

Preventing post-operative pulmonary complications : **The Role of Surgeon**

Dr N. Debergh
Digestive Surgeon
Clinique CHC Montlégia

CHC
GROUPE SANTÉ



With the support of



This live webcast has been realized thanks to the support of MSD. The views expressed in this presentation reflect the experience and opinions of the speakers and not necessarily that of MSD. Please note that this presentation may contain information about experimental uses of drugs that are currently not approved by regulatory agencies. Meeting attendees are encouraged to consult the prescribing information for the drugs mentioned in this presentation (via www.afmps.be or <https://www.fagg.be/nl>).

Table 1 European Perioperative Clinical Outcome definitions¹ for postoperative pulmonary complications and other defined outcome measures, shown to highlight the variation of definitions in the literature; in particular, respiratory failure and pneumonia. International statistical classification of diseases and related health problems, ninth revision (ICD-9) codes have also been used to define PPCs.^{2,3} ARDS, acute respiratory distress syndrome; CXR, chest radiograph; EPCO, European Perioperative Clinical Outcome; FI_{O_2} , fraction of inspired oxygen; NIV, non-invasive ventilation; Pa_{O_2} , partial pressure of oxygen in arterial blood; PPC, postoperative pulmonary complication

Outcome measure	EPCO definitions (identical set used by Canet and colleagues ⁴ and subsequent studies) ^{5,6}	Other published definitions
Respiratory infection	Antibiotics for suspected infection with one or more of the following: new or changed sputum, new or changed lung opacities, fever, white blood cell count $>12 \times 10^9$ litre ⁻¹	Two or more of the following for >48 h: new cough/sputum production, physical findings compatible with pneumonia, fever $>38^\circ\text{C}$, and new infiltrate on CXR ⁷
Respiratory failure	Postoperative $Pa_{O_2} <8$ kPa (60 mm Hg) on room air, a $Pa_{O_2}:FI_{O_2}$ ratio <40 kPa (300 mm Hg), or arterial oxyhaemoglobin saturation measured with pulse oximetry $<90\%$ and requiring oxygen therapy	Ventilator dependence for >1 postoperative day or re-intubation ^{8,9} Need for postoperative mechanical ventilation >48 h ¹⁰⁻¹³ Unplanned re-intubation because of respiratory distress, hypoxia, hypercarbia, or respiratory acidosis within 30 days of surgery ^{10,11,13-15} Re-intubation within 3 days requiring mechanical ventilation ¹⁶ Postoperative acute lung injury ¹⁷ ARDS ¹⁷⁻¹⁹ Requiring mechanical ventilation within 7 days of surgery ^{20,21} Requiring NIV ²²
Pleural effusion	CXR with blunting of costophrenic angle, loss of sharp silhouette of the ipsilateral hemidiaphragm in upright position, displacement of adjacent anatomical structures, or (in supine position) hazy opacity in one hemithorax with preserved vascular shadows	Pleural effusion requiring thoracocentesis ^{8,9,20}
Atelectasis	Lung opacification with mediastinal shift, hilum or hemidiaphragm shift towards the affected area, with compensatory hyperinflation in adjacent non-atelectatic lung	Requiring bronchoscopic intervention ²⁰ Major atelectasis (one or more pulmonary segments) ²³
Pneumothorax	Air in the pleural space with no vascular bed surrounding the visceral pleura	Pneumothorax requiring thoracocentesis ^{20,22}
Bronchospasm	Newly detected expiratory wheeze treated with bronchodilators	Clinical diagnosis resulting in change in therapy ⁸⁹ Refractory wheeze requiring parenteral drugs in addition to preoperative regimen ²⁴
Aspiration pneumonitis	Acute lung injury after inhalation of regurgitated gastric contents	
Pneumonia	CXR with at least one of the following: infiltrate, consolidation, cavitation, plus at least one of the following: fever $>38^\circ\text{C}$ with no other cause, white cell count <4 or $>12 \times 10^9$ litre ⁻¹ , >70 yr of age with altered mental status with no other cause; plus at least two of the following: new purulent/changed sputum, increased secretions/suctioning, new/worse cough/dyspnoea/tachypnoea, rales/bronchial breath sounds, worsening gas exchange	Radiographic change and antibiotics ⁸⁹ Antibiotics with new/changed sputum or radiographic change or fever or increased white cell count $>12\,000$ μl^{-1} ⁴ Two or more of the following for ≥ 2 consecutive days: new cough/sputum production, examination compatible with pneumonia, temperature $>38^\circ\text{C}$, and radiographic change ^{7,23} New or progressive infiltrate on CXR or crackles or dullness on percussion and any of the following: new purulent/changed sputum, positive blood cultures, isolation of pathogen from sputum ^{20,25} Positive sputum culture or infiltrate on CXR, and diagnosis of pneumonia or pneumonitis ¹³ New infiltrate on CXR plus fever, leucocytosis, and positive sputum Gram stain/culture ²⁴
ARDS		Ventilated, bilateral infiltrates on CXR, $Pa_{O_2}:FI_{O_2} \leq 300$, minimal evidence of left atrial fluid overload within 7 days of surgery ¹⁹
Tracheobronchitis		Purulent sputum with normal chest radiograph, no i.v. antibiotics ^{8,9}

