Enhanced Recovery after Surgery (ERAS) for Thoracic Operations

APACVS
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Objectives

• Understand enhanced recovery after surgery (ERAS)
• Review components of ERAS for lung surgery
• Implementing an ERAS protocol
Introduction

What is ERAS?

• Comprehensive program developed around the patient to facilitate recovery for specific specialty
• Evidence based
• Divided into pre-op, peri-op, post-op components
• Interdisciplinary involvement
Introduction

Main goals of ERAS?

• Reduce physiologic stress
• Reduce complications
• Reduce hospital stay
• Improve patient outcomes
• Improve patient satisfaction
• Reduce hospital costs
• Henrik Kehlet MD PhD
• Recognized as a key figure in the development of ERAS
• Colorectal surgeon
• 1990s in Denmark
• Discharged patients on POD2 after colon resections
Introduction
Fundamental changes in care in colorectal surgery

• Education preparation of patients
• No NG tubes
• Early feeding
• Immediate ambulation
• Euvolemic fluid balance
Introduction
Spread to other fields

- Colorectal
- Gynecologic / oncology
- Gastrointestinal
- Gastrectomy
- Cystectomy / bladder surgery
- Breast reconstruction
- Lung surgery
- Esophagectomy
ERAS for Lung Surgery

Introduction


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## ERAS for Lung Surgery

### Overview

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Evidence level grade system by quality

- High: further studies unlikely to Δ confidence
- Moderate: further studies likely to Δ confidence
- Low: further studies very likely to Δ confidence
- Very low: estimated effect uncertain
Recommendation grade system

- **Strong**: benefits clearly do/don’t outweigh risks
- **Weak**: benefits likely do/don’t outweigh risks
Pre-operative education and counseling

- Written and oral instructions
- Setting expectations
- Pain management education
- Discuss minimal use of opioids

Evidence level: Weak
Recommendation grade: Strong
Preoperative nutrition Screening

- Weight loss > 10-15% 6 months
- BMI < 18.5 kg/m²
- Albumin < 3 g/dL
- 7-10 days oral nutritional support

Evidence level: High
Recommendation grade: Strong

ESPEN guideline: Clinical nutrition in surgery

Arved Weimann, Marco Braga, Franco Carli, Takashi Higashiguchi, Martin Hübner, Stanislaw Klek, Alessandro Laviano, Olle Ljungqvist, Dileep N. Lobo, Robert Martindale, Dan L. Waltzberg, Stephan C. Bischoff, Pierre Singer
Immune-Enhancing Nutritional Supplement

- Meta-analysis in abd surg – no benefit
- Definition for supplement not clear
- One thoracic study – higher plasma albumin levels post-op

Evidence level: Low
Recommendation grade: Weak
Smoking cessation

- Smokers - ↑ pulm complications / death
- 4 weeks before surgery
- < 4 weeks possible higher complications
- > 4 weeks possible upstaging of CA
- Cost affective

Evidence level: High
Recommendation grade: Strong
Alcohol cessation in abusers

- Alcohol - ↑ pulm complications / death
- 4 weeks of intensive cessation programs
- Studies show decreased complications
- Optimal timing is not known

Evidence level: Moderate
Recommendation grade: Strong
Anemia

- ↑ mortality and ↓ long term survival
- Investigate cause of anemia and treat
- Iron therapy oral or IV
- Avoid transfusions pre-op and intra-op
- Avoid erythropoiesis agents ↑ risk for thromboembolic events and death

Evidence level: High
Recommendation grade: Strong
Pulmonary Rehab

- ↑ lung function (FEV1 FVC), ↑ 6 min walk test
- ↓ length of stay, ↓ post-op complications
- length of exercises, structure, intensity unknown
- Median length of therapy 4 wks
- Aerobic moderate intensity exercises prescribed

Evidence level: High
Recommendation grade: Strong
ERAS for Lung Surgery
Pre-operative Phase

Fasting guidelines *(no delayed gastric emptying)*

- 6 hours for solids
- 2 hours for liquids
- No ↑ gastric residual, no ↑ in complications

Evidence level: High
Recommendation grade: Strong
Carbohydrate loading

- Oral carbohydrate loading in drinks
- Decreased post operative insulin resistance
- Decreased nausea and vomiting post op
- Not tested in diabetic patients

Evidence level: low (in thoracic patients)
Recommendation grade: Strong
Pre-anesthetic avoidance of sedatives

- Benzodiazepines associated with confusion, delirium, upper airway obstruction
- Long acting benzos increased time to extubation
- Alternative anxiolytics, melatonin maybe equally effective

