# Preventing Postoperative Pulmonary Complications

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# Objectives

- Postoperative pulmonary physiology
- Pulmonary risk assessment for postoperative complications
- Strategies to reduce postoperative pulmonary complications

# Perioperative pulmonary complications

- 165,196 patients
- major abdominal surgery
- 9595 (5.8%) suffered PPCs
  - pneumonia 3.2%
  - prolonged ventilator support ≥48 h 3.0%
  - unplanned intubation 2.8%

Pulmonary complications after major abdominal surgery: National Surgical Quality Improvement Program Analysis.Yang CK, et al, J Surg Res. 2015 Oct;198(2):441-9.

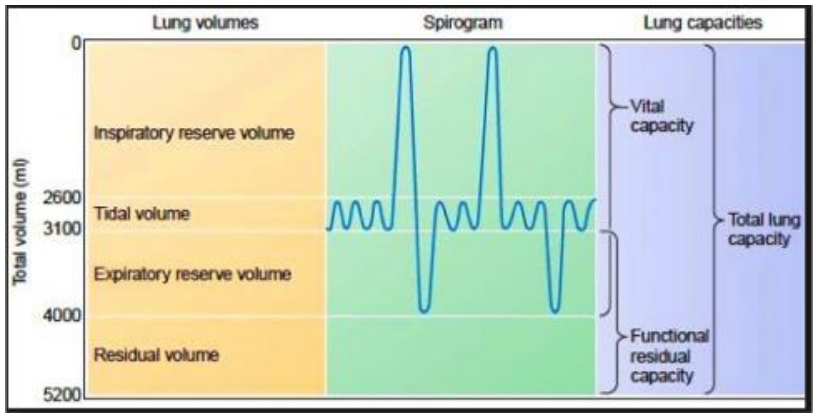
# Perioperative Pulmonary Complications

**The major categories of clinically significant complications:**

- Atelectasis
- Pneumonia
- ARDS
- Pulmonary aspiration
- Unplanned need for supplemental oxygen or noninvasive or invasive ventilation
- Exacerbation of underlying chronic lung disease
- Bronchoconstriction

# Perioperative pulmonary physiology

- Vital capacity (VC) is reduced by 50 to 60 percent and may remain decreased for up to one week
- Functional residual capacity (FRC) is reduced about 30 percent



# Perioperative pulmonary physiology

- Diaphragmatic dysfunction + Postoperative pain and splinting
  - Reduction of the FRC below closing volumes
    - Atelectasis
      - V/Q mismatching
        - Hypoxemia

# Perioperative pulmonary physiology

- Residual effects of anesthetic agents and opioids
  - Depressed respiratory drive
    - Inhibition of cough and impairment of mucociliary clearance
      - Infection

# Risk Factors

7 independent risk factors

**Table 6.** Independent Predictors of Risk for PPCs Identified in the Logistic Regression Model

| | Multivariate Analysis OR (95% CI) n = 1,624* | β Coefficient | Risk Score† |
|---|---|---|---|
| Age, yr | | | |
| ≤50 | 1 | | |
| 51–80 | 1.4 (0.6–3.3) | 0.331 | 3 |
| >80 | 5.1 (1.9–13.3) | 1.619 | 16 |
| Preoperative $Spo_2$, % | | | |
| ≥96 | 1 | | |
| 91–95 | 2.2 (1.2–4.2) | 0.802 | 8 |
| ≤90 | 10.7 (4.1–28.1) | 2.375 | 24 |
| Respiratory infection in the last month | 5.5 (2.6–11.5) | 1.698 | 17 |
| Preoperative anemia (≤10 g/dl) | 3.0 (1.4–6.5) | 1.105 | 11 |
| Surgical incision | | | |
| Peripheral | 1 | | |
| Upper abdominal | 4.4 (2.3–8.5) | 1.480 | 15 |
| Intrathoracic | 11.4 (4.9–26.0) | 2.431 | 24 |
| Duration of surgery, h | | | |
| ≤2 | 1 | | |
| >2 to 3 | 4.9 (2.4–10.1) | 1.593 | 16 |
| >3 | 9.7 (4.7–19.9) | 2.268 | 23 |
| Emergency procedure | 2.2 (1.0–4.5) | 0.768 | 8 |

* Because of a missing value for some variables, three patients were excluded. Logistic regression model constructed with the development subsample, c-index = 0.90; Hosmer-Lemeshow chi-square test = 7.862; $P = 0.447$. † The simplified risk score was the sum of each β logistic regression coefficient multiplied by 10, after rounding off its value.

CI = confidence interval; OR = odds ratio; PPC = postoperative pulmonary complications; $Spo_2$ = oxyhemoglobin saturation by pulse oximetry breathing air in supine position.

Anesthesiology. 2010 Dec;113(6):1338-50. Prediction of postoperative pulmonary complications in a population-based surgical cohort. Canet J et al

# ARISCAT (Canet) risk index:
## Independent predictors of postoperative pulmonary complications

| Factor | Adjusted odds ratio (95% CI) | Risk score |
|---|---|---|
| Age, years | | |
| ≤50 | 1 | |
| 51-80 | 1.4 (0.6-3.3) | 3 |
| >80 | 5.1 (1.9-13.3) | 16 |
| Preoperative $O_2$ saturation | | |
| ≥96 percent | 1 | |
| 91-95 percent | 2.2 (1.2-4.2) | 8 |
| ≤90 percent | 10.7 (4.1-28.1) | 24 |
| Respiratory infection in the last month | 5.5 (2.6-11.5) | 17 |
| Preoperative anemia - hemoglobin ≤10 g/dL | 3 (1.4-6.5) | 11 |
| Surgical incision | | |
| Upper abdominal | 4.4 (2.3-8.5) | 15 |
| Intrathoracic | 11.4 (1.9-26.0) | 24 |
| Duration of surgery | | |
| ≤2 hours | 1 | |
| 2-3 hours | 4.9 (2.4-10.1) | 16 |
| >3 hours | 9.7 (2.4-19.9) | 23 |
| Emergency surgery | 2.2 (1.0-4.5) | 8 |

| Risk class | Number of points in risk score | Pulmonary complication rate (validation sample) |
|---|---|---|
| Low | <26 points | 1.6 percent |
| Intermediate | 26-44 points | 13.3 percent |
| High | ≥45 points | 42.1 percent |

# Arozullah respiratory failure index

| Preoperative predictor | Point value |
|---|---|
| Type of surgery | |
| Abdominal aortic aneurysm | 27 |
| Thoracic | 21 |
| Neurosurgery, upper abdominal, peripheral vascular | 14 |
| Neck | 11 |
| Emergency surgery | 11 |
| Albumin <3.0 g/dL | 9 |
| BUN >30 mg/dL | 8 |
| Partially or fully dependent functional status | 7 |
| History of chronic obstructive pulmonary disease | 6 |
| Age | |
| ≥70 years | 6 |
| 60 to 69 years | 4 |

# Arozullah respiratory failure index

| Class | Point total | Percent respiratory failure |
|---|---|---|
| 1 | ≤10 | 0.5 |
| 2 | 11 to 19 | 1.8 |
| 3 | 20 to 27 | 4.2 |
| 4 | 28 to 40 | 10.1 |
| 5 | >40 | 26.6 |

Multifactorial risk index for predicting postoperative respiratory failure in men after major noncardiac surgery. The National Veterans Administration Surgical Quality Improvement Program., Arozullah AM, et al, Ann Surg. 2000;232(2):242.