Continued

Post-operative pulmonary complications (PPCs) : Definition

- **Definition** : Any complication affecting the respiratory system after anesthesia & surgery

Table 1 Continued

Outcome measure	EPCO definitions (identical set used by Canet and colleagues ⁴ and subsequent studies) ^{5,6}	Other published definitions
Pulmonary oedema		Pulmonary congestion/hypostasis, acute oedema of lung, congestive heart failure, fluid overload ^{2,3}
Exacerbation of pre-existing lung disease ²³		Not further defined
Pulmonary embolism ²³		Not further defined
Death ^{24,26}		

Jamner I, Wickboldt N, Sander M, et al. Standards for definitions and use of outcome measures for clinical effectiveness research in perioperative medicine: European Perioperative Clinical Outcome (EPCO) definitions: a statement from the ESA-ESICM joint taskforce on perioperative outcome measures. Eur J Anaesthesiol 2015; 32: 88-105

Post-operative pulmonary complications (PPCs) : Incidence & Impact

• **Incidence** : <1-23% different definition & population

• **Mortality** :

• No PPC : 0,2-0,3%

• PPC : 14-30%

• **LOS** : ↑13-17days

• **Health care cost** : ↑ 41-47%

Table 2 Incidence and mortality rates of major studies evaluating postoperative pulmonary complications since the year 2000. Prospective studies are followed by retrospective studies in reverse chronological order. Where more than three surgical specialties are included, the term 'multi-specialty' is used. Where risk prediction model papers include a training set and a validation set, data from the validation set have been used. AAA, open abdominal aortic aneurysm; ALI, acute lung injury; ARDS, acute respiratory distress syndrome; ARISCAT, Assess Respiratory Risk in Surgical Patients in Catalonia; CXR, chest radiograph; EPCO, European Perioperative Clinical Outcome definition (Table 1); EVAR, endovascular aneurysm repair; PE, pulmonary embolus; PERISCOPE, Prospective Evaluation of a Risk Score for postoperative pulmonary COmplications in Europe; PPC, postoperative pulmonary complication; RF, respiratory failure; Sp_{o2}, peripheral oxygen saturation; UFI, unplanned incubation

Study	Year	Design	PPCs	Sample size	PPC incidence (%)	Mortality rate with PPC (%)	Operative specialty
Canet and colleagues ²⁹	2015	Secondary analysis of 'PERISCOPE' Prospective multi-centre cohort; evaluating PPCs	RF	5384	4.2	10.3 (in hospital)	Multi-specialty elective and emergency, including abdominal, vascular, cardiac, and thoracic
Mazo and colleagues ⁶	2014	'PERISCOPE' Prospective multicentre cohort; external validation of 'ARISCAT'	As per EPCO	5099	7.9	8.3 (in hospital)	Multi-specialty elective and emergency, including abdominal, vascular, cardiac, and thoracic
Canet and colleagues ⁴	2010	'ARISCAT' Prospective multicentre cohort	As per EPCO	2454	5.0	19.5 (30 day) 24.4 (90 day)	Multi-specialty elective and emergency, including abdominal, vascular, cardiac, and thoracic
Scholes and colleagues ³⁷	2009	Prospective multi-centre cohort	More than four of the following: i. collapse/consolidation on CXR; ii. Sp _{o2} <90%; iii. abnormal sputum production; iv. positive sputum culture; v. leucocytosis; vi. abnormal auscultation; or vii. physician's diagnosis	268	13.0	Not stated	Upper abdominal
McAlister and colleagues ³⁵	2005	Prospective single-centre cohort	HF, pneumonia, atelectasis, pneumothorax, pleural effusion	1055	2.7	Not stated	Multi-specialty (non-thoracic) elective, including abdominal
Yang and colleagues ¹²	2015	Retrospective analysis of multi-centre prospective cohort (not specific to PPCs)	Pneumonia, UFI, or RF	165 196	5.8	Not stated	Elective major abdominal (non-vascular)
Jeong and colleagues ⁵	2014	Retrospective single-centre analysis of prospectively collected cohort regarding PPC risk	As per EPCO	2059	6.8	Not stated	Multi-specialty elective and emergency, including abdominal (open and laparoscopic), vascular, cardiac, and thoracic
Bhat and colleagues ¹³	2013	Retrospective single-centre cohort	ARDS	50 367	0.2	27.0 (90 day)	Multi-specialty (non-cardiothoracic) elective and emergency, including abdominal
Brückmann and colleagues ¹⁹	2013	Retrospective single-centre cohort	UFI	33 759	0.43	16.0	Multi-specialty elective and emergency, including abdominal, vascular, cardiac, and thoracic
Gupta and colleagues ¹²	2013	Retrospective analysis of multi-centre prospective cohort (not specific to PPCs)	Pneumonia	211 410	1.8	17.0 (30 day)	Multi-specialty elective and emergency, including abdominal, vascular, cardiac, and thoracic
Li and colleagues ¹⁰	2013	Retrospective single-centre cohort	Pneumonia, pulmonary oedema, atelectasis, ARDS, pleural effusion	316	18.9	Not specific to PPC	Elective and emergency infrarenal AAA
Hua and colleagues ¹⁵	2012	Retrospective analysis of multi-centre prospective cohort (not specific to PPCs)	UFI	231 548	1.9	28.0 (30 day)	Multi-specialty elective and emergency, including major abdominal, vascular (open and EVAR), cardiac, and thoracic
Kor and colleagues ³⁷	2011	Retrospective analysis of prospective single-centre cohort evaluating intraoperative ventilator settings and ALI	ALI/ARDS	4366	2.6	14.2	Multi-specialty elective, including abdominal (open and laparoscopic), vascular, cardiac, and thoracic
Gupta and colleagues ¹¹	2011	Retrospective analysis of multi-centre prospective cohort (not specific to PPCs)	RF, UFI	211 410	2.6	25.6 (30 day)	Multi-specialty elective and emergency, including abdominal, vascular, cardiac, and thoracic
Ramachandran and colleagues ¹⁷	2011	Retrospective analysis of multi-centre prospective cohort (not specific to PPCs)	UFI	222 094	0.9	9.7 (low-risk group), 30.6 (high-risk group)	Elective multi-specialty (non-cardiac)
Smith and colleagues ²³	2010	Retrospective single-centre cohort	Pneumonia, acute bronchitis, atelectasis, exacerbation of pre-existing lung disease, RF, PE	329	7.0	16.0 (30 day)	Elective and emergency laparotomy, including AAA
Johnson and colleagues ³¹	2007	Retrospective analysis of multi-centre prospective cohort (non-specific to PPCs)	RF, UFI	180 359	3.0	26.5 (30 day)	Elective and emergency major vascular and general
Arozullah and colleagues ²²	2001	Retrospective analysis of multi-centre prospective cohort (non-specific to PPCs)	Pneumonia	160 805	1.5	21 (30 day)	Multi-specialty (non-cardiac), including abdominal, vascular, and thoracic
Arozullah and colleagues ²¹	2000	Retrospective analysis of multi-centre prospective cohort (non-specific to PPCs)	RF	81 719	3.4	27 (30 day)	Multi-specialty (non-cardiac), including abdominal, vascular, and thoracic

