Surgery Checklist
- Early Mobilization
- Wound care Management

**Postop**

- Clinical team communication
- Wound care Management
- Post acute care resource utilization
# Safe Spine Surgery Checklist

## TABLE 2: Checklist pros and cons

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>serve as reminders ensuring critical steps in a procedure are not missed</td>
<td>over-reliance can lead to lack of appropriate use of judgment &amp; experience</td>
</tr>
<tr>
<td>can enhance teamwork, communication, culture centered on pt safety</td>
<td>costs &amp; resources associated w/ checklist implementation &amp; outcomes assessment are barriers to implementation</td>
</tr>
<tr>
<td>serve as memory aids when humans are most apt to fail (fatigue, stress, emergencies)</td>
<td>inappropriate checklist selection in an emergency may lead to mismanagement</td>
</tr>
<tr>
<td>have been shown to reduce death &amp; complications in other surgical fields</td>
<td>difficulty achieving appropriate checklist length (too long is onerous &amp; impractical, too short may miss critical items)</td>
</tr>
<tr>
<td>initial results in neurosurgery demonstrate error reduction</td>
<td>difficulty obtaining consensus on items to include</td>
</tr>
<tr>
<td>may reduce net costs by prevention of errors</td>
<td>overemphasis may divert attention/resources from other safety initiatives critical to error reduction</td>
</tr>
<tr>
<td>may improve OR efficiency by prevention of errors</td>
<td>difficulty deciding how many/which procedures will benefit from checklist use</td>
</tr>
<tr>
<td>may reduce malpractice claims</td>
<td>inability to create checklists for every scenario</td>
</tr>
<tr>
<td>used in all other high-reliability fields (e.g., aviation) to mitigate human error</td>
<td>best way to present checklists (paper, electronic, etc.) is not known</td>
</tr>
</tbody>
</table>

Learning: It is crucial for the team to ensure that all personnel are familiar with and competent in the use of the checklist. Following initial design, the checklist draft was reviewed and amended with stakeholder input. The checklist was then evaluated in a small-scale trial and revised based on usability and feasibility.

Conclusions. The authors have developed an evidence-based algorithm for the design, development, and implementation of checklists in neurosurgery and have used this algorithm to devise a checklist for responding to intraoperative neuromonitoring alerts in spine surgery.

(http://thejns.org/doi/abs/10.3171/2012.9.FOCUS12263)

**KEY WORDS**  • surgical checklist  • algorithm  • operating room  • neuromonitoring

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Penn Medicine
Preop

- Surgical Education & Expectation Management
- Surgical Site Education
- Nutrition Optimization
- Diabetes Management
- Smoking Cessation
- Narcotic/Alcohol use
- Obstructive sleep apnea
- Discharge planning

Periop

- Metabolism Management
- Multimodal Analgesia
- Surgery Checklist
- Early Mobilization
- Wound care Management

Postop

- Clinical team communication
- Wound care Management
- Post acute care resource utilization
Early mobilization in spine surgery

- Prehab + rehab?
  - Nielsen et al. 2010
  - Randomized design
  - 60 patients undergoing elective spinal procedures for degenerative disease
    - 28 prehab+rehab
    - 32 standard of care
  - Better postop mobilization, shorter LOS (5 vs. 7), postoperative satisfaction
  - No changes in postoperative complications, adverse events, and low back radiating pain

ERAS early mobilization protocol

- OOB within six hours post-operatively

- Ambulate 3-5 times daily beginning POD 1 unless bedrest restrictions

- All meals are encouraged out of bed in a chair

- Avoiding the use of Foley catheters
  - Foley catheter only in the setting of expected operative time >2 hours with plan for removal immediately following surgery
  - Indwelling foley for all patients with bedrest precautions due to spinal fluid leak, >3 levels of thoracic or lumbar fusion, or other medical or urologic necessity
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Postop

- Clinical team communication
- Wound care Management
- Post acute care resource utilization
POD 1 dressing removal

Chlorhexidine bath daily beginning POD 1

Wound wash daily beginning POD 1
Preop
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Postop
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- Wound care Management
- Post acute care resource utilization
Clinical team communication post-discharge

- Goal: provide patient with a safe transition, reduce health care expenditures associated with readmissions

