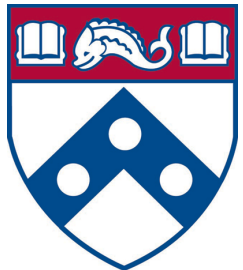


# Enhanced Recovery After NeuroSurgery: Opioid Management in Spinal Surgery

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Michigan Spine Surgery Improvement Collaborative  
August 2, 2019



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Pennsylvania Hospital  
University of Pennsylvania  
Department of Neurosurgery

♦ **No relevant disclosures**



# Prescribing Guidelines for Pennsylvania

A grayscale photograph of a person's back and shoulder. The person is holding their right hand to their lower back, where a red, glowing area indicates pain.

## **TREATING CHRONIC NON-CANCER PAIN**

# Incidence of and Risk Factors for Chronic Opioid Use Among Opioid-Naive Patients in the Postoperative Period

Eric C. Sun, MD, PhD; Beth D. Darnall, PhD; Laurence C. Baker, PhD; Sean Mackey, MD, PhD

**IMPORTANCE** Chronic opioid use imposes a substantial burden in terms of morbidity and economic costs. Whether opioid-naive patients undergoing surgery are at increased risk for chronic opioid use is unknown, as are the potential risk factors for chronic opioid use following surgery.

**OBJECTIVE** To characterize the risk of chronic opioid use among opioid-naive patients following 1 of 11 surgical procedures compared with nonsurgical patients.

**DESIGN, SETTING, AND PARTICIPANTS** Retrospective analysis of administrative health claims to determine the association between chronic opioid use and surgery among privately insured patients between January 1, 2001, and December 31, 2013. The data included 11 surgical procedures (total knee arthroplasty [TKA], total hip arthroplasty, laparoscopic cholecystectomy, open cholecystectomy, laparoscopic appendectomy, open appendectomy, cesarean delivery, functional endoscopic sinus surgery [FESS], cataract surgery, transurethral prostate resection [TURP], and simple mastectomy). Multivariable logistic regression analysis was performed to control for possible confounders, including sex, age, preoperative history of depression, psychosis, drug or alcohol abuse, and preoperative use of benzodiazepines, antipsychotics, and antidepressants.

**EXPOSURES** One of the 11 study surgical procedures.

**MAIN OUTCOMES AND MEASURES** Chronic opioid use, defined as having filled 10 or more prescriptions or more than 120 days' supply of an opioid in the first year after surgery, excluding the first 90 postoperative days. For nonsurgical patients, chronic opioid use was defined as having filled 10 or more prescriptions or more than 120 days' supply following a randomly assigned "surgery date."

**RESULTS** The study included 641 941 opioid-naive surgical patients (169 666 men; mean [SD] age, 44.0 [12.8] years), and 18 011 137 opioid-naive nonsurgical patients (8 849 107 men; mean [SD] age, 42.4 [12.6] years). Among the surgical patients, the incidence of chronic opioid in the first preoperative year ranged from 0.119% for Cesarean delivery (95% CI, 0.104%-0.134%) to 1.41% for TKA (95% CI, 1.29%-1.53%). The baseline incidence of chronic opioid use among the nonsurgical patients was 0.136% (95% CI, 0.134%-0.137%). Except for cataract surgery, laparoscopic appendectomy, FESS, and TURP, all of the surgical procedures were associated with an increased risk of chronic opioid use, with odds ratios ranging from 1.28 (95% CI, 1.12-1.46) for cesarean delivery to 5.10 (95% CI, 4.67-5.58) for TKA. Male sex, age older than 50 years, and preoperative history of drug abuse, alcohol abuse, depression, benzodiazepine use, or antidepressant use were associated with chronic opioid use among surgical patients.

**CONCLUSIONS AND RELEVANCE** In opioid-naive patients, many surgical procedures are associated with an increased risk of chronic opioid use in the postoperative period. A certain subset of patients (eg, men, elderly patients) may be particularly vulnerable.

JAMA Intern Med. 2016;176(9):1286-1293. doi:10.1001/jamainternmed.2016.3298  
Published online July 11, 2016. Corrected on August 8, 2016.

# Penn Neurosurgery ERAS Protocol

## Pre-op

Surgical Education &  
Expectation Management

Surgical Site Education

Nutrition Optimization

Diabetes Management

Smoking Cessation

Narcotic/Alcohol Use

Obstructive Sleep Apnea

Discharge Planning

## Peri-op

Metabolism Management

Multimodal Analgesia

Surgery Checklist

Early Mobilization

Wound Care Management

## Post-op

Clinical Team  
Communication

Wound Care Management

Post Acute Care  
Resource Utilization

# Penn Neurosurgery ERAS – Pre-op

## Pre-op

Surgical Education & Expectation Management

Surgical Site Education

Nutrition Optimization

Diabetes Management

Smoking Cessation

Narcotic/ Alcohol Use

Obstructive Sleep Apnea

Discharge Planning

## ERAS Consult Letter

Neurosurgery-Enhanced Recovery After Surgery (ERAS)  
Department of Neurosurgery  
235 S. 8<sup>th</sup> Street-Entrance on Locust  
Philadelphia, PA 19106  
Phone: 215-829-6700 Fax: 215-829-6645

We are requesting that you be referred for consultation and/or treatment for the following: **Pain Management**. 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 convenience.

**Consulting Department**  
Penn Pain Medicine Center  
Tuttleman Center  
1840 South St. 2<sup>nd</sup> Floor  
Philadelphia, PA 19146  
215-893-7246

If you have any questions for your neurosurgeon, please contact:

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

Neurosurgery-Enhanced Recovery After Surgery (ERAS)  
Department of Neurosurgery

**Patient Checklist: Preoperative History & Physical Visit And Prior To Surgery (1,4)**

**I. Necessary Appointments Before Surgery**

- Preanesthesia Testing
  - Baseline pre-operative labs
  - Chest X-ray if cardiopulmonary disease
  - ECG/BG
  - Serum Albumin if Body Mass Index (BMI) is <18.5 or >35
  - Neurologist Visit if indicated
- Appointment with Primary Care Physician or Cardiologist
- Additional Consultations, if requested by your surgeon:
  - Narcotics Consultation
  - Pain Medicine Consultation
  - Sleep Medicine Consultation
  - Endocrine Consultation

**II. Preoperative/Inpatient Care Before Surgery**

- Pick up 20 oz. of non-red Gatorade or Powerade for the day before AND day of surgery
- Discuss holding your NSAIDs (e.g. Ibuprofen and naproxen), Aspirin, Plavix or other anti-platelet agents for 7 days with your surgeon
- Discuss with your cardiologist and surgeon about holding your Coumadin or other anticoagulation medications for 7 days before surgery
- Continue to take any other medications not listed above after discussing with your neurosurgeon
- Continue regular diet unless instructed otherwise by your surgery team
- Refrain from smoking for a minimum of four weeks
- Continue your normal activity routine until day of surgery
- Engaged Recovery at Penn (ERAP) Test Messaging
- Sign up to participate in text messaging program
- Review and respond to text messages that contain valuable information to help you through your surgical experience

**Patient Checklist: Day Prior to Surgery (2,4)**

**Day Before Surgery**

- You may eat a regular diet
- Drink 20 oz. of non-red Gatorade or Powerade
- After midnight, do not eat or drink anything – no liquids and Gatorade/Powerade up until 2hrs before your surgery
- Call OR for surgery time if not contacted by Sign
- Bring CPAP machine to hospital (if you use one)

Diabetes Education Center  
Penn Medicine  
University of Pennsylvania Hospital

**Protein Intake Pre/Post Spinal Surgery**

What is protein and why is it so important to consume?