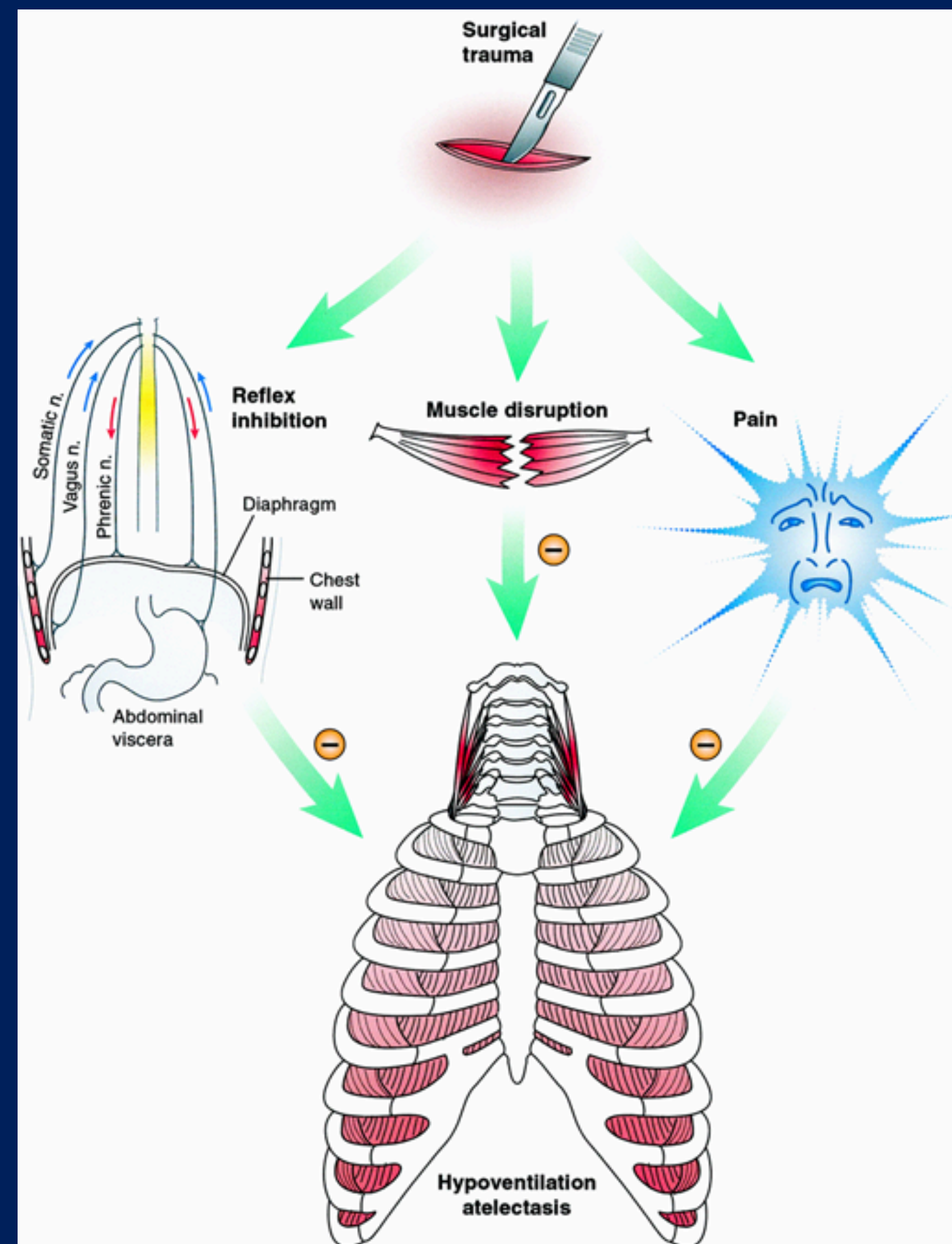
Surgical Trauma and PPCs

- **Incisions :**

- Disruption of respiratory muscle (intercostal/abdominal), even after repair

- **Visceral stimulation :**

- Organ traction, dilatation
- ↓ Phrenic motoneuron output
- Ascension of diaphragm



- **Pain :**

- May cause voluntary limitation of respiration

PATIENT Related Risk Factors of PPCs

Non Modifiable

- **Age** (>60 years old)
- **Male sex**
- **ASA score** (>2, X5 risk)
- **Acute respiratory infection in the last month** (delay surgery?)
- **Weight loss >10%** (within 6months)
- **Frailty, Long term steroid use, Malignancy, CVA**
- **Prolonged hospitalization**

Modifiable

- **Smoking** (>20 pack/year, smoking duration)
- **Chronic lung disease (COPD)** (x6 risk, optimize treatment)
- **Asthma** (optimize treatment)
- **Congestive heart failure** (X 3 risk, optimize treatment)
- **OSA** (x2 risk, Cpap)
- **BMI** (<18,5 or >40)
- **Low Albumin level** (<35g/l)
- **Anemia** (<10g/l x 3 PPCs) correct with Iron oral or IV, B12 oral or IM, no
- **SpO2 on air** (<95-91% 2x risk, <90%, 10x risk)

Jammer I, Wickboldt N, Sander M, et al. Standards for definitions and use of outcome measures for clinical effectiveness research in perioperative medicine: European Perioperative Clinical Outcome (EPCO) definitions: a statement from the ESA-ESICM joint taskforce on perioperative outcome measures. Eur J Anaesthesiol 2015; 32: 88–105