- Heterogeneity
  - Types of interventions
  - Patient populations
  - Outcomes

- Most effective interventions were those that were complex, multifaceted, and supported patients’ capacity for self-care (Leppin AL et al. Preventing 30-day hospital readmissions: a systematic review and meta-analysis of randomized trials. JAMA Intern Med 2014; 174:1095)
Surgical Site Education: ERAS
Preop

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Post acute care resource utilization

- “The hospital must not specify or otherwise limit the qualified providers that are available to the patient”

- Informed decision making in post-acute care
  - Home care
  - Skilled nursing facilities
  - Inpatient Rehabilitation Centers
# ERAS Post acute care resource utilization

## PAH Postop Spine Triage Protocol

**Department of Neurosurgery**
235 S. 8th Street-Entrance on Locust
Philadelphia, PA 19106
Phone: 215-829-6700  Fax: 215-829-6645

<table>
<thead>
<tr>
<th>Routine Contact</th>
<th>Routine Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Neurosurgery Main Number:</em></td>
<td>215-829-6700</td>
</tr>
</tbody>
</table>

### Routine Care
- Medication management or refill
- Physical or Occupational Therapy Orders
- Schedule Routine Post-Op Visits
- Requesting Office Notes or Discharge Summaries to be faxed
- Non-urgent patient-related questions

### Urgent Care Contact
- Call **215-829-6700** to speak to a nurse right away to address serious patient concerns related to surgery
- Hours: **24/7**
- You may be asked to send the patient to the Emergency Room for evaluation

*Use for clinical staff only*

### Urgent Care
Patients showing worsening symptoms related to:
- Wound drainage or dehiscence
- Warm, Red, Swollen site
- Fever (≥101.5)
- Uncontrollable pain

<table>
<thead>
<tr>
<th>Urgent Care Contact</th>
<th>Emergent Care</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Call 911 right away</em></td>
<td>Call 911 right away</td>
</tr>
</tbody>
</table>

### Emergent Care
- Abnormal / difficulty breathing
- Confusion
- Unrelieved chest pain
- Loss of consciousness

---

*Penn Medicine*
Preop
- Surgical Education & Expectation Management
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Postop
- Clinical team communication
- Wound care Management
- Post acute care resource utilization

Outline

❖ What is ERAS?
  • History
  • Literature

❖ ERAS elements
  • Data
  • Interventions

❖ Pilot Data & Outcomes

❖ Future Directions

Zarina S. Ali, MD,1 Tracy M. Flanders, MD,1 Ali K. Ozturk, MD,1 Neil R.Malhotra, MD,1 Lena Leszinsky,1 Brendan J. McShane, BA,1 Diana Gardiner, CRNP,1 Kristin Ruprich, CRNP,1 H. Isaac Chen, MD,1 James Schuster, MD, PhD,1 Paul J. Marcotte, MD,1 Michael J. Kallan, MS,2 M. Sean Grady, MD,1 Lee A. Fleicher, MD,1 and William C. Welch, MD1

1Department of Neurosurgery, Center for Clinical Epidemiology and Biostatistics, and Department of Anesthesia, Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania.

OBJECTIVE Enhanced recovery after surgery (ERAS) protocols address pre-, peri-, and postoperative factors of a patient's surgical journey. The authors sought to assess the effects of a novel ERAS protocol on clinical outcomes for patients undergoing elective spine or peripheral nerve surgery.

METHODS The authors conducted a prospective cohort analysis comparing clinical outcomes of patients undergoing elective spine or peripheral nerve surgery after implementation of the ERAS protocol compared to a historical control cohort in a tertiary care academic medical center. Patients in the historical cohort (September–December 2018) underwent traditional surgical care. Patients in the intervention group (April–June 2017) were enrolled in a unique ERAS protocol created by the Department of Neurosurgery at the University of Pennsylvania. Primary objectives were as follows: opioid and nonopioid pain medication consumption, need for opioid use at 1 month postoperatively, and patient-reported pain scores. Secondary objectives were as follows: mobilization and ambulation status, Foley catheter use, need for straight catheterization, length of stay, need for ICU admission, discharge status, and readmission within 30 days.