- Protein is an important macronutrient used by the body as a building block, repair and maintain tissues.
- Protein is part of every cell, tissue, and organ in our bodies.
- It is important to consume enough protein before surgery to ensure that our tissues are optimal before opening them up for surgery. If not, they may not heal back all of the tissues in our body (including organs, muscle, and bone).

How much protein should you consume pre/post-surgery?

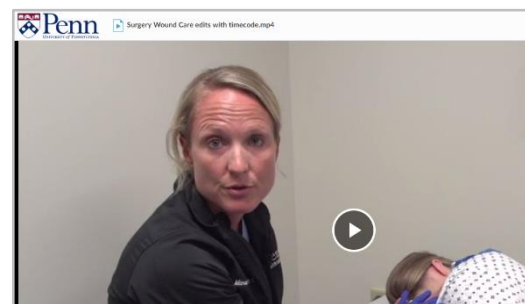
- It is common to consume about 60 grams of protein per day (including prior to surgery).
- After surgery we need much more for healing purposes and will depend on current body weight and height but may include over 100 grams of protein daily.

**High Protein Foods**

Food	Amount	Protein (grams)
Chicken, white	3 oz.	24
Turkey, lean	3 oz.	20
Lean, fat-free ground beef	3 oz.	20
Pork tenderloin	3 oz.	18.5
Chicken breast, boneless/skinless	3 oz.	12.5
Corned beef, lean	1/2 cup	12.5
Lean pork	1 cup (8 oz.)	11
Lean beef	1/2 cup	11
Vegetables, raw, green	1 cup	11
Protein smoothie	1 cup	8.5
Milk (1% fat, low fat, whole)	1 cup (8 oz.)	8
Protein bar, smoothie or yogurt	2 tablespoons	8
Yogurt	1 cup	8
Egg whites	1 cup	7.5
Chickpeas	1/2 cup (1 oz.)	7
Chicken breast, cooked	1/2 cup	7
Nuts, peanuts, pistachios, almonds	1 oz.	6
Fish (brockfish, flounder, perch, yellow)	1 oz.	6.5
Egg, whole or hard-boiled	1 egg	6
Swiss cheese	1 oz.	5.5

Created by Marissa Reed, MS, RD  
2015-2016  
Diabetes Education Center  
Source: Nutrition Care Manual - College of Dietitians

## Patient Education



**What Do You Do if OSA is Suspected: STOP-BANG**

**STOP Questionnaire**

- S** Snoring
- T** Tiredness
- O** Observed you stop breathing
- B** Blood Pressure

**BANG**

- B** BMI >35
- A** Age >50
- N** Neck circumference >40 cm (>15.7")
- G** Gender male

**High risk: Yes to ≥3 items → Refer for sleep testing**

**Quit Smoking Before Your Operation**

**SURGICAL PATIENT EDUCATION PROGRAM**  
Prepares for the best recovery

Did you know that before surgery is the best time to quit smoking?

- Yes will decrease your risk of complications.
- Smoking can make anesthesia more difficult, so you won't be as comfortable.
- The quit date is much higher when you quit before your operation.

Do your part and quit now! Your surgical team is here to help.

**Smoking Increases Your Risk of Heart and Breathing Problems**

Smoking increases the risk of heart and breathing problems. It also increases the risk of complications and other health problems. Before surgery, it's important to quit smoking to reduce your risk of complications.

Smoking increases the risk of heart and breathing problems. It also increases the risk of complications and other health problems. Before surgery, it's important to quit smoking to reduce your risk of complications.

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## “Game Plan Bag”



Patients receive text reminders about the critical ERAS behaviors

AT&T LTE 2:58 PM 100%

**Messages ERAP Details**

Text Message  
Fri, Feb 17, 9:06 AM

Hi Zarina. Welcome to ERAP, Engaged Recovery at Penn. ERAP will send tips and reminders to coach you through your preparation for surgery.

Fri, Feb 17, 10:06 AM

Did you know you can contact your doctor's office online? Sign up for myPennMedicine! <http://mypennmedicine.org>

Be sure you have a stock of food for when you come home from the hospital; prepare some meals now that are easy to reheat.

Fri, Feb 17, 12:05 PM

To help prevent infection have plenty of clean sheets, towels, and comfortable clothing so friends and family can concentrate on YOU and not chores.

Fri, Feb 17, 1:05 PM

Text Message Send



# Penn Neurosurgery ERAS – Peri-op

# Peri-op

## Metabolism Management

## Multimodal Analgesia

## Surgery Checklist

## Early Mobilization

## Wound Care Management

## PRACTICE PARAMETERS

# Practice Guidelines for Preoperative Fasting and the Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration: Application to Healthy Patients Undergoing Elective Procedures

### *An Updated Report by the American Society of Anesthesiologists Task Force on Preoperative Fasting and the Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration\**

**P**RACTICE guidelines are systematically developed recommendations that assist the practitioner and patient in making decisions about health care. These recommendations may be adopted, modified, or rejected according to clinical needs and constraints, and are not intended to replace local institutional policies. In addition, practice guidelines developed by the American Society of Anesthesiologists (ASA) are not intended as standards or absolute requirements, and their use cannot guarantee any specific outcome. Practice guidelines are subject to revision as warranted by the evolution of medical knowledge, technology, and practice. They provide basic recommendations that are supported by a synthesis and analysis of the current literature, expert and practitioner opinion, open forum commentaries, and clinical feasibility data.