Canet J, Gallart L, Gomar C, et al. Prediction of postoperative pulmonary complications in a population-based surgical cohort. Anesthesiology 2010; 113: 1338–50

Robinson TN, Wu DS, Pointer L, et al. Simple frailty score predicts postoperative complications across surgical specialties. Am J Surg 2013; 206: 544–50

Patient factors
Non-modifiable
Age ^{4, 7, 10, 13, 14, 18, 20, 24, 25, 27, 33, 35}
Male sex ^{12, 19, 33}
ASA ≥II ^{5, 11, 14, 16, 19, 27, 33}
Functional dependence (frailty) ^{10, 13, 25, 27, 34, 36}
Acute respiratory infection (within 1 month) ^{4, 6}
Impaired cognition ⁷
Impaired sensorium ²⁵
Cerebrovascular accident ²⁵
Malignancy ^{7, 15}
Weight loss >10% (within 6 months) ^{15, 25}
Long-term steroid use ²⁵
Prolonged hospitalization ¹⁵
Modifiable
Smoking ^{37, 12, 13, 15, 25, 32, 33, 61}
COPD ^{10, 12, 13, 15, 19, 24, 25, 27, 32, 33, 36}
Asthma ^{20, 32}
CHF ^{15, 16, 18, 27, 29, 33}
OSA ⁶²
BMI <18.5 or > 40 kg m ⁻² ¹⁵
BMI >27 kg m ⁻² ⁷
Hypertension ¹⁵
Chronic liver disease ²⁹
Renal failure ¹⁹
Ascites ¹²
Diabetes mellitus ^{15, 17}
Alcohol ^{17, 25}
GORD ¹⁷
Preoperative sepsis ^{13, 15, 33}
Preoperative shock ¹²
Laboratory testing
Urea >7.5 mmol litre ⁻¹ ^{10, 25}
Increased creatinine ³³
Abnormal liver function tests ¹⁵
Low preoperative oxygen saturation ^{4, 6, 29}
Positive cough test ²⁰
Abnormal preoperative CXR ^{9, 27}
Preoperative anaemia (<100 g litre ⁻¹) ^{4, 6}
Low albumin ^{5, 10, 27}
Predicted maximal oxygen uptake ³²
FEV ₁ :FVC <0.7 and FEV ₁ <80% of predicted ⁵