RESULTS A total of 201 patients underwent surgical care via an ERAS protocol and were compared to a total of 74 patients undergoing traditional perioperative care (control group). Two groups were similar in baseline demographics. Intravenous opioid medications postoperatively via patient-controlled analgesia was nearly eliminated in the ERAS group (0.5% vs 54.1%, p < 0.001). This change was not associated with an increase in the average or daily pain scores in the ERAS group. At 1 month following surgery, a smaller proportion of patients in the ERAS group were using opioids (38.8% vs 52.7%, p = 0.041). The ERAS group demonstrated greater mobilization on postoperative day 0 (53.4% vs 17.1%, p < 0.001) and postoperative day 1 (84.1% vs 48.7%, p < 0.001) compared to the control group. Postoperative Foley use was decreased in the ERAS group (20.4% vs 47.3%, p = 0.001) without an increase in the rate of straight catheterization (8.1% vs 11.9%, p = 0.51).

CONCLUSIONS Implementation of this novel ERAS pathway safely reduces patients' postoperative opioid requirements during hospitalization and 1 month postoperatively. ERAS results in improved postoperative mobilization and ambulation.

Pilot Neurosurgery ERAS Study: Elective Spine and Peripheral Nerve Surgery

- Novel Enhanced Recovery After Surgery (ERAS) protocol developed and implemented at Pennsylvania Hospital (PAH)

- Prospective enrollment of 201 ERAS patients (April – June 2017)

- PAH Historical Control N=74 (Sept-Dec 2016)
  - Traditional surgical care at the discretion of the attending neurosurgeon in a non-standardized fashion, including routine post-operative pain management with patient-controlled analgesia (PCA) from POD 0-1
Pilot Neurosurgery ERAS Study: Elective Spine and Peripheral Nerve Surgery

- **Inclusion criteria:**
  - clinical history and diagnostic imaging supporting the need for elective spine or peripheral nerve surgery, age over 18 years, the ability to understand and actively participate in the program as deemed by the attending neurosurgeon

- **Exclusion criteria:**
  - contraindications to elective spine or peripheral nerve surgery, diagnosis of liver disease, and pregnancy

- **Primary outcomes**
  - opioid and non-opioid consumption on POD 1, need for opioid use at one month post-operatively, and patient-reported pain scores

- **Secondary outcomes**
  - length of stay (days), need for ICU admission, discharge status, re-admission within 30 days, and re-admission within 90 days

- **Statistics**
  - Independent two-sample t-tests for continuous variables and Fisher’s exact test for categorical variables
  - All data for the study were collected and analyzed by independent observers in collaboration with a biostatistician
## Baseline Patient Demographics

If any missing: \( n = \) for PAH Control / ERAS

<table>
<thead>
<tr>
<th></th>
<th>PAH Control (n=74)</th>
<th>ERAS (n=201)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>( \mu = 63.0 ) (( \sigma = 11.3 ))</td>
<td>( \mu = 60.5 ) (( \sigma = 14.5 ))</td>
<td>0.13²</td>
</tr>
<tr>
<td><strong>BMI [n=74/200]</strong></td>
<td>( \mu = 30.2 ) (( \sigma = 5.6 ))</td>
<td>( \mu = 29.7 ) (( \sigma = 5.4 ))</td>
<td>0.53¹</td>
</tr>
<tr>
<td><strong>Males</strong></td>
<td>42 (56.8%)</td>
<td>106 (52.7%)</td>
<td>0.59⁰</td>
</tr>
<tr>
<td><strong>History of prior spinal surgery</strong></td>
<td>28 (37.8%)</td>
<td>68 (34.0%)</td>
<td>0.57⁰</td>
</tr>
<tr>
<td><strong>Use of preop narcotics</strong></td>
<td>19 (25.7%)</td>
<td>47 (23.4%)</td>
<td>0.75⁰</td>
</tr>
<tr>
<td><strong>History of Sleep apnea [n=74/199]</strong></td>
<td>13 (17.6%)</td>
<td>31 (15.6%)</td>
<td>0.71⁰</td>
</tr>
<tr>
<td><strong>Smoking Status [n=74/200]</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (current)</td>
<td>11 (14.9%)</td>
<td>20 (10.0%)</td>
<td>0.42⁰</td>
</tr>
<tr>
<td>Former</td>
<td>30 (40.5%)</td>
<td>77 (38.5%)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>33 (44.6%)</td>
<td>103 (51.5%)</td>
<td></td>
</tr>
<tr>
<td><strong>Diabetes (total)</strong></td>
<td>16 (21.6%)</td>
<td>32 (15.9%)</td>
<td>0.29⁰</td>
</tr>
<tr>
<td><strong>COPD (total)</strong></td>
<td>4 (5.4%)</td>
<td>9 (4.5%)</td>
<td>0.75⁰</td>
</tr>
</tbody>
</table>