This document updates the "Practice Guidelines for Preoperative Fasting and the Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration: An Updated Report" adopted by the ASA in 2010 and published in 2011.<sup>1</sup>


#### Methodology

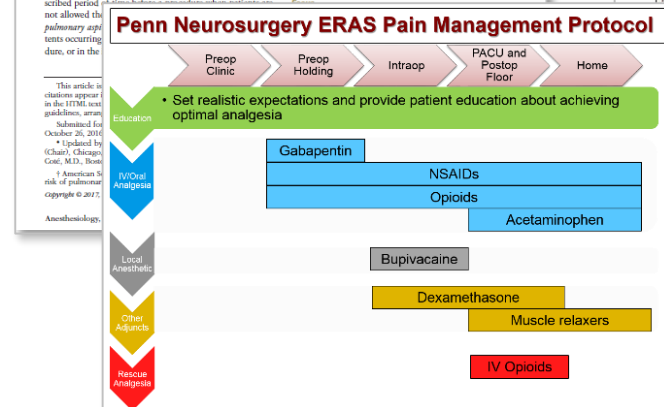
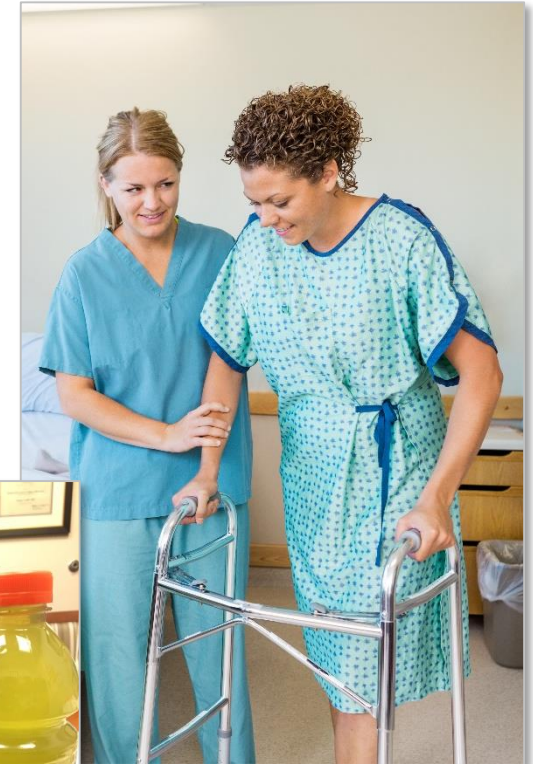
**Definition of Preoperative Fasting and Pulmonary Aspiration**  
For these guidelines, *preoperative fasting* is defined as a pre-

these guidelines, the term "preoperative" should be considered synonymous with "preprocedural" as the latter term is often used to describe procedures that are not considered to be operations. Anesthesia care during procedures refers to general anesthesia, regional anesthesia, or procedural sedation and analgesia.

#### Purposes of the Guidelines

The purposes of these guidelines are to provide direction for clinical practice related to preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration and to reduce the severity of complications related to perioperative pulmonary aspiration. Clinical practice includes, but is not limited to, the timing of liquids and solids for specified time periods before surgery and prescribing pharmacologic agents to reduce gastric volume and acidity. Enhancements in the quality and efficiency of anesthesia care include, but are not limited to, the utilization of perioperative preventive medication, increased patient satisfaction, avoidance of delays and cancellations, decreased risk of dehydration or hypoglycemia from prolonged fasting, and the minimization of perioperative morbidity. Complications of aspiration include, but are not limited to, aspiration pneumonia, respiratory compromise, and related morbidities.

 <b>Enhanced Recovery After Surgery (ERAS)</b> Department of Neurosurgery	
DATE _____	PATIENT STICKER: _____
<b>FOLEY</b> <input type="checkbox"/> No foley during or after procedure <input type="checkbox"/> Foley placed for procedure and removed <input type="checkbox"/> Foley placed and kept in place due to <ul style="list-style-type: none"> <li><input type="checkbox"/> CSF leak</li> <li><input type="checkbox"/> &gt;3 levels of thoracic or lumbar fusion</li> <li><input type="checkbox"/> medical urologic necessity</li> </ul>	
<b>Spine Surgery Checklist</b>	
N/A <input type="checkbox"/>	1. Decompression/Stabilization/Reconstruction & Realignment
N/A <input type="checkbox"/>	2. Neuromonitoring assessment
N/A <input type="checkbox"/>	3. Final imaging
N/A <input type="checkbox"/>	4. Final screw tightening
N/A <input type="checkbox"/>	5. Antibiotic irrigation
N/A <input type="checkbox"/>	6. Decortication & Application of bone graft
N/A <input type="checkbox"/>	7. Hemostasis and placement of drain
N/A <input type="checkbox"/>	8. Vancomycin powder application
N/A <input type="checkbox"/>	9. Final neuromonitoring assessment
N/A <input type="checkbox"/>	10. Local anesthetic
N/A <input type="checkbox"/>	11. Closure
N/A <input type="checkbox"/>	12. Check drain



# Penn Neurosurgery ERAS – Post-op

## Post-op

- Clinical Team Communication
- Wound Care Management
- Post Acute Care Resource Utilization



PAH Postop Spine Triage Protocol	
Department of Neurosurgery 235 S. 8 <sup>th</sup> Street-Entrance on Locust Philadelphia, PA 19106 Phone: 215-829-6700 Fax: 215-829-6645	
Routine Care	Routine Contact
<ul style="list-style-type: none"><li>Medication management or refill</li><li>Physical or Occupational Therapy Orders</li><li>Schedule Routine Post-Op Visits</li><li>Requesting Office Notes or Discharge Summaries to be faxed</li><li>Non-urgent patient-related questions</li></ul>	Neurosurgery Main Number: <b>215-829-6700</b>
Urgent Care	Urgent Care Contact
Patients showing worsening symptoms related to: <ul style="list-style-type: none"><li>Wound drainage or dehiscence</li><li>Warm, Red, Swollen site</li><li>Fever (<math>\geq 101.5</math>)</li><li>Uncontrollable pain</li></ul>	<ul style="list-style-type: none"><li>Call <b>215-829-6700</b> to speak to a nurse right away to address serious patient concerns related to surgery</li><li>Hours: <b>24/7</b></li><li>You may be asked to send the patient to the Emergency Room for evaluation</li></ul> <p><b>*Use for clinical staff only</b></p>
Emergency Care	Emergency: Call 911
<ul style="list-style-type: none"><li>Abnormal / difficulty breathing</li><li>Confusion</li><li>Unrelieved chest pain</li><li>Loss of consciousness</li></ul>	<b>Call 911 right away</b>

ERAP Home   Colorectal Surgery   Gynecologic Surgery   Neurosurgery

## Neurosurgery

In an effort to provide the best care before, during, and after spine surgery, the Department of Neurosurgery has introduced an evidence-based approach to delivering spine care, called Enhanced Recovery After Surgery (ERAS). Through our protocol and Engaged Recovery at Penn (ERAP), we will address your pain, nutrition, movement, surgical site care and educational needs. Our goal is to deliver the highest quality of care across all phases of your surgical journey.