Evidence level: Moderate
Recommendation grade: Strong
Venous thromboembolism (VTE) prophylaxis

- Thoracic patients high risk for VTE/PE
- VTE study in cancer surgery demonstrated increase in mortality from 1.3% to 8%
- Mechanical (stocking/SCD) + Pharmacologic
- LMWH or Heparin (renal patients)
- Oral Anticoagulants (no evidence)
- LMWH single dose ≈ twice per day dosing

Evidence level: Moderate
Recommendation grade: Strong
Extended VTE prophylaxis in high risk patients

• Prospective study 12.1% (n=157) VTE at 1 month
• Highest risk for post discharge VTE is in 1st month
• No prospective randomized studies for post op discharge VTE prophylaxis
• One study using Caprini risk assessment model gave post op LMWH for 1 month demonstrated decrease in symptomatic VTE

Evidence level: Low
Recommendation grade: Weak
Antibiotic prophylaxis

- Decreases surgical site infections (not pneumonia)
- Give within 60 minutes of skin incision
- Cephalosporin / Amoxicillin-clavulanic acid
- Vanc / Teicoplanin in PCN / cephalosporin allergy
- Adjust dose for BMI > 35

Evidence level: High
Recommendation grade: Strong
Chlorhexidine – Alcohol skin preparation

- Reduction of SSI by 40% compared to povidone-iodine solution
- Bath night before, plain soap ≈ chlorhexidine

Evidence level: High
Recommendation grade: Strong
Continuous core temperature monitoring

- Heat loss risk high (pleural space exposure)
- Hypothermia: ↑ SSI, ↑ bleeding, ↑ O₂ consumption, ↑ inflammatory response, ↓ homeostasis
- Monitoring with nasopharyngeal probe convenient
- Necessary to determine compliance and to determine if adjustments necessary

Evidence level: High
Recommendation grade: Strong
Use of active warming devices

- Forced air-warming, heating mattress, circulating water all produce equivalent clinical results
- ↓ SSI, absolute risk reduction of 13%
- Additional recommendations:
  - Pre-warm patients before transfer to OR
  - Warming IV fluids to body temperature

Evidence level: High
Recommendation grade: Strong
One lung ventilation protective strategies

- Lower tidal volumes 4-6ml/kg (↓ barotrauma)
- PEEP 5-10 cm H₂O (varies on resp mechanics)
- Continuous positive airway pressure on the operative side (↓ local inflammatory response)

Evidence level: Moderate
Recommendation grade: Strong
Non-intubated thoracic anesthesia

- Bullectomy, lung volume reduction, lobectomy, pneumonectomy
- Single center studies lower length of stay compared to intubated patients
- Length of stay in non-intubated studies were higher than usual fast track standards

Evidence level: Low
Recommendation grade: Not recommended
Anesthesia technique:

- Combined Regional and general anesthesia
- Regional: Use of local to block nerves
- General: Short acting volatile and IV anesthetic
- Desflurane decreases inflammatory markers in ventilated lung
- Sevoflurane decreases inflammation in the non-ventilated lung

Evidence level: Low
Recommendation grade: Strong
Non-Rx control of post-op nausea and vomiting (PONV)

- Preoperative carbohydrate loading
- Avoid fasting, clear liquids up to 2 hrs before OR
- Avoiding opiates post op
- Peripheral nerve blocks

Evidence level: High
Recommendation grade: Strong
Rx control of post-op nausea and vomiting (PONV)

- Multimodal pharmacological approach
- 5-hydroxytryptamine (5-HT3) receptor antagonists
- Neurokinin-1 (NK1) receptor antagonists
- Corticosteroids
- Phenothiazines
- Anticholinergics
- Avoid antihistamines, butyrophenones (sedating)

Evidence level: Moderate
Recommendation grade: Strong
Pain control in thoracic surgery

- Set thoracic operation pain expectations
- Poor pain control: ↑ splinting, ↓ coughing, ↓ clearing of secretions, ↑ hypercarbia, ↑ hypoxia, ↑ ischemia, ↑ arrhythmias, ↑ pneumonias, ↑ respiratory failure
- Multimodal pain therapy
- Regional and local anesthesia use
- Oral and parenteral medications
ERAS for Lung Surgery
Peri-operative Phase Pain Control

Avoiding opiates due to deleterious effects

- Sedation
- Respiratory depression
- Urinary retention
- Post operative nausea and vomiting
- Constipation
- Addiction
- May cause delay in discharge
Regional / local anesthesia for pain control