### Procedures

<table>
<thead>
<tr>
<th></th>
<th>PAH Control (n=74)</th>
<th>ERAS (n=201)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P&gt;0.05</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[1] Laminectomy / Discectomy / Foraminotomy</td>
<td>31 (41.9%)</td>
<td>91 (46.0%)</td>
</tr>
<tr>
<td></td>
<td>[2] Thoracolumbosacral fusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;4 levels</td>
<td>12 (16.2%)</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>4+ levels</td>
<td>3 (4.1%)</td>
<td>4 (2.0%)</td>
</tr>
<tr>
<td></td>
<td>[3] Cervicothoracic lami with or without fusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;4 levels</td>
<td>5 (6.8%)</td>
<td>17 (8.6%)</td>
</tr>
<tr>
<td></td>
<td>4+ levels</td>
<td>11 (14.9%)</td>
<td>10 (5.1%)</td>
</tr>
<tr>
<td></td>
<td>[3] ACDF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>5 (6.8%)</td>
<td>12 (6.1%)</td>
</tr>
<tr>
<td></td>
<td>Single level</td>
<td>2 (2.7%)</td>
<td>9 (4.5%)</td>
</tr>
<tr>
<td></td>
<td>2 level</td>
<td>3 (4.1%)</td>
<td>3 (1.5%)</td>
</tr>
<tr>
<td></td>
<td>3 level</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td></td>
<td>[4] Other</td>
<td>7 (9.5%)</td>
<td>17 (8.6%)</td>
</tr>
</tbody>
</table>
# Opioid and non-opioid use

<table>
<thead>
<tr>
<th></th>
<th>Control (n=74)</th>
<th>ERAS (n=201)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Opioid medications</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCA use</td>
<td>40 (54.1%)</td>
<td>1 (0.5%)</td>
<td>&lt;0.001⁰</td>
</tr>
<tr>
<td>Narcotic use post-op (1 month)</td>
<td>39 (53%)</td>
<td>78 (39%)</td>
<td>0.041⁰</td>
</tr>
<tr>
<td><strong>Non-opioid medications</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acetaminophen</td>
<td>62 (83.8%)</td>
<td>182 (90.5%)</td>
<td>0.13⁰</td>
</tr>
<tr>
<td>Dexamethasone</td>
<td>12 (16.2%)</td>
<td>27 (13.4%)</td>
<td>0.56⁰</td>
</tr>
<tr>
<td>Tramadol</td>
<td>2 (2.7%)</td>
<td>27 (13.4%)</td>
<td>0.008⁰</td>
</tr>
<tr>
<td>Ketorolac</td>
<td>8 (10.8%)</td>
<td>48 (23.9%)</td>
<td>0.018⁰</td>
</tr>
<tr>
<td>Flexeril</td>
<td>33 (44.6%)</td>
<td>105 (52.2%)</td>
<td>0.280</td>
</tr>
<tr>
<td>Valium</td>
<td>45 (60.8%)</td>
<td>119 (59.2%)</td>
<td>0.89⁰</td>
</tr>
<tr>
<td>Gabapentin</td>
<td>17 (23.0%)</td>
<td>162 (80.6%)</td>
<td>&lt;0.001⁰</td>
</tr>
<tr>
<td>3+ non-opioid agents</td>
<td>31 (41.9%)</td>
<td>149 (74.1%)</td>
<td>&lt;0.001⁰</td>
</tr>
<tr>
<td>4+ non-opioid agents</td>
<td>15 (20.3%)</td>
<td>98 (48.8%)</td>
<td>&lt;0.001⁰</td>
</tr>
</tbody>
</table>
### Maximum pain scores