### Reducing Pneumonia Risk: Breathing and Oral Care

### Staying Active After Surgery

### Strengthening Exercises

### Checklists & Instructions

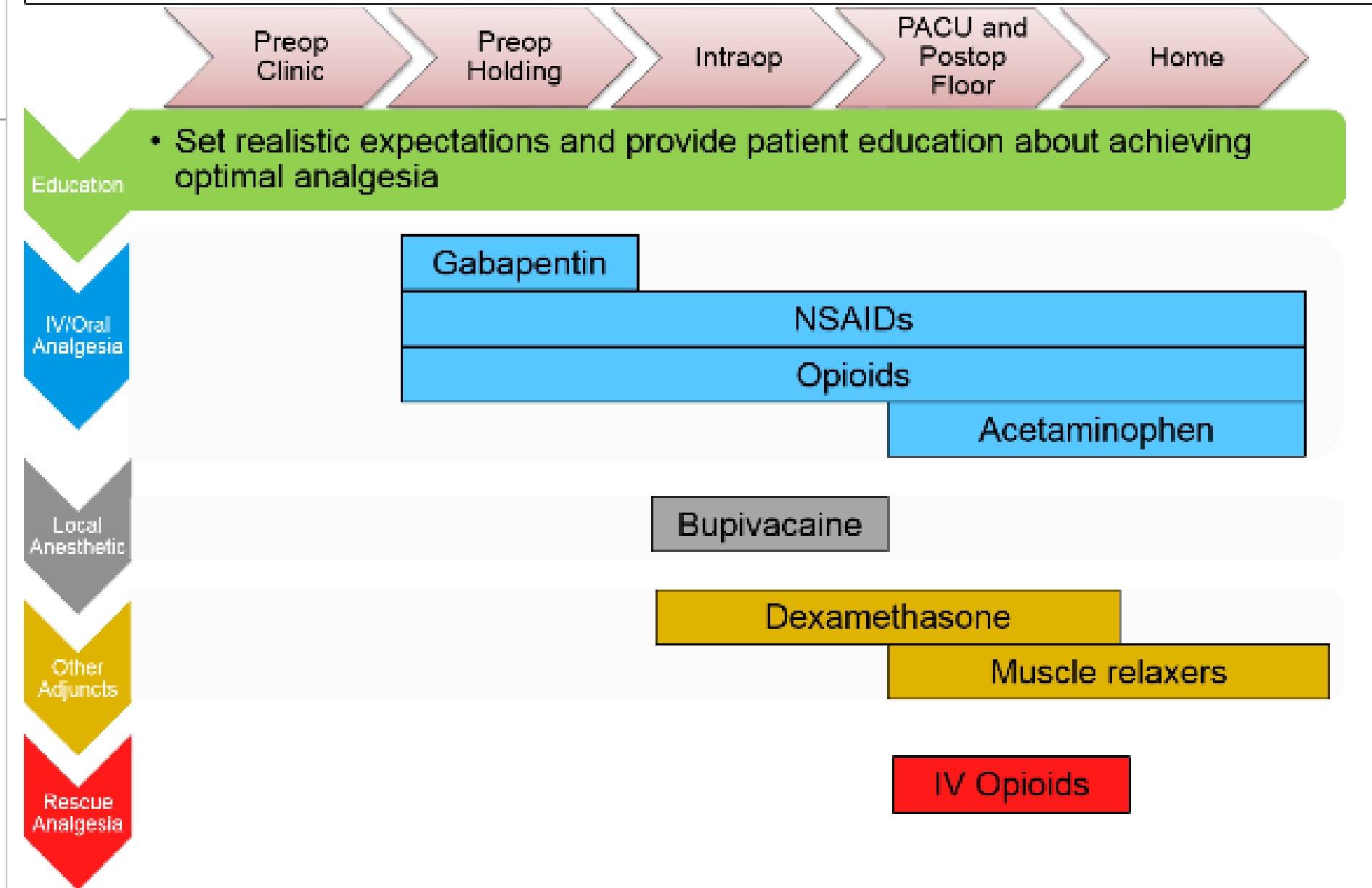
- Preoperative Skin Wash Instructions (PDF)
- Quit Smoking Before Your Operation (PDF)
- Protein Intake Pre/Post Spinal Surgery (PDF)
- ERAS Patient Checklist (PDF)
- Video on Surgical Site Care
- Eating and Drinking Before Surgery (PDF)
- Opioid Fact Sheet (PDF)
- Safe Pain Management (PDF)
- Home Safety Tips (PDF)
- Preventing Blood Clots (PDF)

### Other Resources

- Free mindfulness meditation app to reduce stress



# Penn Neurosurgery ERAS Pain Management Protocol



# Penn Neurosurgery ERAS Study: Patient Inclusion and Exclusion Criteria/Outcomes

## Inclusion Criteria:

- ♦ Have a clinical history and diagnostic imaging supporting the need for elective spine or peripheral nerve surgery
- ♦ Be over 18 years of age
- ♦ 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
- ♦ Pregnancy

## Primary Outcomes:

- ♦ Opioid and non-opioid consumption on POD 1
- ♦ Need for opioid use at one month post-operatively
- ♦ Patient-reported pain scores

## Secondary Outcomes:

- ♦ Length of stay (days)
- ♦ Need for ICU admission
- ♦ Discharge status
- ♦ Re-admission within 30 days
- ♦ 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

# Penn Neurosurgery ERAS Study: One Year Data

- ♦ **Prospective enrollment of 805 ERAS patients (April 2017 – June 2018)**
- ♦ **PAH Historical Control n=149 (September – December 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

# Baseline Demographics

## PAH Controls vs. PAH ERAS

Preoperative Characteristics	PAH Controls (n=149)	PAH ERAS (n=805)	p-value
Age (years)	61.9	61.7	0.86
BMI	30.3	29.9	0.53
Males	51.70%	53.90%	0.66
History of Spinal/Peripheral Nerve Surgery	47.00%	37.50%	<b>0.035</b>
History of Sleep Apnea	18.80%	16.90%	0.56
CPAP Use	10.70%	9.70%	0.66
Smoking Status			0.16
Current	17.40%	12.20%	
Former	38.90%	37.90%	
Never	43.60%	49.90%	0.64
Diabetes	18.80%	17.30%	
Hypertension	61.70%	57.30%	
COPD	2.00%	3.90%	0.34
Mental Health Disorder	26.20%	23.00%	0.40
Substance Abuse Disorder	6.00%	3.10%	0.09
Glucose (mg/dL)	102.8	106.3	0.11
HbA1c (mg/dL)	9.0	7.1	0.64
Albumin (mg/dL)	4.4	4.4	0.71
Lag Time (days)	44.6	42.8	0.70
Preoperative Working Status			0.17
Yes	43.40%	49.70%	
No	56.60%	50.30%	
Disabled	27.20%	20.30%	0.17
Retired	60.50%	70.90%	
Due to reason other than the condition being treated	11.10%	6.40%	
No reason given	1.20%	2.30%	