# Gupta calculator for postoperative respiratory failure

- http://www.surgicalriskcalculator.com/prf-risk-calculator
- Procedure
- ASA class
- Emergency case
- Functional status
- Sepsis

Development and validation of a risk calculator predicting postoperative respiratory failure. Gupta H, et al, Chest. 2011;140(5):1207.

# Definite Risk Factors

- Upper abdominal, thoracic (open), aortic, head and neck, neurosurgical, and abdominal aortic aneurysm surgery
- Emergency surgery
- Age >65 years
- Surgery lasting greater than three hours
- Poor general health status as defined by ASA class >2
- Heart failure
- Serum albumin <3 g/dL
- Chronic obstructive lung disease
- Intraoperative long acting neuromuscular blockade
- Functional dependence

# Probable Risk Factors

- General anesthesia (compared to spinal, epidural anesthesia, or other regional anesthetic techniques)
- Arterial tension of carbon dioxide ($PaCO_2$) >45 mmHg (5.99 kPa)
- Abnormal chest radiograph
- Cigarette use within the previous eight weeks
- Current upper respiratory tract infection
- Postoperative nasogastric tube placement

# Pre-operative pulmonary work-up

- Pulmonary function test
- Chest radiograph
- Cardiopulmonary exercise test
- Arterial blood gas

Risk assessment for and strategies to reduce perioperative pulmonary complications for patients undergoing noncardiothoracic surgery: a guideline from the American College of Physicians. , Qaseem A, et al  Clinical Efficacy Assessment Subcommittee of the American College of Physicians , Ann Intern Med. 2006;144(8):575.
Value of routine preoperative chest x-rays: a meta-analysis.Archer C,etal, Can J Anaesth. 1993;40(11):1022.
Value of preoperative 6-minute walk test for predicting postoperative pulmonary complications, Keeratichananont W, et al, Adv Respir Dis. 2016;10(1):18.

# Preoperative strategies

# Smoking

- Patients who had stopped smoking for 2 months or less had a pulmonary complication rate almost 4 times that of patients who had stopped for more than 2 months (57.1% versus 14.5%).
- Patients who had stopped smoking for more than 6 months had rates similar to those who had never smoked (11.1% and 11.9%, respectively)

Mayo Clinic Proc1989 Jun;64(6):609-16.
Role of preoperative cessation of smoking and other factors in postoperative pulmonary complications: a blinded prospective study of coronary artery bypass patients. Warner MA et al

# COPD

- Median length of stay 4 days vs 1 day
- 30 day death rates were 6.7% vs 1.4%
- Even after controlling for comorbidities through logistic regression modeling

**Table 3—*Univariate Analysis of Intraoperative and Postoperative Events***

| Intraoperative and Postoperative Variable | Patients, No. (N = 468,795) | With COPD, % (n = 22,576) | Without COPD, % (n = 446,219) | *P* Value |
|---|---|---|---|---|
| Intraoperative | | | | |
| Intraoperative RBC transfusion | 0.17± 1.06 | 0.44 ±1.72 | 0.15 ±1.01 | <.0001 |
| Anesthesia time, min | 135 | 165 | 133 | <.0001 |
| Operative time, min | 85 | 105 | 83 | <.0001 |
| Postoperative | | | | |
| Major complications | | | | |
| Cardiac arrest | 0.42 | 1.57 | 0.36 | <.0001 |
| Myocardial infarction | 0.17 | 0.57 | 0.15 | .0002 |
| RBC transfusion >4 U | 0.46 | 1.35 | 0.42 | <.0001 |
| Graft/prosthesis failure | 0.28 | 0.78 | 0.26 | <.0001 |
| Infection | | | | |
| Organ space infection | 1.32 | 1.83 | 1.29 | <.0001 |
| Sepsis | 2.09 | 4.55 | 1.96 | <.0001 |
| Septic shock | 1.35 | 5.01 | 1.16 | <.0001 |
| Neurologic | | | | |
| Coma | 0.1 | 0.3 | 0.09 | <.0001 |
| Nerve deficit | 0.07 | 0.11 | 0.07 | .01 |
| Stroke | 0.26 | 0.81 | 0.24 | <.0001 |
| Renal | | | | |
| Acute renal failure | 0.49 | 1.73 | 0.42 | <.0001 |
| Renal insufficiency | 0.36 | 1.04 | 0.33 | <.0001 |
| Respiratory | | | | |
| Pneumonia | 1.63 | 6.51 | 1.38 | <.0001 |
| Reintubation | 1.4 | 5.51 | 1.19 | <.0001 |
| Ventilator > 48 h | 2.32 | 8.83 | 1.99 | <.0001 |
| Return to operating room | 5.34 | 10.78 | 5.07 | <.0001 |
| VTE | | | | |
| DVT | 0.71 | 1.67 | 0.67 | <.0001 |
| Pulmonary embolism | 0.32 | 0.56 | 0.31 | <.0001 |
| Wound | | | | |
| Deep wound infection | 0.78 | 1.46 | 0.74 | <.0001 |
| Wound dehiscence | 0.62 | 1.74 | 0.56 | <.0001 |
| Overall morbidity | 10.98 | 25.77 | 10.24 | <.0001 |
| Minor complications | | | | |
| Superficial wound infection | 2.91 | 4.6 | 2.82 | <.0001 |
| Urinary tract infection | 1.65 | 3.51 | 1.56 | <.0001 |
| Other postoperative parameters | | | | |
| LOS, d | 1 | 4 | 1 | <.0001 |
| Mortality | 1.68 | 6.7 | 1.43 | <.0001 |

Data are presented as mean ± SD or median. LOS = length of stay.