SURGERY Related Risk Factors of PPCs

- **Type of surgery :**
 - Thoracic, AAA, upper abdominal, neck, neurosurgery, major vascular > others
- **Type of incision** (open vs laparoscopy, muscle sparing, upper abdominal x15 risk vs lower abdominal)
- **Duration of surgery (>2-3h)**
- **Re-Operation** (x4-6 risk of PPCs)
- **Emergency procedure** (x2-6 risk of PPCs)
- **Intraoperative blood transfusion**
- **Perioperative nasogastric tube**

Jammer I, Wickboldt N, Sander M, et al. Standards for definitions and use of outcome measures for clinical effectiveness research in perioperative medicine: European Perioperative Clinical Outcome (EPCO) definitions: a statement from the ESA-ESICM joint taskforce on perioperative outcome measures. *Eur J Anaesthesiol* 2015; 32: 88–105

Arozullah AM, Khuri SF, Henderson WG, Daley J. Development and validation of a multifactorial risk index for predicting postoperative pneumonia after major noncardiac surgery. *Ann Intern Med* 2001; 135: 847–57

Smith PR, Baig MA, Brito V, Bader F, Bergman MI, Alfonso A. Postoperative pulmonary complications after laparotomy. *Respiration* 2010; 80: 269–74

Yang CK, Teng A, Lee DY, Rose K. Pulmonary complications after major abdominal surgery: national surgical quality improvement program analysis. *J Surg Res* 2015; 198: 441–9

Lee CZ, Kao LT, Lin HC, Wei PL. Comparison of clinical outcome between laparoscopic and open right hemicolectomy: a nationwide study. *World J Surg Oncol* 2015; 13: 250

Bablekos GD, Michaelides SA, Analitis A, Charalabopoulos KA. Effects of laparoscopic cholecystectomy on lung function: a systematic review. *World J Gastroenterol* 2014; 20: 17603–17

Jiang L, Yang KH, Guan QL, et al. Laparoscopy-assisted gastrectomy versus open gastrectomy for resectable gastric cancer: an update meta-analysis based on randomised controlled trials. *Surg Endosc* 2013; 27: 2466–80

Johnson RG, Arozullah AM, Neumayer L, Henderson WG, Hosokawa P, Khuri SF. Multivariable predictors of postoperative respiratory failure after general and vascular surgery: results from the patient safety in surgery study. *J Am Coll Surg* 2007; 204: 1188–98

Antoniou SA, Antoniou GA, Koch OO, Koehler G, Pointner R, Grandrath FA. Laparoscopic versus open obesity surgery: a meta-analysis of pulmonary complications. *Dig Surg* 2015; 32: 98–107

Procedure factors

Non-modifiable

Type of surgery:^{4-7 10-13 15-18 23 25 27 29}

- upper abdominal
- AAA
- Thoracic
- Neurosurgery
- head and neck
- vascular

Emergency (vs elective)^{4-6 10 11 16 18 19 23 25 29 33 36}

Duration of procedure^{6 12 14 20 22 27 29 32}

Re-operation^{18 23 36}

Multiple GA during admission¹⁹

Modifiable

Mechanical ventilation strategy^{3 19 63-71}

GA (vs regional)^{4 25 27 72}

Long-acting NMBDs and TOF ratio <0.7 in PACU⁷³

Residual neuromuscular block

Intermediate-acting NMBDs with surgical time <2 h (not antagonized)²¹

Neostigmine^{21 74}

Sugammadex with supraglottic airway^{75 76}

Failure to use peripheral nerve stimulator^{21 74}

Open abdominal surgery (vs laparoscopic)^{5 26 77-79}

Perioperative nasogastric tube^{18 20 22 23 25 80}

Intraoperative blood transfusion^{19 25 36}

Preoperative Risk stratification

- **ARISCAT score** (Assess Respiratory Risk in Surgical Patient in catalonia)
- **PERISCOPE** (Prospective Evaluation of a Risk Score for Postoperative Pulmonary Complications in Europe)
- Impractical in routine use :
 - Complexity
 - Lack of agreement between studies
- No consensus of best one to use

Mazo V, Sabate S, Canet J, et al. Prospective external validation of a predictive score for postoperative pulmonary complications. *Anesthesiology* 2014; 121: 219–31

Canet J, Sabate S, Mazo V, et al. Development and validation of a score to predict postoperative respiratory failure in a multicentre European cohort. A prospective, observational study. *Eur J Anaesthesiol* 2015; 32: 458–70

Gupta H, Gupta PK, Schuller D, et al. Development and validation of a risk calculator for predicting postoperative pneumonia. *Mayo Clin Proc* 2013; 88: 1241–9

Brueckmann B, Villa-Urbe JL, Bateman BT, et al. Development and validation of a score for prediction of postoperative respiratory complications. *Anesthesiology* 2013; 118: 1276–85