# Procedures

## PAH Controls vs. PAH ERAS

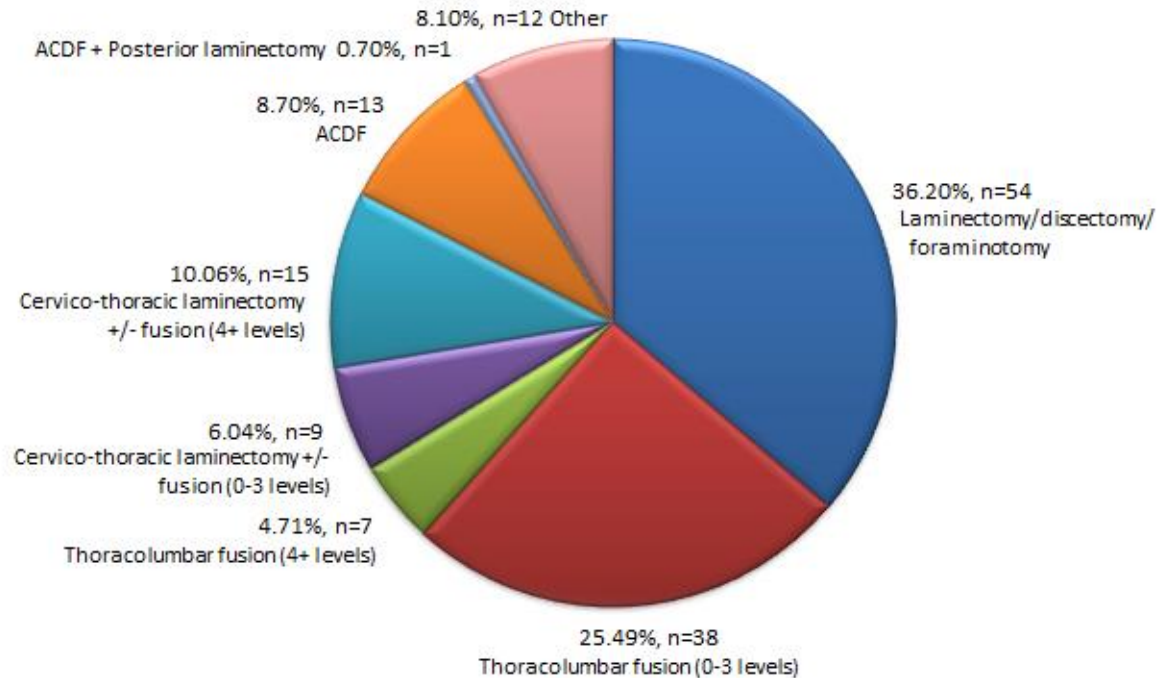
Procedures	PAH Controls (n=149)	PAH ERAS (n=805)	p-value
Laminectomy/discectomy/foraminotomy	36.20%	39.10%	0.56
Thoracolumbosacral fusion (0-3 levels)	25.49%	21.21%	
Thoracolumbosacral fusion (4+ levels)	4.71%	4.59%	
Cervico-thoracic laminectomy +/- fusion (0-3 levels)	6.04%	12.15%	
Cervico-thoracic laminectomy +/- fusion (4+ levels)	10.06%	5.95%	
ACDF	8.70%	6.00%	
ACDF + Posterior Laminectomy	0.70%	0.60%	
Other	8.10%	10.30%	