Chest. 2013 Jun;143(6):1599-1606. Impact of COPD on postoperative outcomes: results from a national database. Gupta H et al,

# Suppressed HPA axis patients

- Any patient who is currently taking more than 20 mg/day of predisone or its equivalent for more than three weeks
- Any patient on glucocorticoids who has clinical Cushing's syndrome

Christy NP. Corticosteroid withdrawal. In: Current Therapy in Endocrinology and Metabolism, 3rd Ed, Bardin CW (Ed), BC Decker, New York 1988. p.113

# Corticosteroid coverage for surgery in patients taking exogenous corticosteroids

| |
|---|
| For minor procedures or surgery under local anesthesia (eg, inguinal hernia repair), take usual morning steroid dose. **No extra supplementation** is necessary. |
| For moderate surgical stress (eg, lower extremity revascularization, total joint replacement), take usual morning steroid dose. Give **50 mg hydrocortisone intravenously** just before the procedure and 25 mg of hydrocortisone every eight hours for 24 hours. Resume usual dose thereafter. |
| For major surgical stress (eg, esophagogastrectomy, total proctocolectomy, open heart surgery), take usual morning steroid dose. Give **100 mg of intravenous hydrocortisone** before induction of anesthesia and 50 mg every eight hours for 24 hours. Taper dose by half per day to maintenance level. |

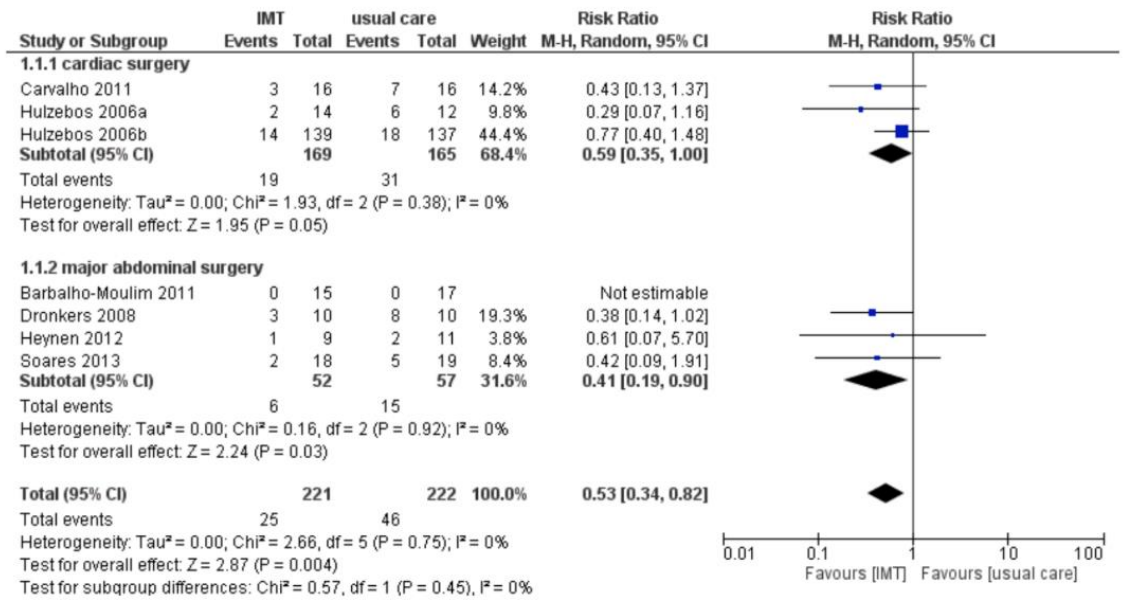
# Asthma

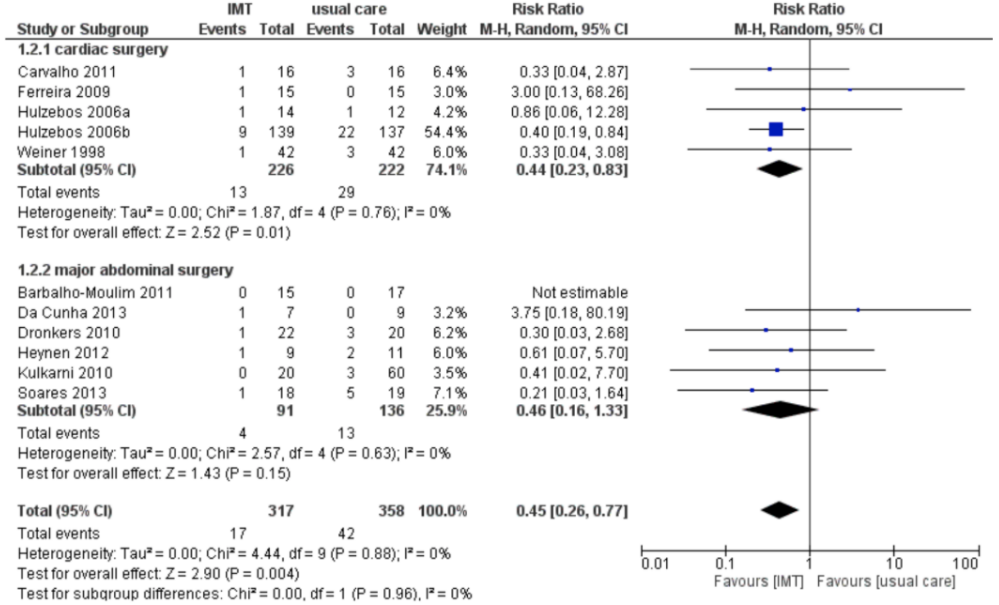
| Assessing Asthma Control and Adjusting Therapy in Youths ≥12 Years of Age and Adults | | | | |
|---|---|---|---|---|
| **Components of Control** | | **Classification of Asthma Control (≥12 Years of Age)** | | |
| | | **Well Controlled** | **Not Well Controlled** | **Very Poorly Controlled** |
| **Impairment** | Symptoms | ≤2 days/week | >2 days/week | Throughout the day |
| | Nighttime awakenings | ≤2×/month | 1–3×/week | ≥4×/week |
| | Interference with normal activity | None | Some limitation | Extremely limited |
| | Short-acting $\beta_2$-agonist use for symptom control (not prevention of EIB) | ≤2 days/week | >2 days/week | Several times per day |
| | $FEV_1$ or peak flow | >80% predicted/ personal best | 60%–80% predicted/ personal best | <60% predicted/ personal best |
| | Validated questionnaires*<br>ATAQ<br>ACQ<br>ACT | <br>0<br>≤0.75†<br>≥20 | <br>1–2<br>≥1.5<br>16–19 | <br>3–4<br>N/A<br>≤15 |
| **Risk** | **Exacerbations requiring oral systemic corticosteroids** | **0–1/year** | **≥2/year** | |
| | | **Consider severity and interval since last exacerbation** | | |
| | Progressive loss of lung function | Evaluation requires long-term follow-up care | | |
| | Treatment-related adverse effects | Medication side effects can vary in intensity from none to very troublesome and worrisome. The level of intensity does not correlate to specific levels of control but should be considered in the overall assessment of risk. | | |
| **Recommended Action for Treatment** | | • Maintain current step<br>• Regular follow-ups every 1 to 6 months to maintain control<br>• Consider step down if well controlled for at least 3 months | • Step up 1 step and<br>• Reevaluate in 2 to 6 weeks<br>• For side effects, consider alternative treatment options | • Consider short course of oral systemic corticosteroids<br>• Reevaluate in 2 weeks<br>• For side effects, consider alternative treatment options |

# Respiratory Tract Infection

- Elective surgery should be cancelled until such treatment is completed and patient’s sputum production has returned to baseline.