<table>
<thead>
<tr>
<th></th>
<th>Control (n=74)</th>
<th>ERAS (n=201)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>POD0 [n=73/199]</strong></td>
<td>μ=6.3 (σ=2.7)</td>
<td>μ=6.6 (σ=2.9)</td>
<td>0.45(^1)</td>
</tr>
<tr>
<td><strong>POD1 [n=65/181]</strong></td>
<td>μ=7.6 (σ=2.4)</td>
<td>μ=7.5 (σ=2.3)</td>
<td>0.79(^1)</td>
</tr>
<tr>
<td><strong>POD2 [n=52/139]</strong></td>
<td>μ=7.6 (σ=1.9)</td>
<td>μ=7.1 (σ=2.4)</td>
<td>0.14(^1)</td>
</tr>
<tr>
<td><strong>POD3 [n=33/78]</strong></td>
<td>μ=6.5 (σ=2.6)</td>
<td>μ=6.9 (σ=2.4)</td>
<td>0.42(^1)</td>
</tr>
</tbody>
</table>

\(^1\) Significant difference at p < 0.05
## Resource allocation

<table>
<thead>
<tr>
<th></th>
<th>Control (n=74)</th>
<th>ERAS (n=201)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall hospital length of stay (days)</td>
<td>μ=4.0 (σ=3.2)</td>
<td>μ=3.6 (σ=2.4)</td>
<td>0.37¹</td>
</tr>
<tr>
<td>ICU admission</td>
<td>11 (14.9%)</td>
<td>25 (12.4%)</td>
<td>0.69⁰</td>
</tr>
<tr>
<td>Complications</td>
<td>12 (16.2%)</td>
<td>22 (10.9%)</td>
<td>0.30⁰</td>
</tr>
<tr>
<td>Re-admission within 30 days</td>
<td>5 (6.8%)</td>
<td>12 (6.0%)</td>
<td>0.78⁰</td>
</tr>
<tr>
<td>Re-admission within 90 days</td>
<td>6 (8.1%)</td>
<td>14 (7.0%)</td>
<td>0.79⁰</td>
</tr>
</tbody>
</table>
Conclusions

- ERAS engages each aspect of the patient’s surgical journey in order to improve outcomes in a multi-disciplinary, multi-modal approach

- In the elective spinal and peripheral nerve surgical patient, ERAS is feasible and necessary

- The present study has shown that our ERAS protocol, and, in particular, our ERAS pain management protocol has the potential to safely reduce opioid use both in the peri-operative period as well as at one month after surgery

- ERAS patients demonstrated a trend towards reduced hospital length of stay, which may be more apparent with a larger cohort analysis

- Re-admission rates at 30 and 90 days were not found to be significantly different, though these conclusions may also be limited due to the small sample size.
Limitations

- Moderate sample size
- Historical control group
- Retrospective data analysis, Randomization and blinding not performed
- Data collection is limited to the information provided in medical records
- Minor protocol deviation not well documented and difficult to assess
Outline

❖ What is ERAS?
  • History
  • Literature

❖ ERAS elements
  • Data
  • Interventions

❖ Pilot Data & Outcomes

❖ Future Directions
Enhanced Recovery After Neurosurgery: v2.0?

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Neurosurgery ERAS Next Steps

- Randomized Clinical Trial
- Patient reported outcomes and satisfaction review
- Cost effectiveness analysis
- Long term data
  - Opioid use
- Documentation barriers
ERAS:
An iterative process of Quality Improvement, From Bench to Bedside and BEYOND

“This is the way we do it.”
Acknowledgements

- M. Sean Grady, Chair
- William C. Welch, Vice-Chair
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  - Neil Malhotra, Director, Neurosurgery Quality Improvement Initiative
- PAH ERAS champions
  - Allen Bar, MD, Stephanie Diem
- Neurosurgery advanced practice providers
- Neurosurgery residents
- Neurosurgery clinical and Operating Room staff
- PAH nursing, social work, PT/OT therapy services, pharmacy
- Society Hill Anesthesia group
- Neurosciences Service Line
- NCRD team, Lena Leszinsky
  - Penn Undergraduate Research Mentoring Program
- Penn Innovation Center, Stacey Hirsh

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