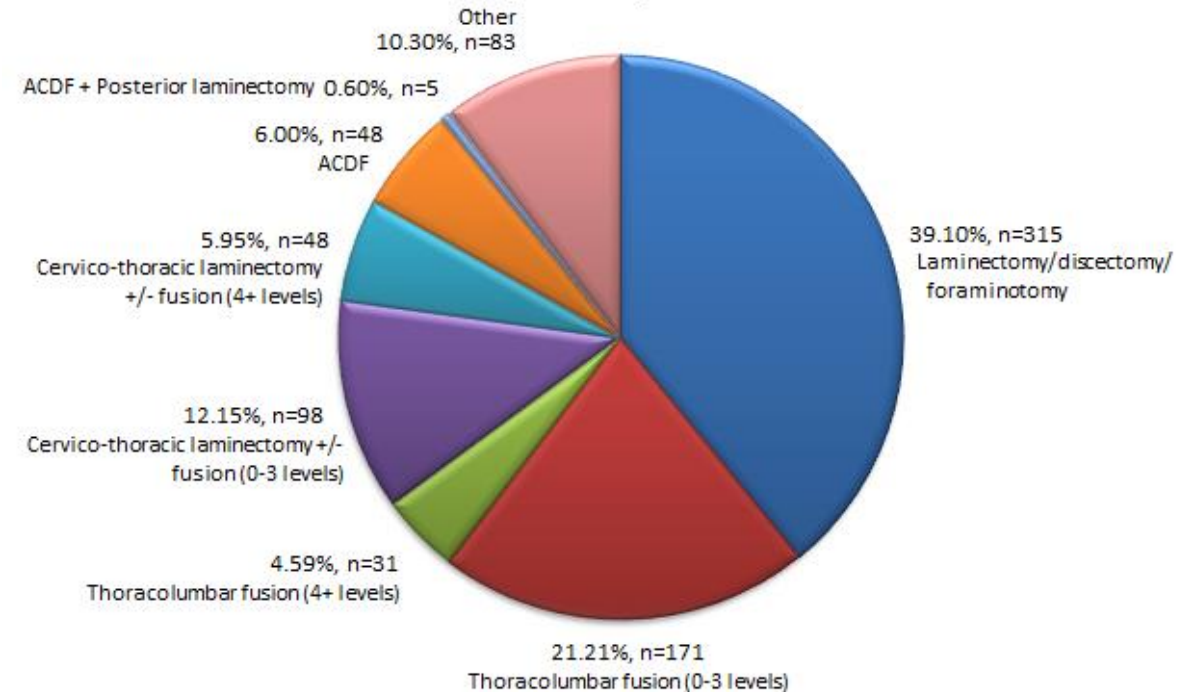
# Procedures

## PAH Controls vs. PAH ERAS

**PAH Controls (n=149): Procedures**



**PAH ERAS (n=805): Procedures**

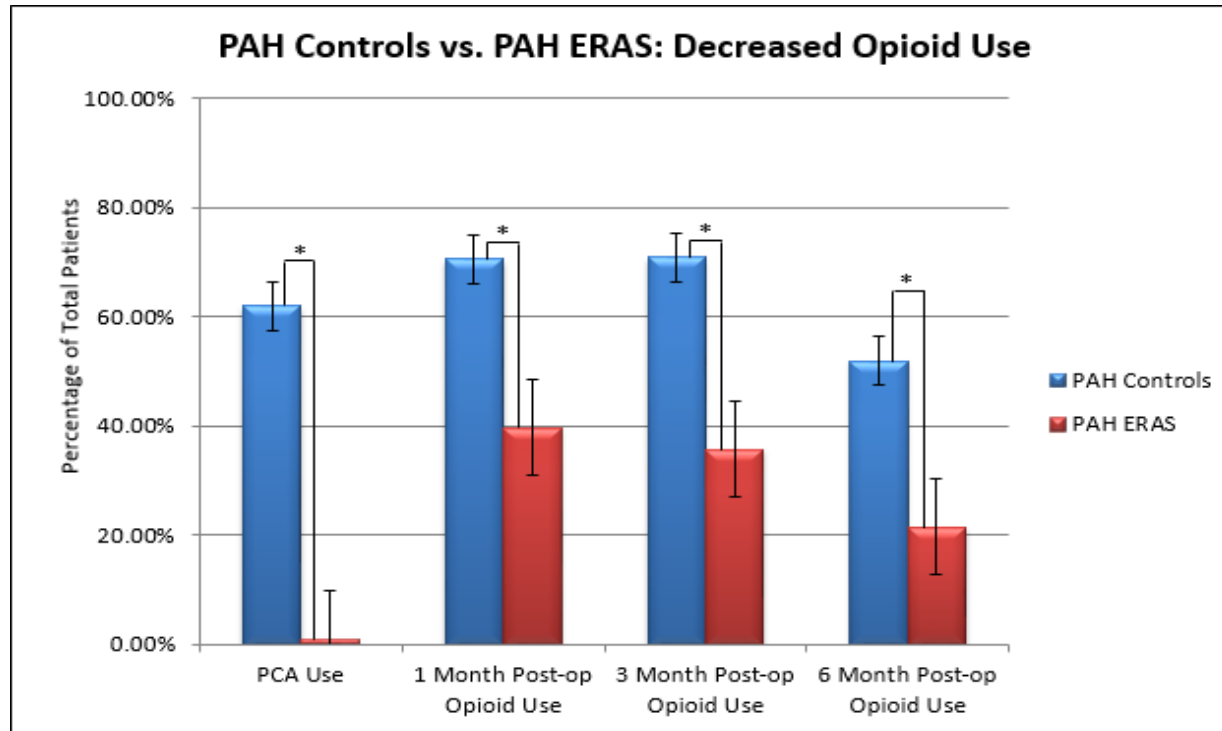


$p=0.56$

# Decreased Opioid Use

## PAH Controls vs. PAH ERAS

	PAH Controls	PAH ERAS	p-value
PCA Use (n=149/805)	62.00%	1.00%	<b>&lt;0.001</b>
1 Month Post-op Opioid Use (n=139/772)	70.50%	39.60%	<b>&lt;0.001</b>
3 Month Post-op Opioid Use (n=55/168)	70.90%	35.70%	<b>&lt;0.001</b>
6 Month Post-op Opioid Use (n=27/103)	51.90%	21.40%	<b>0.003</b>



# Pain Scores

## PAH Controls vs. PAH ERAS

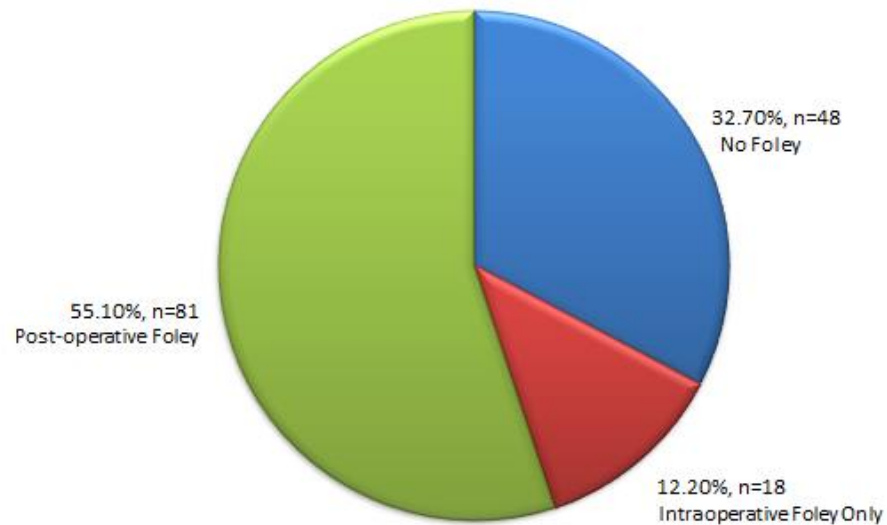
Post-op Day	PAH Controls	PAH ERAS	p-value
POD0 (n=141/793)	4.4	4.1	0.20
POD1 (n=106/686)	5.6	5.6	0.87
POD2 (n=87/505)	5.6	5.6	0.99
POD3 (n=56/309)	5.4	5.3	0.57

# Decreased Foley Use

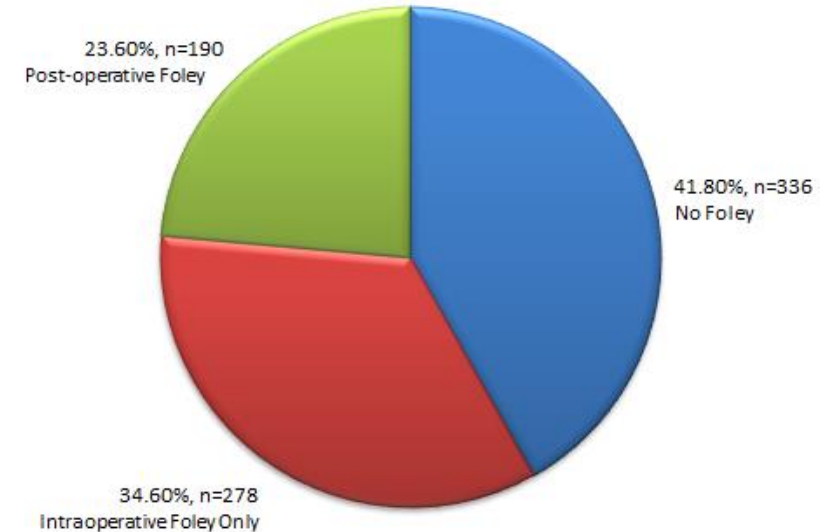
## PAH Controls vs. PAH ERAS

Use of Foley/Straight Catheter	PAH Controls (n=149)	PAH ERAS (n=805)	p-value
No Foley	32.70%	41.80%	<0.001
Intra-operative Foley Only	12.20%	34.60%	
Post-operative Foley	55.10%	23.60%	
Straight catheterization	9.40%	10.30%	0.88