# Preoperative inspiratory muscle training vs usual care



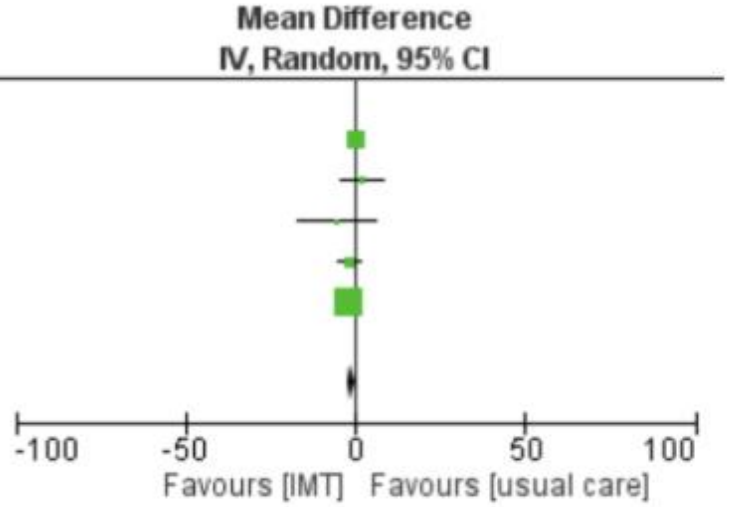

Preoperative inspiratory muscle training for postoperative pulmonary complications in adults undergoing cardiac and major abdominal surgery, Katsura M,et al,Cochrane Database Syst Rev. 2015

# Preoperative inspiratory muscle training vs usual care

| Study or Subgroup | IMT Mean | IMT SD | IMT Total | usual care Mean | usual care SD | usual care Total | Weight | Mean Difference IV, Random, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Barbalho-Moulim 2011 | 2 | 0 | 15 | 2.11 | 0.33 | 17 | | Not estimable |
| Carvalho 2011 | 8 | 3.1 | 16 | 8 | 2.9 | 16 | 29.2% | 0.00 [-2.08, 2.08] |
| Da Cunha 2013 | 9 | 4.9 | 7 | 7 | 7.6 | 9 | 3.7% | 2.00 [-4.15, 8.15] |
| Dronkers 2010 | 16.2 | 11.5 | 22 | 21.6 | 23.7 | 20 | 1.1% | -5.40 [-16.84, 6.04] |
| Hulzebos 2006a | 7.93 | 1.94 | 14 | 9.92 | 5.78 | 12 | 11.7% | -1.99 [-5.41, 1.43] |
| Hulzebos 2006b | 7.89 | 2.17 | 139 | 9.94 | 8.27 | 137 | 54.3% | -2.05 [-3.48, -0.62] |
| **Total (95% CI)** | | | **213** | | | **211** | **100.0%** | **-1.33 [-2.53, -0.13]** |

Heterogeneity: $Tau^2 = 0.16$; $Chi^2 = 4.29$, df = 4 (P = 0.37); $I^2 = 7\%$

Test for overall effect: Z = 2.17 (P = 0.03)




Preoperative inspiratory muscle training for postoperative pulmonary complications in adults undergoing cardiac and major abdominal surgery, Katsura M,et al,Cochrane Database Syst Rev. 2015

# Pulmonary hypertension

- Emergency surgery (odds ratio [OR] 2.4, 95% CI 1.4-3.6)
- Elevated right atrial pressure (>7 mmHg) (OR 1.1, 95% CI 1.0-1.3)
- Six-minute walking distance (≤399 meters) (OR 2.2, 95% CI 1.1-3.7)
- Perioperative use of vasopressors (OR 1.5, 95% CI 1.2-2.7)

Outcomes of noncardiac, nonobstetric surgery in patients with PAH: an international prospective survey.Meyer S, et al Eur Respir J. 2013 Jun;41(6):1302-1307.

# Obesity

- In one of the largest studies to date that used the NSQIP database (n = 141,802), pulmonary complications were no more common among obese adults (BMI >30 $kg/m^2$) than among those with a healthy weight (BMI 18.5 to 24.9 $kg/m^2$)

The Effect of Body Mass Index on Perioperative Outcomes After Major Surgery: Results from the National Surgical Quality Improvement Program (ACS-NSQIP) 2005-2011, Sood A, et al, World J Surg. 2015 Oct;39(10):2376-85.

# Obstructive Sleep Apnea

- The majority reported worse outcomes for a number of events, including pulmonary and combined complications, among patients with OSA versus the reference group.
- The association between OSA and in-hospital mortality varied among studies.

Does Obstructive Sleep Apnea Influence Perioperative Outcome? A Qualitative Systematic Review for the Society of Anesthesia and Sleep Medicine Task Force on Preoperative Preparation of Patients with Sleep-Disordered Breathing, Opperer M, et al, , Anesth Analg. 2016;122(5):1321.

# Enhanced STOP-Bang questionnaire

| | | |
|---|---|---|
| Yes | No | **Snoring?** Do you **snore loudly** (loud enough to be heard through closed doors, or your bed partner elbows you for snoring at night)? |
| Yes | No | **Tired?** Do you often feel **tired, fatigued, or sleepy** during the daytime (such as falling asleep during driving or talking to someone)? |
| Yes | No | **Observed?** Has anyone **observed** you **stop breathing** or **choking/gasping** during your sleep? |
| Yes | No | **Pressure?** Do you have or are being treated for **high blood pressure**? |
| Yes | No | **Body mass index more than 35 kg/m$^2$?** |
| Yes | No | **Age older than 50 years old?** |
| Yes | No | **Neck size large? (measured around Adam's apple)** For male, is your shirt collar 17 inches/43 cm or larger? For female, is your shirt collar 16 inches/41 cm or larger? |
| Yes | No | **Gender = Male?** |
| | | |

| **Scoring criteria:** |
|---|
| **Low risk of OSA:** Yes to 0 to 2 questions |
| **Intermediate risk of OSA:** Yes to 3 to 4 questions |
| **High risk of OSA:** Yes to 5 to 8 questions<br>or Yes to 2 or more of 4 STOP questions + male gender<br>or Yes to 2 or more of 4 STOP questions + BMI >35kg/m$^2$<br>or Yes to 2 or more of 4 STOP questions + neck circumference 17 inches/43 cm in male or 16 inches/41 cm in female |

Association of STOP-Bang Questionnaire as a Screening Tool for Sleep Apnea and Postoperative Complications: A Systematic Review and Bayesian Meta-analysis of Prospective and Retrospective Cohort Studies., Nagappa M, etal, Anesth Analg. 2017;125(4):1301.

# Obstructive Sleep Apnea

- The Society of Anesthesia and Sleep Medicine recommends against the routine use of empiric PAP therapy in most patients with suspected OSA just prior to surgery, because of lack of evidence of benefit

Society of Anesthesia and Sleep Medicine Guidelines on Preoperative Screening and Assessment of Adult Patients With Obstructive Sleep Apnea., Chung F,, et al,Analg. 2016;123(2):452.

# Obstructive Sleep Apnea

Select populations might benefit, including those with

- obesity hypoventilation syndrome (OHS)
- overlap syndrome
- severe OSA (AHI >30)
- resting hypoxemia
- those with high arousal threshold

CPAP in the Perioperative Setting: Evidence of Support., Chung F, et al, . 2016;149(2):586.