ARISCAT Score for Postoperative Pulmonary Complications ☆

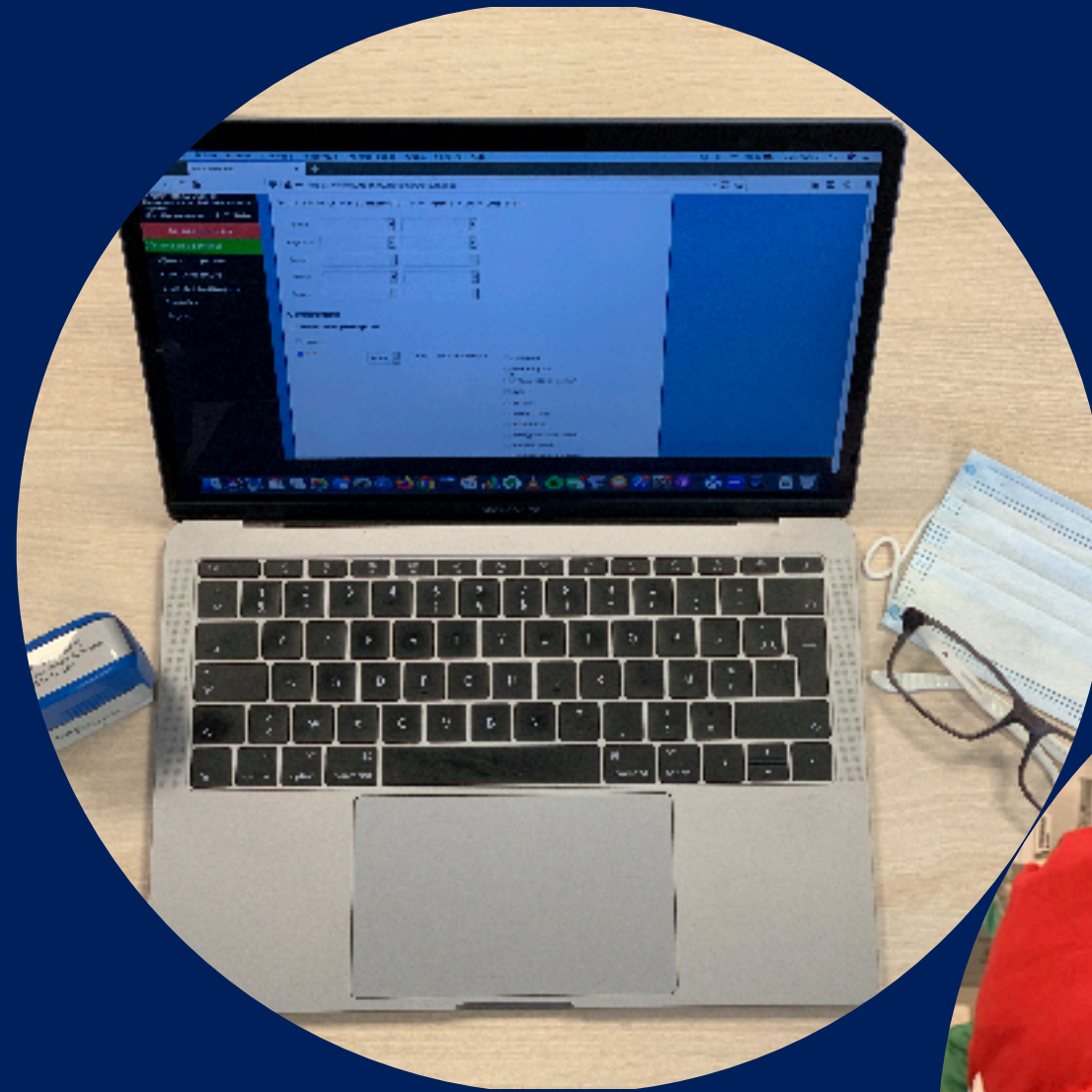
Predicts risk of pulmonary complications after surgery, including respiratory failure.

When to Use ▾

Age, years	≤50 0	51-80 +3	>80 +16
Preoperative SpO ₂	≥96% 0	91-95% +8	≤90% +24
Respiratory infection in the last month Either upper or lower (i.e., URI, bronchitis, pneumonia), with fever and antibiotic treatment	No 0	Yes +17	
Preoperative anemia (Hgb ≤10 g/dL)	No 0	Yes +11	
Surgical incision	Peripheral 0	Upper abdominal +15	Intrathoracic +24
Duration of surgery	<2 hrs 0	2-3 hrs +16	>3 hrs +23
Emergency procedure	No 0	Yes +8	