**PAH Controls (n=149): Foley Use**



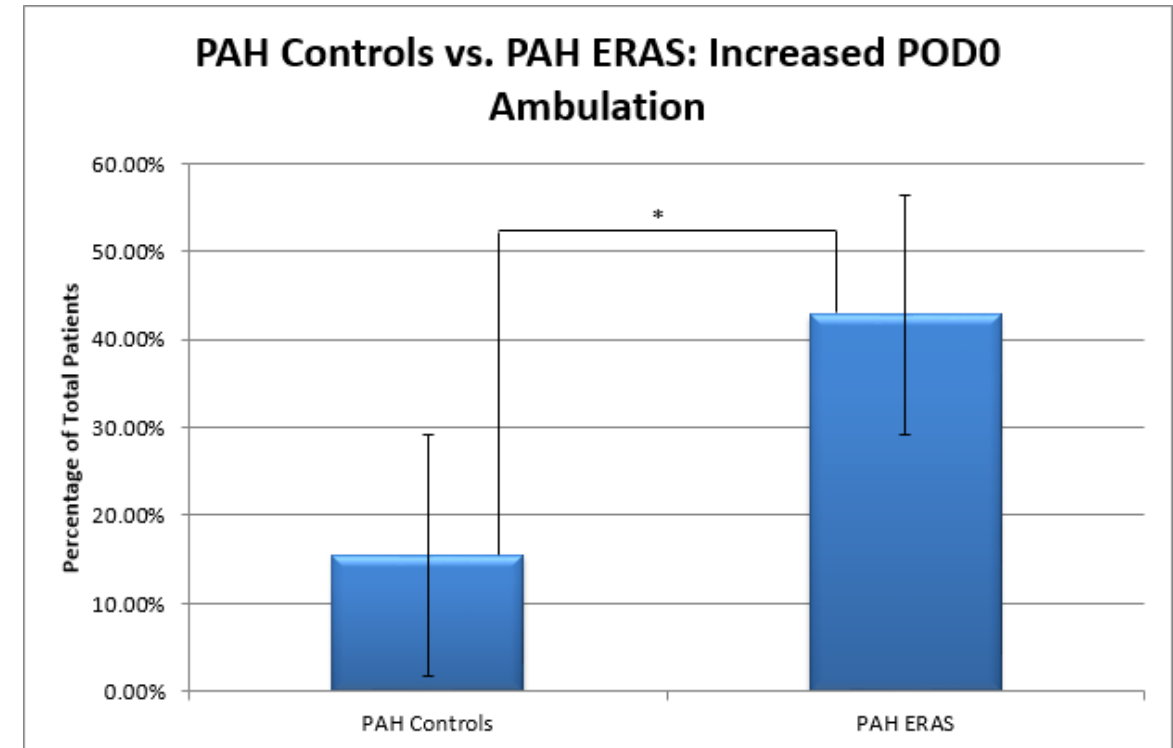
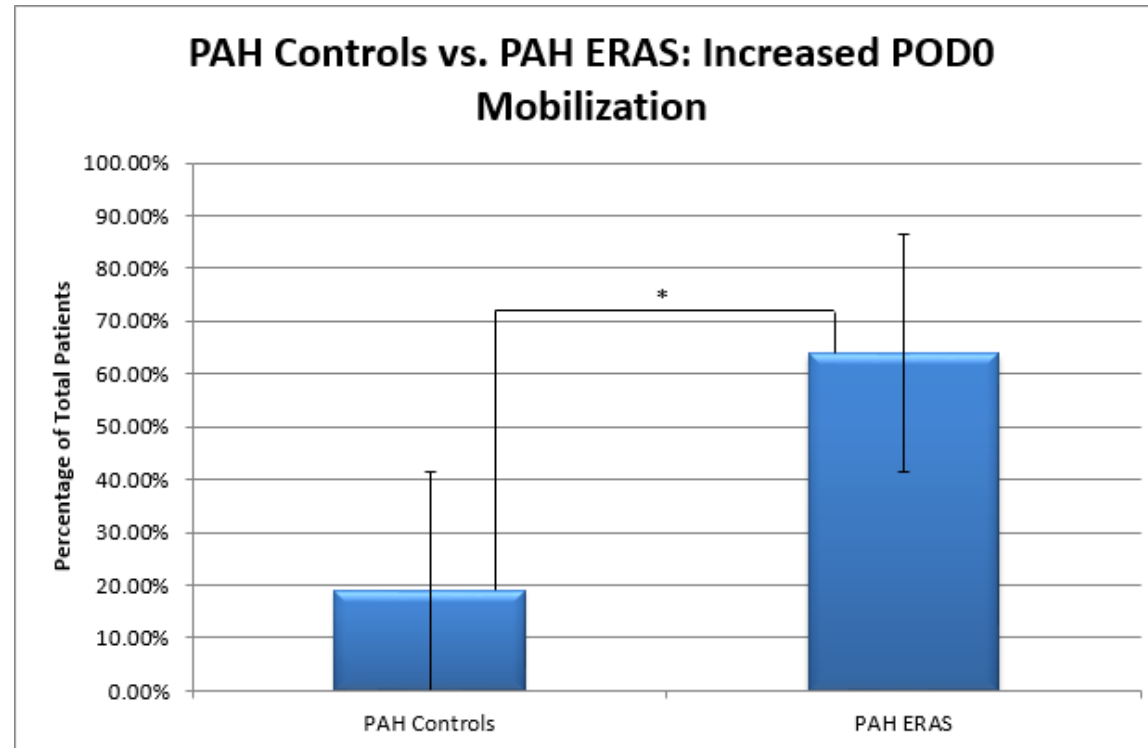
**PAH ERAS (n=805): Foley Use**



# Increased POD0 Mobilization/Ambulation

## PAH Controls vs. PAH ERAS

	PAH Controls	PAH ERAS	p-value
POD0 Mobilization (n=116/783)	19.00%	63.90%	<0.001
POD0 Ambulation (n=116/782)	15.50%	42.80%	<0.001