- Thoracic epidural analgesia “gold standard”
- Epidural risks: ↑ Urinary retention, ↑ hypotension, ↑ muscular weakness, epidural hematoma (paralysis)
- Paravertebral block maybe equivalent to epidural pain control after first few hours
- Intercostal nerve space injection reduces pain vs placebo

Evidence level: High
Recommendation grade: Strong
Acetaminophen and NSAIDS use in combination

• Acetaminophen decreases morphine use by ~20%
• NSAIDS in combination with acetaminophen controls pain better than either drug alone
• Acetaminophen with minimal risks, NSAIDS with risks of renal failure in elderly
• No evidence for NSAIDS related decrease in efficacy of pleurodesis procedures

Evidence level: High
Recommendation grade: Strong
N-methyl-D-aspartate (NMDA) antagonists (Ketamine)

- Decreases morphine use when used in PCA in thoracotomy patients
- Decreases respiratory desaturation
- PCA dose 1mg morphine to 1mg ketamine ratio given at 0.015ml/kg Q10 min
- Consider in patients already on opioids

Evidence level: Moderate
Recommendation grade: Strong
Gabapentin

- Pre and post-op use decreased pain and opioid use in thoracotomy (1 randomized control study)
- One preop dose did not decrease thoracotomy pain (1 randomized control study)
- Further randomized control studies needed in thoracic surgery patients

Not currently recommended based on lack of evidence
Glucocorticoids (dexamethasone, methylprednisolone)

• Antiemetic, analgesic, antipyretic, anti-inflammatory
• Dexamethasone single dose 10-40mg shown to decrease opioid use and pain scores after surgery
• Methylpred 40mg preop dose trial in VATS lobectomy resulted in decrease pain and nausea
• Risks: impaired wound healing, salt retention, hyperglycemia
• Optimum dosage unknown

Evidence level: Low
Recommendation grade: Strong
Euvolemic fluid balance

- Liberal fluid regime increases risk for ARDS, atelectasis, pneumonia and death
- Restrictive fluid regime (1-2ml/kg/hr) increases hypoperfusion and AKI risks (5.1% - retrospective)
- 2-3ml/kg/hr was not associated with AKI
- Goal to minimize hydrostatic pressure in pulmonary capillaries while minimizing hypoperfusion

Evidence level: Moderate
Recommendation grade: Strong
Goal-directed therapy (GDT) for fluid balance

- Cardiac output monitoring with pulse contour analysis, doppler ultrasound, central venous oximetry, transpulmonary thermodilution
- No difference in outcomes when GDT was used in an ERAS setting
- Evidence is inconclusive regarding GDT benefits thoracic surgery
- More studies needed
Balanced crystalloids

- LR, Plasma-lyte > NS (0.9% saline)
- Normal saline associated hyperchloremic metabolic acidosis, ↑ major adverse kidney events, ↑ hypotension, possibly ↑ mortality
- Ongoing trials will make this even clearer

Evidence level: High
Recommendation grade: Strong
Restarting Oral intake

• Oral intake should be started as soon as patient is awake and alert
• Decreases insulin resistance from a nutritional stand point
• Balanced crystalloids should be stopped at the time of resuming oral intake

Evidence level: Moderate (extrapolated)
Recommendation grade: Strong
Atrial fibrillation after lung surgery

- Afib / Aflutter incidence is ~12% post lung surgery
- Age, gender, heart disease, HTN, COPD ↑ risk
- Larger lung resections ↑ risk
- VATS or minimally invasive invasive surgery may ↓ risk
- Other post-op complications ↑ risk x 2
Atrial fibrillation prevention and beta blockers

- Beta blocker withdrawal ↑ risk for afib / aflutter
- Affects patients on beta blockers pre-op
- Continue beta blocker peri-op and post-op to prevent acute withdrawal

Evidence level: High
Recommendation grade: Strong
Atrial fibrillation prevention and low magnesium

• Identify patients with low serum or total body Mg
• May replete with IV magnesium peri-op

Evidence level: Low
Recommendation grade: Weak
Atrial fibrillation prophylaxis in high risk patients

- Digoxin does not prevent post-op afib
- Perioperative diltiazem can be considered
- Amiodarone post-op can be considered
- High risk post lung surgery model not defined
- CHADS$_2$ score maybe useful

Evidence level: Low
Recommendation grade: Weak
Post thoracotomy pain causes

- Chest wall trauma
- Rib fractures
- Muscle injury
- CNS hyper-excitability
- Intercostal nerve injury
Muscle sparing thoracotomy

- Improved muscle strength 1\textsuperscript{st} month
- Improved range of motion 1\textsuperscript{st} month
- Decrease pain 1\textsuperscript{st} month
- Pulmonary function and complications unchanged