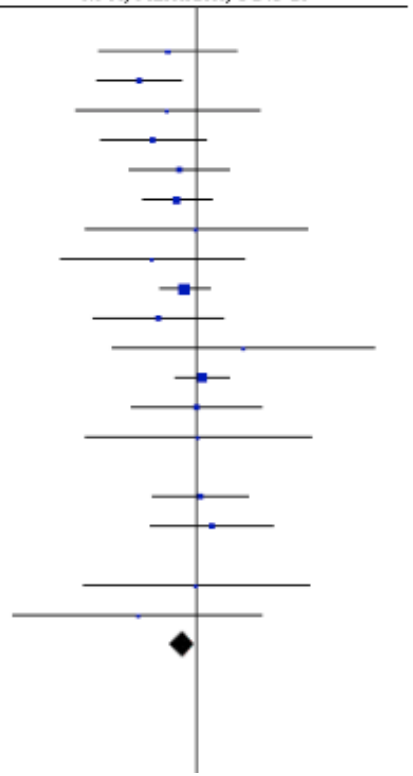
# Intraoperative strategies

# Neuraxial blockade vs general anesthesia

| Study or Subgroup | Regional anaesthesia Events | Total | Genreal anaesthesia Events | Total | Weight | Risk Ratio M-H, Random, 95% CI | Year |
|---|---|---|---|---|---|---|---|
| **1.1.1 Regional Anaesthesia versus General Anaesthesia** | | | | | | | |
| Couderc 1977 | 2 | 50 | 4 | 50 | 3.0% | 0.50 [0.10, 2.61] | 1977 |
| McLaren 1978 | 4 | 56 | 17 | 60 | 7.8% | 0.25 [0.09, 0.70] | 1978 |
| Hodgkinson 1980 | 1 | 10 | 2 | 10 | 1.6% | 0.50 [0.05, 4.67] | 1980 |
| Davis 1981 | 3 | 64 | 9 | 68 | 5.1% | 0.35 [0.10, 1.25] | 1981 |
| Tasker 1983 | 4 | 50 | 6 | 50 | 5.6% | 0.67 [0.20, 2.22] | 1983 |
| McKenzie 1984 | 8 | 73 | 13 | 75 | 12.2% | 0.63 [0.28, 1.44] | 1984 |
| Bigler 1985 | 1 | 20 | 1 | 20 | 1.1% | 1.00 [0.07, 14.90] | 1985 |
| Cook 1986 | 1 | 50 | 3 | 51 | 1.6% | 0.34 [0.04, 3.16] | 1986 |
| Valentin 1986 | 17 | 281 | 24 | 297 | 22.7% | 0.75 [0.41, 1.36] | 1986 |
| Racle 1986 | 2 | 35 | 5 | 35 | 3.3% | 0.40 [0.08, 1.93] | 1986 |
| Berggren 1987 | 1 | 28 | 0 | 29 | 0.8% | 3.10 [0.13, 73.12] | 1987 |
| Davis 1987 | 17 | 259 | 16 | 279 | 18.7% | 1.14 [0.59, 2.22] | 1987 |
| Ungemach 1993 | 3 | 57 | 3 | 57 | 3.4% | 1.00 [0.21, 4.75] | 1993 |
| Christopherson 1993 | 1 | 49 | 1 | 51 | 1.1% | 1.04 [0.07, 16.18] | 1993 |
| Wallace 1995 | 0 | 58 | 0 | 26 | | Not estimable | 1995 |
| Bode 1996 | 9 | 285 | 4 | 138 | 6.1% | 1.09 [0.34, 3.48] | 1996 |
| Juelsgaard 1998 | 6 | 29 | 2 | 14 | 3.8% | 1.45 [0.33, 6.28] | 1998 |
| Wulf 1999 | 0 | 44 | 0 | 46 | | Not estimable | 1999 |
| Dyer 2003 | 1 | 35 | 1 | 35 | 1.1% | 1.00 [0.07, 15.36] | 2003 |
| Dodds 2007 | 0 | 37 | 2 | 45 | 0.9% | 0.24 [0.01, 4.89] | 2007 |
| **Subtotal (95% CI)** | | **1570** | | **1436** | **100.0%** | **0.71 [0.53, 0.94]** | |
| Total events | 81 | | 113 | | | | |

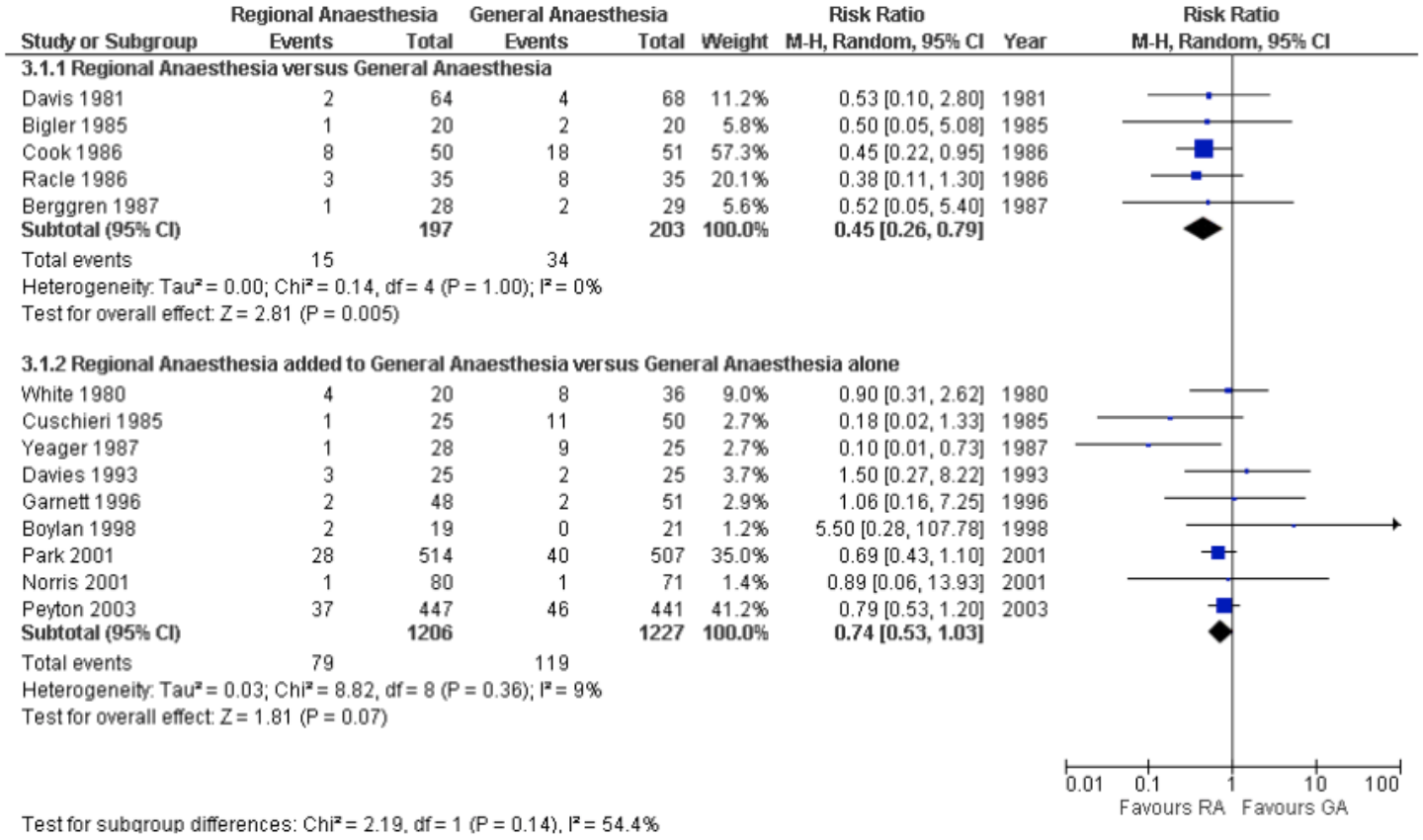
Heterogeneity: Tau² = 0.00; Chi² = 11.57, df = 17 (P = 0.83); I² = 0%