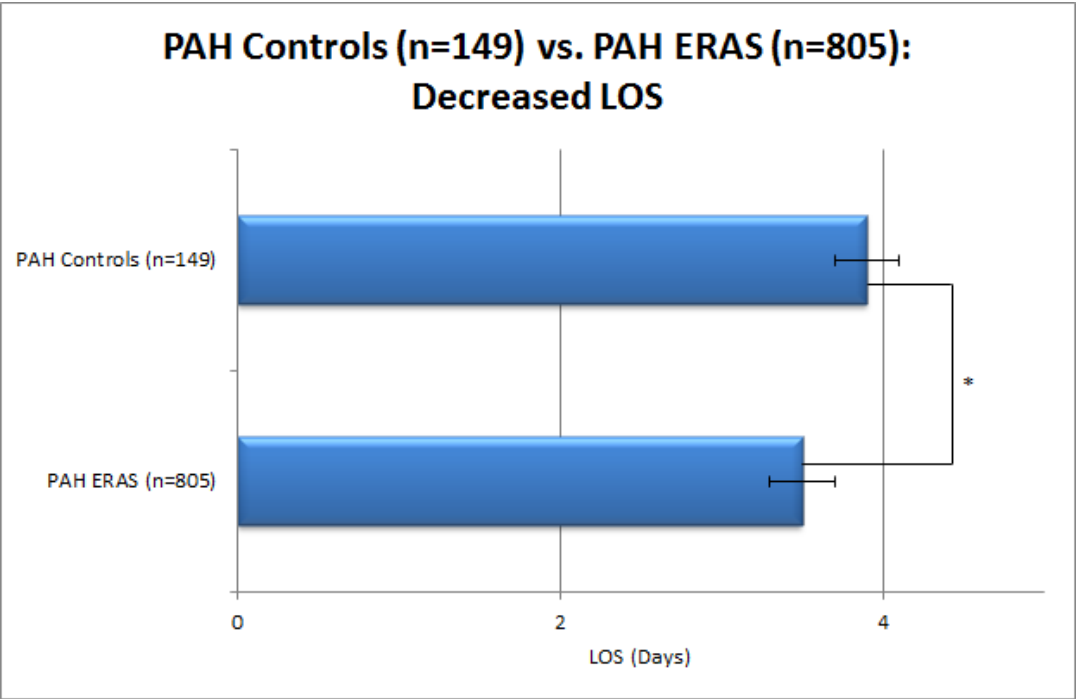




# Resource Allocation

## PAH Controls vs. PAH ERAS

	PAH ERAS (n=805)	PAH Controls (n=149)	p-value
Total LOS (days)	3.5	3.9	<b>0.043</b>



# 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, three, and six months after surgery.
- ♦ ERAS patients demonstrated reduced hospital length of stay.
- ♦ Re-admission rates at 30 and 90 days were not found to be significantly different.

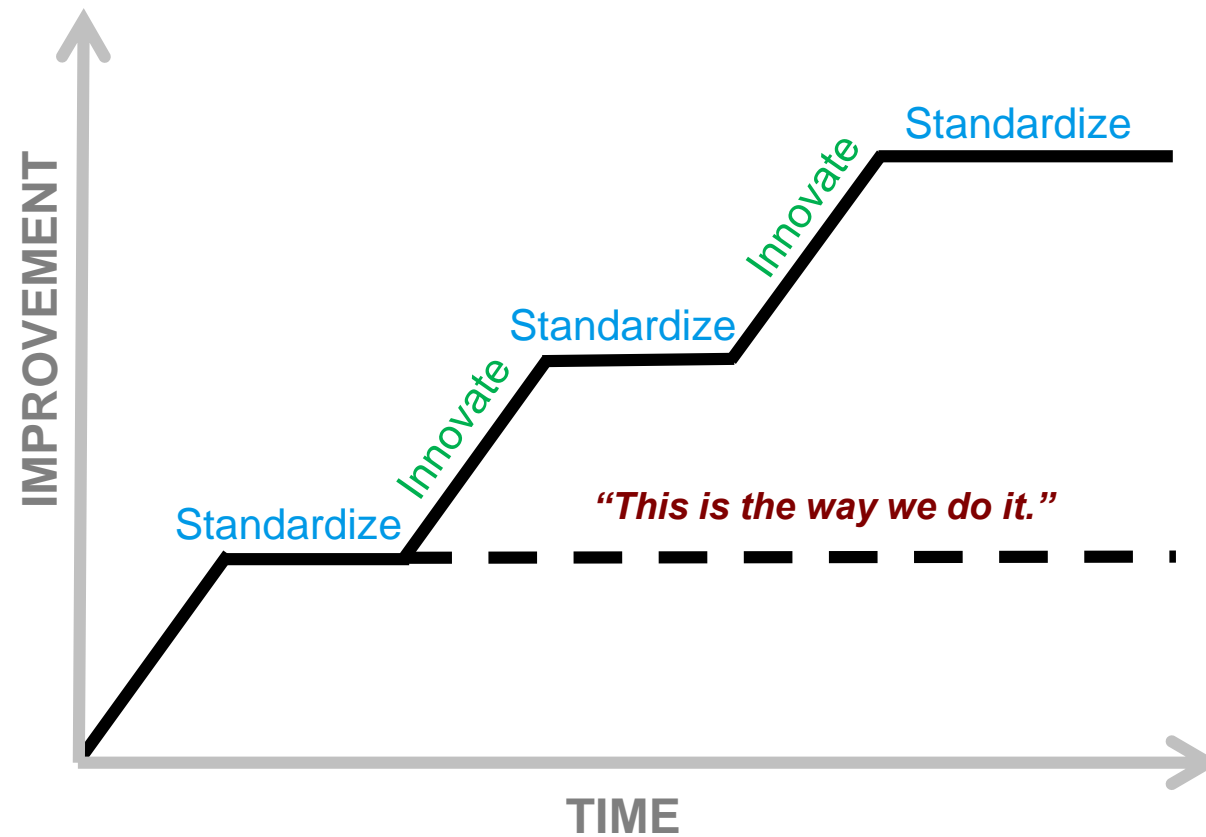
# Limitations

- ◆ Opioid data monitoring
- ◆ Retrospective data analysis, randomization and blinding not performed

.....Penn Neurosurgery ERAS Randomized Clinical Trial

# ERAS:

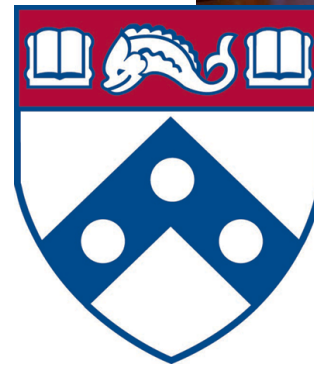
## An Iterative Process of Quality Improvement, From Bench to Bedside and BEYOND



Clifford Ko, MD; ACS Director of NSIQP

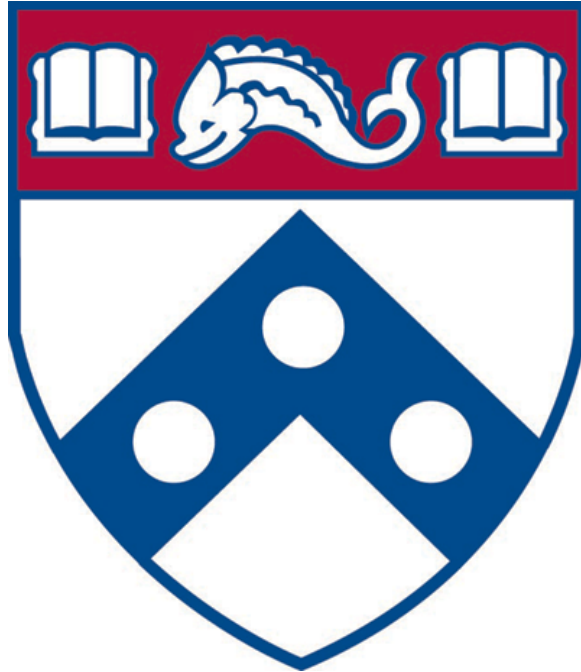
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# Thank you



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