Evidence level: Moderate
Recommendation grade: Strong
Intercostal muscle flap

- Separate the intercostal muscle from both ribs
- Place retractor between the ribs and not impinge the intercostal nerve
- Additional benefit of having the muscle flap available for use

Evidence level: Moderate
Recommendation grade: Strong
Rib approximation avoids intercostal nerve

• Intracostal approximation - drilling holes in the inferior rib for suture passage
• No compression technique – passage of suture just at the bony border of the inferior rib

Evidence level: Moderate
Recommendation grade: Strong
Minimally invasive surgery (VATS) vs thoracotomy

- For early stage lung cancer treatment
- ↓ pain, ↑ shoulder function, ↓ hospital stay, ↑ mobility, ↑ pulm function, ↓ post-op complications, ↓ infections
- Benefits patients with poor predicted post-op PFTs
- Did not show a difference in loco-regional recurrence
- Data suggests ↑ compliance with adjuvant therapy

Evidence level: High
Recommendation grade: Strong
Uniportal VATS and robotic surgery

- No significant data to support uniportal over multiportal VATS
- Robotic surgery has many potential advantages, 3D camera, ↑ dexterity, ↓ tremor, motion scaling
- Robotic surgery safety and feasibility have been demonstrated
- Data regarding clinical improvements have not been conclusively demonstrated with robotic
**ERAS for Lung Surgery**

**Post-op Phase Chest drain management**

Avoid routine external chest tube suction

- Suction may improve lung apposition / allow closure of air leaks and resolve large air leaks
- Suction - ↑ applied level of suction → may increase ↑ leak duration
- Suction may cause decreased mobility (wall suction)
- No suction may decrease duration of air leak → decrease LOS

Evidence level: Low (conflicting data)

Recommendation grade: Strong
Digital drainage system

- Portable suction, smaller, encourages mobilization
- Objective quantification of air leak and trend, decrease practice variability
- Early studies showed decreased chest tube duration by 1.1 days and LOS by 1 day
- Later studies showed no difference, however drain management strategy may have affected the results

Evidence level: Low (conflicting data)

Recommendation grade: Strong
High output chest tube removal protocol (< 450ml/day)

- Common cutoff is < 200ml chest tube output – dogma and not based on evidence
- Chest tube output (non-chylous) of < 450ml/day has shown 0.55% readmit rate for recurrent effusion
- Chest tube output of < 500ml/day has shown a 2.8% of patient requiring drainage or aspiration

Evidence level: Moderate
Recommendation grade: Strong
Single versus double chest tube for lobectomy

- Randomized control trials have shown no difference in single versus double chest tube for effusion
- Single tube associated with ↓ chest pain ~40% on pain scores, ↓ duration of chest tube

Evidence level: Moderate
Recommendation grade: Strong
Foley is not required for routine monitoring of urine output in patients with normal renal function

- Intra-op urine output doesn’t correlate w/ post-op AKI
- Fluid bolus to treat oliguria intra-op doesn’t correlate with post-op renal function
- Exceptions for placement are impaired renal function, complex case / prolonged operative time

Evidence level: Moderate
Recommendation grade: Strong
Routine Foley use in thoracic epidural analgesia

- Thoracic epidural analgesia ↑ risk of urinary retention
- Urinary retention 12.4% if foley removed < 48hrs
- Urinary retention 3.2% if foley removed @ time of epidural removal
- Optimal timing of foley removal is unknown

Evidence level: Low
Recommendation grade: Strong
Early mobilization

• Bed rest associated with ↑ deconditioning, ↑ VTE, ↑ pneumonia, ↓ muscle mass
• Mobilization < 24 hours is recommended
• Systematic reviews unable to demonstrate benefit with early ambulation in thoracic patients
• Chest tubes, Foley, IVFs decrease mobility

Evidence level: Low
Recommendation grade: Strong (no harm)
Incentive spirometry

• Standard adjunct to post operative therapy
• No evidence to show improved pulmonary function or reduced postoperative pulmonary complications
• Possible role in high-risk patients (need studies)
Prophylactic minitracheostomy high risk patients

- Allows for repeat suctioning of thick secretions
- Benefit demonstrated in high risk patients
- No recent studies for minimally invasive operations

Evidence level: Low
Recommendation grade: Weak
Prophylactic minitracheostomy high risk patients

- Allows for repeat suctioning of thick secretions
- Benefit demonstrated in high risk patients
- No recent studies for minimally invasive operations

Evidence level: Low
Recommendation grade: Weak
Implementing ERAS

Who is involved?