Test for overall effect: Z = 2.36 (P = 0.02)




Neuraxial blockade for the prevention of postoperative mortality and major morbidity: an overview of Cochrane systematic reviews., Guay J, Choi P, Suresh S, Albert N, Kopp S, Pace NL , Cochrane Database Syst Rev. 2014

# Neuraxial blockade vs general anesthesia



| Study or Subgroup | Regional Anaesthesia Events | Total | General Anaesthesia Events | Total | Weight | Risk Ratio M-H, Random, 95% CI | Year |
|---|---|---|---|---|---|---|---|
| **3.1.1 Regional Anaesthesia versus General Anaesthesia** | | | | | | | |
| Davis 1981 | 2 | 64 | 4 | 68 | 11.2% | 0.53 [0.10, 2.80] | 1981 |
| Bigler 1985 | 1 | 20 | 2 | 20 | 5.8% | 0.50 [0.05, 5.08] | 1985 |
| Cook 1986 | 8 | 50 | 18 | 51 | 57.3% | 0.45 [0.22, 0.95] | 1986 |
| Racle 1986 | 3 | 35 | 8 | 35 | 20.1% | 0.38 [0.11, 1.30] | 1986 |
| Berggren 1987 | 1 | 28 | 2 | 29 | 5.6% | 0.52 [0.05, 5.40] | 1987 |
| **Subtotal (95% CI)** | | **197** | | **203** | **100.0%** | **0.45 [0.26, 0.79]** | |
| Total events | 15 | | 34 | | | | |
| Heterogeneity: Tau² = 0.00; Chi² = 0.14, df = 4 (P = 1.00); I² = 0% | | | | | | | |
| Test for overall effect: Z = 2.81 (P = 0.005) | | | | | | | |
| **3.1.2 Regional Anaesthesia added to General Anaesthesia versus General Anaesthesia alone** | | | | | | | |
| White 1980 | 4 | 20 | 8 | 36 | 9.0% | 0.90 [0.31, 2.62] | 1980 |
| Cuschieri 1985 | 1 | 25 | 11 | 50 | 2.7% | 0.18 [0.02, 1.33] | 1985 |
| Yeager 1987 | 1 | 28 | 9 | 25 | 2.7% | 0.10 [0.01, 0.73] | 1987 |
| Davies 1993 | 3 | 25 | 2 | 25 | 3.7% | 1.50 [0.27, 8.22] | 1993 |
| Garnett 1996 | 2 | 48 | 2 | 51 | 2.9% | 1.06 [0.16, 7.25] | 1996 |
| Boylan 1998 | 2 | 19 | 0 | 21 | 1.2% | 5.50 [0.28, 107.78] | 1998 |
| Park 2001 | 28 | 514 | 40 | 507 | 35.0% | 0.69 [0.43, 1.10] | 2001 |
| Norris 2001 | 1 | 80 | 1 | 71 | 1.4% | 0.89 [0.06, 13.93] | 2001 |
| Peyton 2003 | 37 | 447 | 46 | 441 | 41.2% | 0.79 [0.53, 1.20] | 2003 |
| **Subtotal (95% CI)** | | **1206** | | **1227** | **100.0%** | **0.74 [0.53, 1.03]** | |
| Total events | 79 | | 119 | | | | |
| Heterogeneity: Tau² = 0.03; Chi² = 8.82, df = 8 (P = 0.36); I² = 9% | | | | | | | |
| Test for overall effect: Z = 1.81 (P = 0.07) | | | | | | | |
| Test for subgroup differences: Chi² = 2.19, df = 1 (P = 0.14), I² = 54.4% | | | | | | | |



Neuraxial blockade for the prevention of postoperative mortality and major morbidity: an overview of Cochrane systematic reviews., Guay J, Choi P, Suresh S, Albert N, Kopp S, Pace NL , Cochrane Database Syst Rev. 2014

# Duration of surgery

- A study of risk factors for postoperative pneumonia in 520 patients found an incidence of 8 percent for procedures lasting less than two hours versus 40 percent for those lasting more than four hours

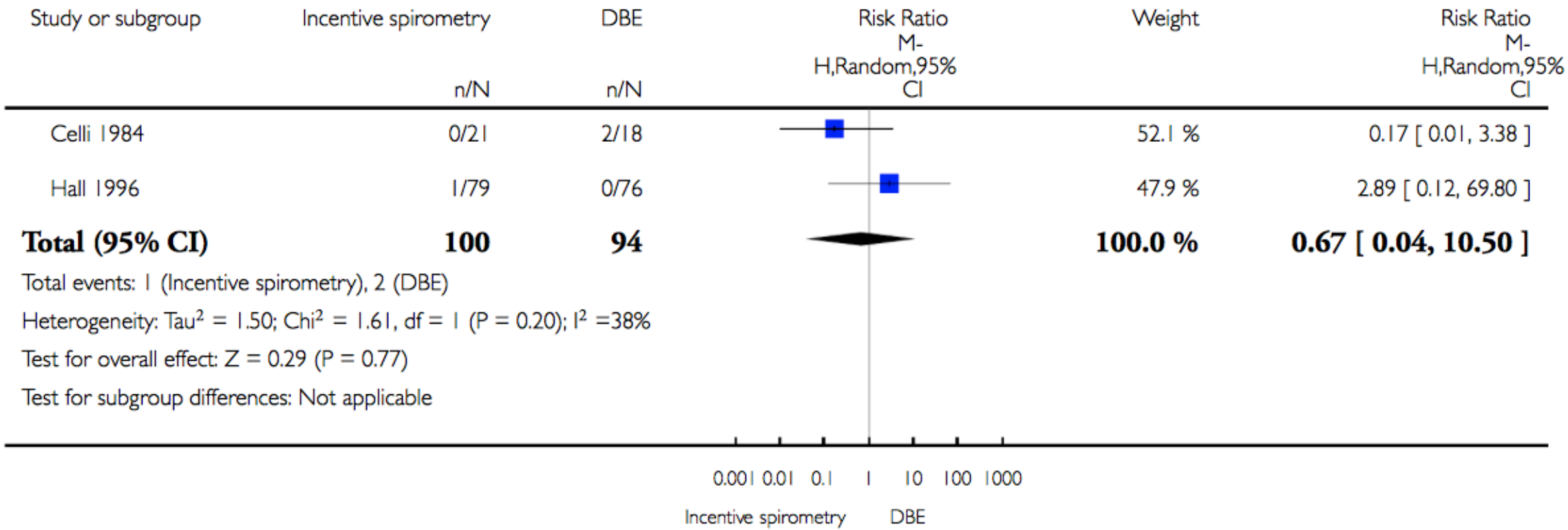
Randomized controlled trial of prophylactic chest physiotherapy in major abdominal surgery. Fagevik Olsén M, et alBr J Surg. 1997;84(11):1535.