Preventing PPCs : The Role of Surgeon, **when?**

- **Pre**-operative



- **Per**-operative



- **Post**-operative



Preventing PPCs : The Role of Surgeon, **when?**

- **Pre**-operative



Preventing PPCs : The Role of Surgeon, **Pre-operative**

• **Preoperative Nutritional Care :**

• Preoperative Nutritional **Screening**

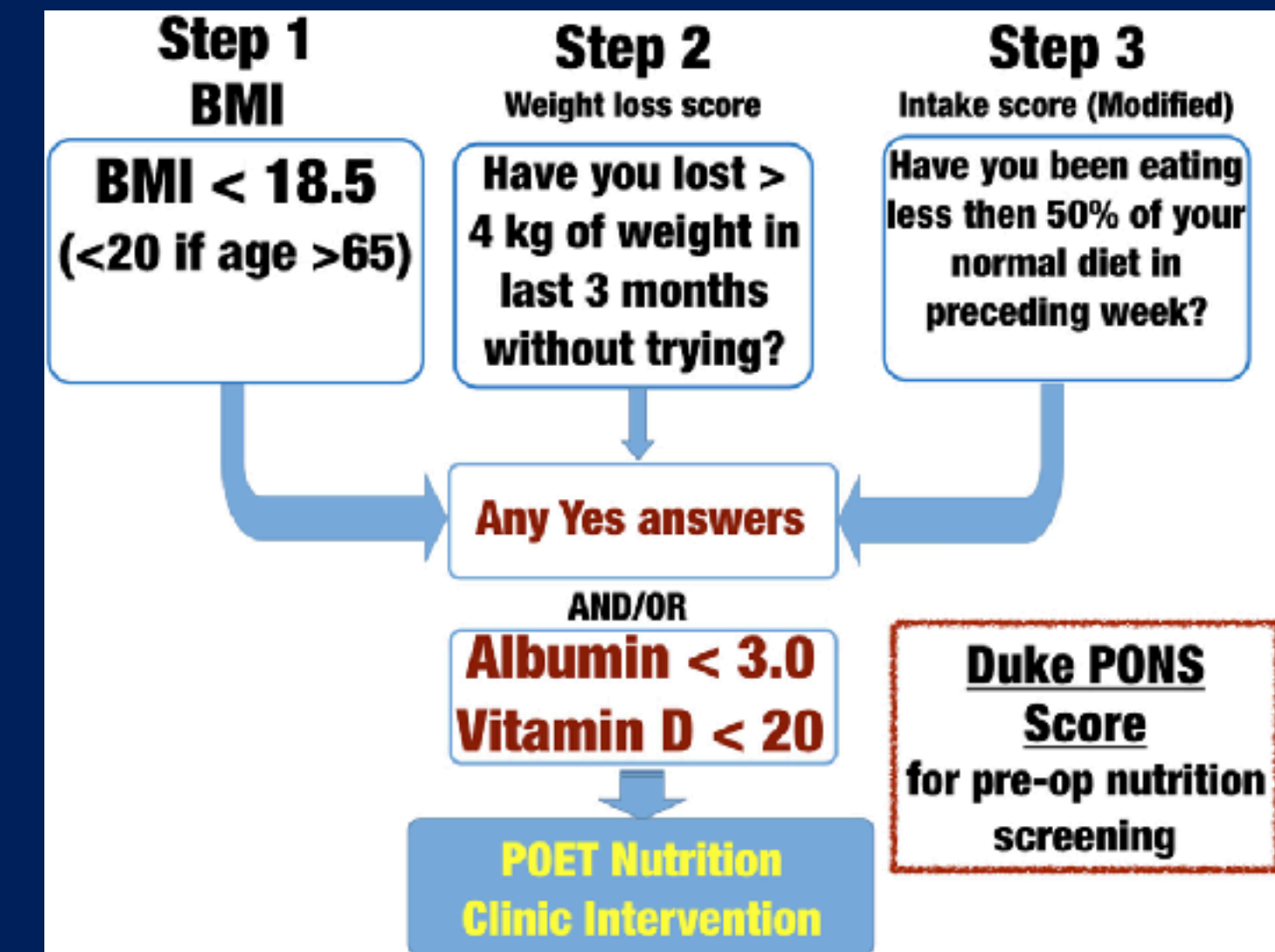
- **BMI** >18,5 (>70yrs) BMI>21 (<70yrs)
- **Weight loss** >5% 1 month, >10% (6 months)
- **↓Food intake** (Less 50%)
- Serum **Albumin** level (>30g/l) **Vitamin D** Level (<20)
- **Mini Nutritional Assessment (MNA)** > 17
- **Nutritional Risk Screening (NRS)** >5

• Preoperative oral > enteral > parenteral (immuno)nutritional **supplementation**