- Office staff
- Clinic staff
- Pre-op staff
- Anesthesia staff
- Surgeons
- OR staff
- Post operative care unit staff
- Inpatient RN, PA and staff
- Hospital leadership and management staff
Implementing ERAS

Three main criteria

- Evidence-based patient care
- Multidisciplinary team work
- Continuous monitoring for complications for correction
Implementing ERAS
Need for data collection

Postoperative Pain Questionnaire

1. Which pain medication did you take **after surgery at home?** *(Please circle all that apply)*

   - Acetaminophen (Tylenol)
   - Tramadol (Ultram)
   - Ibuprofen (Motrin, Advil)
   - Acetaminophen/codeine (Tylenol #3)
   - Naproxen (Aleve)
   - Oxycodone (Percocet)
   - Gabapentin (Neurontin)
   - Hydrocodone (Norco)
   - Other ______________________


2. Which pain medications, if any, were you taking before surgery? (Please circle all that apply)

- Acetaminophen (Tylenol)
- Tramadol (Ultram)
- Ibuprofen (Motrin, Advil)
- Acetaminophen/codeine (Tylenol #3)
- Naproxen (Aleve)
- Oxycodone (Percocet)
- Gabapentin (Neurontin)
- Hydrocodone (Norco)
- Other ____________________
- NONE

3. How much pain are you in right now? (0=no pain to 10=worst pain imaginable)
Implementing ERAS Timeline

- **ERAS as Division**: 2014
- **ERAS as Team**: 2015
- **Pre-emptive Pain Management**: 2016

**Weekly Division Meeting**

- **2017**
- **2018**
Implementing ERAS
Division implementation (Surgical team)

Pre-operative phase

• Walk 1 mile a day
• Practice incentive spirometer
• Quit smoking
• Stop heavy alcohol use
• Evaluation blood thinners and steroid medication
Implementing ERAS
Division implementation (Surgical team)

Peri-operative phase

• Lovenox SC
• IV Abx
• Minimally invasive surgery
• Liposomal bupivacaine intercostal block
Post-operative phase

- Opioid PCA to PO narcotics
- Non-opioid medication
- Sit in the chair for total of 6 hours
- Early PO
- Walk 3 times a day
- Incentive spirometer 10 x every hour with goal > 1000
Implementing ERAS
Division implementation (Surgical team only)

• Liposomal bupivacaine (Exparel)
  – Slow release bupivacaine that inhibits depolarization of nerve cells
• IV Ketorolac Tromethamine (Toradol)
  – Nonsteroidal anti-inflammatory
• IV Acetaminophen (Ofirmev)
  – Inhibition of prostaglandins
• Gabapentin (Neurontin)
  – Alter the way body senses pain
Selective use of central line, a-line and foley

After induction of general anesthesia

- IV abx
- IV Acetaminophen +/- IV Toradol
- Liposomal bupivicaine for incision
- Dexamethasone and Ondansetron
- Euvolemic fluid administration
Emergence from general anesthesia

• At the time of closing the wound
  – Stop dexmedetomidine
  – Decrease propofol by 50%
  – Decrease remifentanil or ketamine by 50%

• 20 min prior to completion of the case
  – Stop propofol

• Prior to extubation
  – Stop remifentanil infusion
  – Ondasetron
Post-operative Phase
- Sit in the chair for total of 6 hours
- Early PO
- Walk 3 times a day
- Incentive spirometer 10 x every hour with goal > 1000
- IV Acetaminophen q8 hours for 24 hours
- PO Tylenol ATC
- IV Toradol 15 mg for 48 hours
- Naproxen q 12 ATC
- Neurontin PO ATC
- Minimize IVF
Assessment of pain after surgery

– If ERAS is not successful
  • Tramadol as needed
– If Tramadol is not adequate
  • IV dilaudid 0.5 mg every 1 hour x 2 doses
– If not adequate
  • IV dilaudid PCA or Norco
Implementing ERAS
Pre-emptive pain control implementation

Home Pain Regimen

- Tylenol 1g PO q8 hours for 5 days
- Aleve 220 mg PO q12 hours for 3 days
- Neurontin 300 mg PO q8 hours for 7 days

Call the office if pain is not adequately controlled
Implementing ERAS

Preliminary data

Schedule II (Norco)
Schedule III (Tylenol #3)
Schedule IV (Tramadol)
No narcotics

Pre-ERAS  Post-ERAS  Pre-emptive Pain Ctrl
• ERAS for thoracic surgery guidelines are available
• Many components to the guidelines to consider
• Implementation requires dedication, team work and patience
• The rewards for implementation are happier patients, decreased complications and decreased hospital costs
Acknowledgements

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