# Lung protective strategy

- For patients undergoing abdominal surgery, a lung protective strategy of low tidal volume ventilation (6 to 8 mL per kg of predicted body weight; PEEP at 6 to 8 cm of water; recruitment maneuvers every 30 min) is associated with a reduction in adverse pulmonary events.

# Postoperative strategies

# Incentive spirometry vs deep breathing exercises




Incentive spirometry for prevention of postoperative pulmonary complications in upper abdominal surgery.do Nascimento Junior P, Módolo NS, Andrade S, Guimarães MM, Braz LG, El Dib R Cochrane Database Syst Rev. 2014

# CPAP

Outcome: 1 Significant atelectasis

| Study or subgroup | CPAP n/N | Control n/N | Risk Ratio M-H,Fixed,95% CI | Weight | Risk Ratio M-H,Fixed,95% CI |
|---|---|---|---|---|---|
| Carlsson 1981 | | | | | |
| Christensen 1991 | | | | | |
| Lindner 1987 | | | | | |
| Lotz 1984 | | | | | |
| Ricksten 1986 | | | | | |
| Stock 1985 | | | | | |
| **Total (95% CI)** | | | | | |

Total events: 39 (CPAP), 5
Heterogeneity: Chi² = 12
Test for overall effect: Z =
Test for subgroup differen

Outcome: 2 Pneumonia

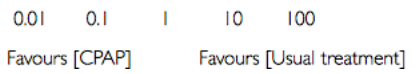
| Study or subgroup | CPAP n/N | Control n/N | Risk Ratio M-H,Fixed,95% CI | Weight | Risk Ratio M-H,Fixed,95% CI |
|---|---|---|---|---|---|
| Bohner 2002 | | | | | |
| Christensen 1991 | | | | | |
| Lindner 1987 | | | | | |
| Squadrone 2005 | | | | | |
| Stock 1985 | | | | | |
| **Total (95% CI)** | | | | | |

Total events: 12 (CPAP), 23
Heterogeneity: Chi² = 2.38,
Test for overall effect: Z = 2
Test for subgroup difference

Outcome: 4 Reintubation

| Study or subgroup | CPAP n/N | Control n/N | Risk Ratio M-H,Fixed,95% CI | Weight | Risk Ratio M-H,Fixed,95% CI |
|---|---|---|---|---|---|
| Bohner 2002 | 1/99 | 5/105 | | 32.6 % | 0.21 [ 0.03, 1.78 ] |
| Squadrone 2005 | 1/105 | 10/104 | | 67.4 % | 0.10 [ 0.01, 0.76 ] |
| **Total (95% CI)** | **204** | **209** | | **100.0 %** | **0.14 [ 0.03, 0.58 ]** |

Total events: 2 (CPAP), 15 (Control)
Heterogeneity: Chi² = 0.26, df = 1 (P = 0.61); I² =0.0%
Test for overall effect: Z = 2.68 (P = 0.0073)
Test for subgroup differences: Not applicable



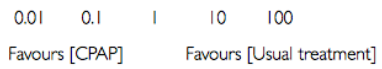

Continuous positive airway pressure (CPAP) during the postoperative period for prevention of postoperative morbidity and mortality following major abdominal surgery.Ireland CJ, et al Cochrane Database Syst Rev. 2014;

# CPAP

Outcome: 1 Mortality

| Study or subgroup | CPAP n/N | Control n/N | Risk Ratio M-H,Fixed,95% CI | Weight | Risk Ratio M-H,Fixed,95% CI |
|---|---|---|---|---|---|
| Bohner 2002 | 4/99 | 0/105 | | 12.1 % | 9.54 [ 0.52, 174.94 ] |
| Squadrone 2005 | 0/105 | 3/104 | | 87.9 % | 0.14 [ 0.01, 2.71 ] |
| **Total (95% CI)** | **204** | **209** | | **100.0 %** | **1.28 [ 0.35, 4.66 ]** |

Total events: 4 (CPAP), 3 (Control)
Heterogeneity: $Chi^2 = 3.97$, df = 1 (P = 0.05); $I^2 = 75\%$
Test for overall effect: Z = 0.38 (P = 0.71)
Test for subgroup differences: Not applicable

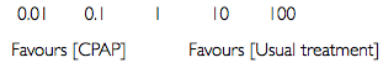



Continuous positive airway pressure (CPAP) during the postoperative period for prevention of postoperative morbidity and mortality following major abdominal surgery.Ireland CJ,et al Cochrane Database Syst Rev. 2014;

Outcome: 3 Severe hypoxia

| Study or subgroup | CPAP n/N | Control n/N | Risk Ratio M-H,Fixed,95% CI | Weight | Risk Ratio M-H,Fixed,95% CI |
|---|---|---|---|---|---|
| Bohner 2002 | 5/99 | 17/105 | | 86.1 % | 0.31 [ 0.12, 0.81 ] |
| Christensen 1991 | 6/34 | 2/17 | | 13.9 % | 1.50 [ 0.34, 6.66 ] |
| **Total (95% CI)** | **133** | **122** | | **100.0 %** | **0.48 [ 0.22, 1.02 ]** |

Total events: 11 (CPAP), 19 (Control)
Heterogeneity: $Chi^2 = 3.02$, df = 1 (P = 0.08); $I^2 = 67\%$
Test for overall effect: Z = 1.90 (P = 0.057)
Test for subgroup differences: Not applicable



# Early mobilization

Table 3
Comparison of postoperative outcomes between pre- and postimplementation period.

| | Pre-implementation period Traditional mobilisation | | Postimplementation period Enforced mobilisation | | Difference OR (95% CI)/B (95% CI) | | | |
|---|---|---|---|---|---|---|---|---|
| | Total group ($n=55$) | Without OES ($n=46$) | Total group ($n=61$) | Without OES ($n=56$) | Total group | | Without OES | |
| PPCs, $n$ (%) | 13(24) | 8(17) | 6(10) | 2(4) | 0.38 (0.12 to 1.20)[a] | $P=0.098$ | 0.08 (0.01 to 0.71)[b] | $P=0.023$ |
| Prescription of antibiotics for pulmonary symptoms | 13(24) | 8(17) | 6(10) | 2(4) | | | | |
| Positive chest X ray | 9(16) | 6(13) | 2(3) | 0(0) | | | | |
| Return to intensive care unit due to respiratory problems | 2(4) | 2(4) | 1(2) | 0(0) | | | | |
| Length of hospital stay in days, mean (SD) | 9.1 (8.2) | 7.9 (6.7) | 6.9 (4.3) | 6.5 (4.3) | 0.82 (0.66 to 1.03)[c] | $P=0.082$ | 0.80 (0.63 to 1.02)[d] | $P=0.072$ |
| Re-admission <30 days, $n$ (%) | 7(13) | 5(11) | 5(8) | 5(9) | 0.60 (0.17 to 2.15)[e] | $P=0.434$ | 0.33 (0.05 to 2.08)[f] | $P=0.236$ |
| Change in 6MWT | | | | | | | | |
| Distance walked in m, mean (SD) | −125.1 (97.6) | −115.8 (91.0) | −101.3 (114.0) | −100.8 (119.3) | 27.98 (−12.71 to 68.67)[g] | $P=0.175$ | 26.95(−17.49 to 71.38)[g] | $P=0.231$ |
| % predicted, mean (SD) | −19.0 (14.7) | −17.3 (13.1) | −13.8 (15.3) | −13.7 (16.0) | 1.50 (−4.36 to 7.36)[h] | $P=0.612$ | 1.39 (−5.20 to 7.98)[h] | $P=0.676$ |

PPCs, postoperative pulmonary complications; 6MWT, 6-minute walk test; BMI, body mass index; OR, odds ratio; B, regression coefficient; CI, confidence interval; Without OES, group without patients who underwent oesophageal resection; SD, standard deviation.

Early enforced mobilisation following surgery for gastrointestinal cancer: feasibility and outcomes. van der Leeden M, Huijsmans R, Geleijn E, de Lange-de Klerk ES, Dekker J, Bonjer HJ, van der Peet DL Physiotherapy. 2016;102(1):103. Epub 2015 May 7.

# Early mobilization

- Patients were 3.0 (95% confidence interval 1.2 to 8.0) times more likely to develop a postoperative pulmonary complication for each postoperative day they did not mobilize away from the bed.

Association of postoperative pulmonary complications with delayed mobilisation following major abdominal surgery: an observational cohort study.Haines KJ, et al, Health POST Study Investigators Physiotherapy. 2013 Jun;99(2):119-25.

# Pain control

| Study (References) | N | Pulmonary complication (%) | | Respiratory Failure (%) | | Pneumonia (%) | |
|---|---|---|---|---|---|---|---|
| | | Epidural | Control | Epidural | Control | Epidural | Control |
| *Meta-analyses* | | | | | | | |
| Rogers 2000 (6) | 9559[a] | na | na | na | na | 3.1* | 6 |
| Nishimori 2006 (7) | 1224 | | | 0.63* RR | | 0.64 RR | |
| Liu 2004 (1) | 1178 | 17.2* | 30.3 | na | na | na | na |
| Beattie 2001 (8) | 1173 | na | na | na | na | na | na |
| Ballantyne 1998 (9) | 1016 | 0.58* RR | na | na | na | 0.38* RR | na |
| Werawatgannon 2005 (10) | 711 | na | na | na | na | na | na |
| Choi 2003 (11) | 555 | na | na | na | na | na | na |
| *RCT* | | | | | | | |
| Park 2001 (12) | 984 | na | na | 9.9 | 14 | 7.9 | 5.4 |
| | 374 | na | na | 14* | 28 | na | na |
| Rigg 2002 (13) | 915 | na | na | 23* | 30 | na | na |
| *Medicare data* | | | | | | | |
| Wu 2004 (2) | 68,723 | na | na | 0 | 0 | 0.02 | 0.02 |
| Wu 2003 (14) | 23,136 | na | na | na | na | 1.3 | 1.5 |



Effect of postoperative analgesia on major postoperative complications: a systematic update of the evidence.Liu SS, Wu CL Anesth Analg. 2007;104(3):689.

# Nasogastric tube

**Table 2. META-ANALYSIS OF ALL 26 CLINICAL TRIALS (3964 PATIENTS)**

| | Selective | Routine | p Value | RR |
|---|---|---|---|---|
| Patients | 1986 | 1978 | | |
| Tubes placed/replaced | 103 | 36 | <0.0001 | 2.9 |
| **Complications** | **833** | **1084** | **0.03** | **0.76** |
| Deaths | 13 | 25 | 0.22 | 0.36 |
| **Pneumonia** | **53** | **119** | **<0.0001** | **0.49** |
| **Atelectasis** | **44** | **94** | **0.001** | **0.46** |
| Aspiration | 8 | 13 | 0.88 | 0.61 |
| **Fever** | **108** | **212** | **0.02** | **0.51** |
| Nausea | 179 | 181 | 0.31 | 0.98 |
| Vomiting | 201 | 168 | 0.11 | 1.19 |
| Abdominal distension | 163 | 165 | 0.36 | 0.98 |
| Wound dehiscence | 12 | 33 | 0.06 | 0.36 |
| Wound infection | 49 | 76 | 0.29 | 0.62 |
| Anastomotic leak | 12 | 16 | 0.93 | 0.75 |
| **Oral feeding (days)** | **3.53** | **4.59** | **0.04** | |
| Length of stay (days) | 9.32 | 10.10 | 0.22 | |

RR = relative risk.
Bold type indicates significant results ($p < 0.05$).

A meta-analysis of selective versus routine nasogastric decompression after elective laparotomy.Cheatham ML, Chapman WC, et al, Ann Surg. 1995;221(5):469.

# Summary

- Preoperative risk stratification
- Preoperative work-up when necessary
- Preoperative, intraoperative and postoperative strategies
- Treat COPD and asthma same as those for patients not preparing for surgery.
- Discuss with surgeon and anesthesiologist plan of therapy

# Thank You

**Pulmonary preoperative evaluation should always include:**

A. Chest x ray
B. Pulmonary function test
C. 6 MWT
D. Arterial blood gas
E. History and physical

**Common denominator on the 3 risk scoring discussed:**

A. Length of surgery
B. Type of surgery
C. Creatinine
D. Albumin
E. Functional status

**Indication for systemic corticosteroids include:**

A. Any patient who has been taking any dose of glucocorticoid for less than three weeks
B. Patients who have received morning doses of less than 5 mg/day of prednisone or its equivalent for any length of time
C. Patients being treated with less than 10 mg of prednisone or its equivalent every other day
D. Patients on chronic inhaled corticosteroids with Cushingoid feature
E. Patients with history of asthma exacerbation within 6 months prior to scheduled surgery