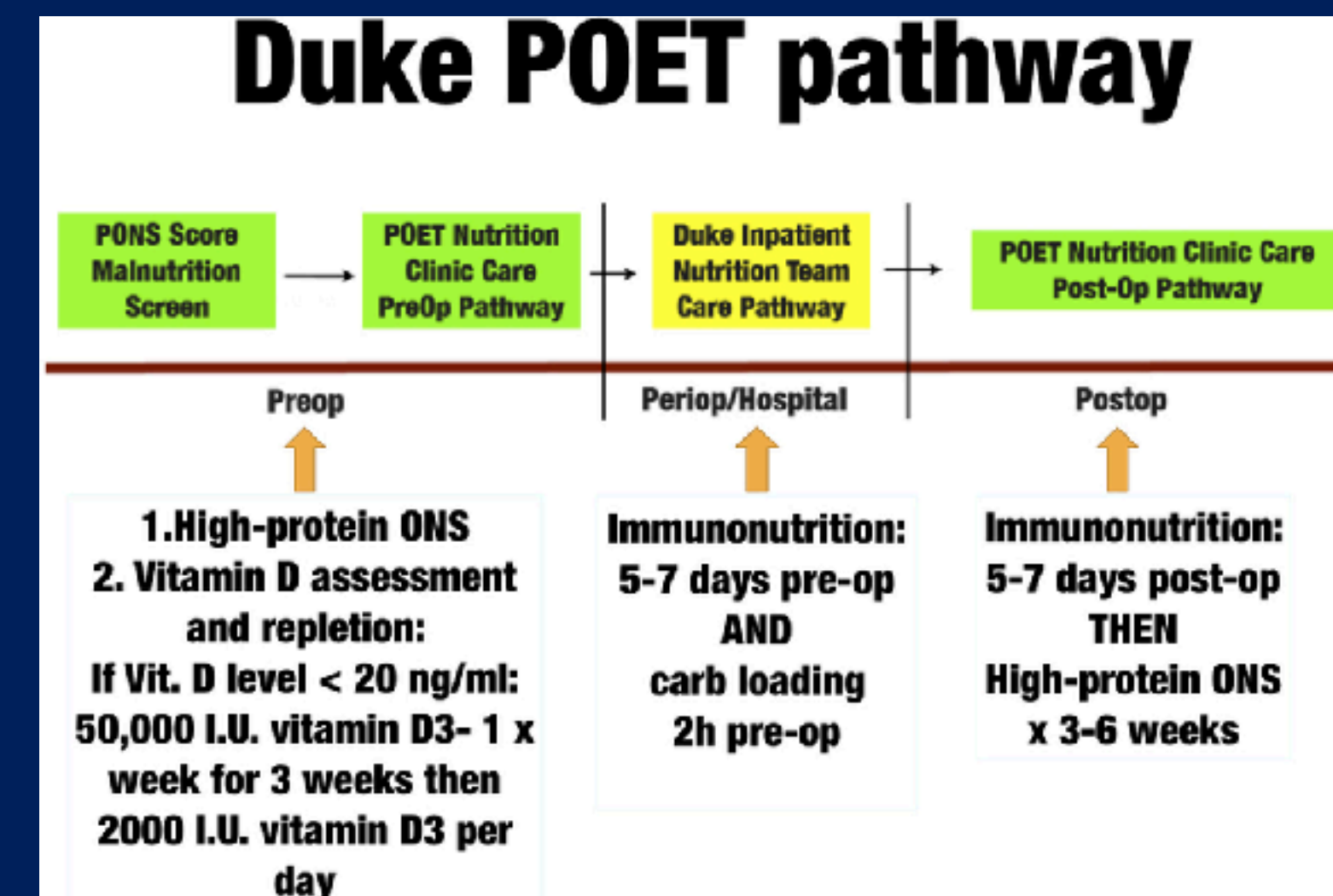
- Impact oral/enteral (Nestlé), 7days before surgery
- **↓Infection & ↓LOS**



Jie B, Jiang ZM, Nolan MT et al (2012) Impact of preoperative nutritional support on clinical outcome in abdominal surgical patients at nutritional risk. Nutrition 28:1022–1027



Duke University Pre-Operative Nutrition Score (PONS)



Pre-operative nutrition intervention plan from the Peri-operative Enhancement Team (POET) clinic at Duke University. PONS, Pre-Operative Nutrition Score.

Preventing PPCs : The Role of Surgeon, **Pre-operative**

• **Preoperative Anemia**

- 1/3 of European patients have anemia
- >10g/l : Risk of PPCs x3

• **Treatment :**

- Autologous transfusion ↑ Risk of PPCs
- Dietary supplement of **B12, Folate, Iron** oral or IV
- **Erythropoietin?**



Created by priyanka
from Noun Project

Baron DM, Hochrieser H, Posch M, et al. Preoperative anaemia is associated with poor clinical outcome in noncardiac surgery patients. *Br J Anaesth* 2014; 113: 416–23

Canet J, Gallart L, Gomar C, et al. Prediction of postoperative pulmonary complications in a population-based surgical cohort. *Anesthesiology* 2010; 113: 1338–50

Fleisher LE, Linde-Zwirble WT. Incidence, outcome, and attributable resource use associated with pulmonary and cardiac complications after major small and large bowel procedures. *Perioper Med* 2014; 3: 7

Unger EF, Thompson AM, Blank MJ, Temple R. Erythropoiesis-stimulating agents — time for a reevaluation. *N Engl J Med* 2010; 362: 189–92

Preventing PPCs : The Role of Surgeon, **Pre-operative**

- **Preoperative Investigations (Pulmonary Function test = PFT):**

- **Spirometry, Arterial Blood Gases (ABGs), chest X-ray (CXR)**

- PFT : Poor predictors of risk of PPCs, not to be used routinely preoperatively

- PFT interesting if :

- Unexplained dyspnea or exercise intolerance

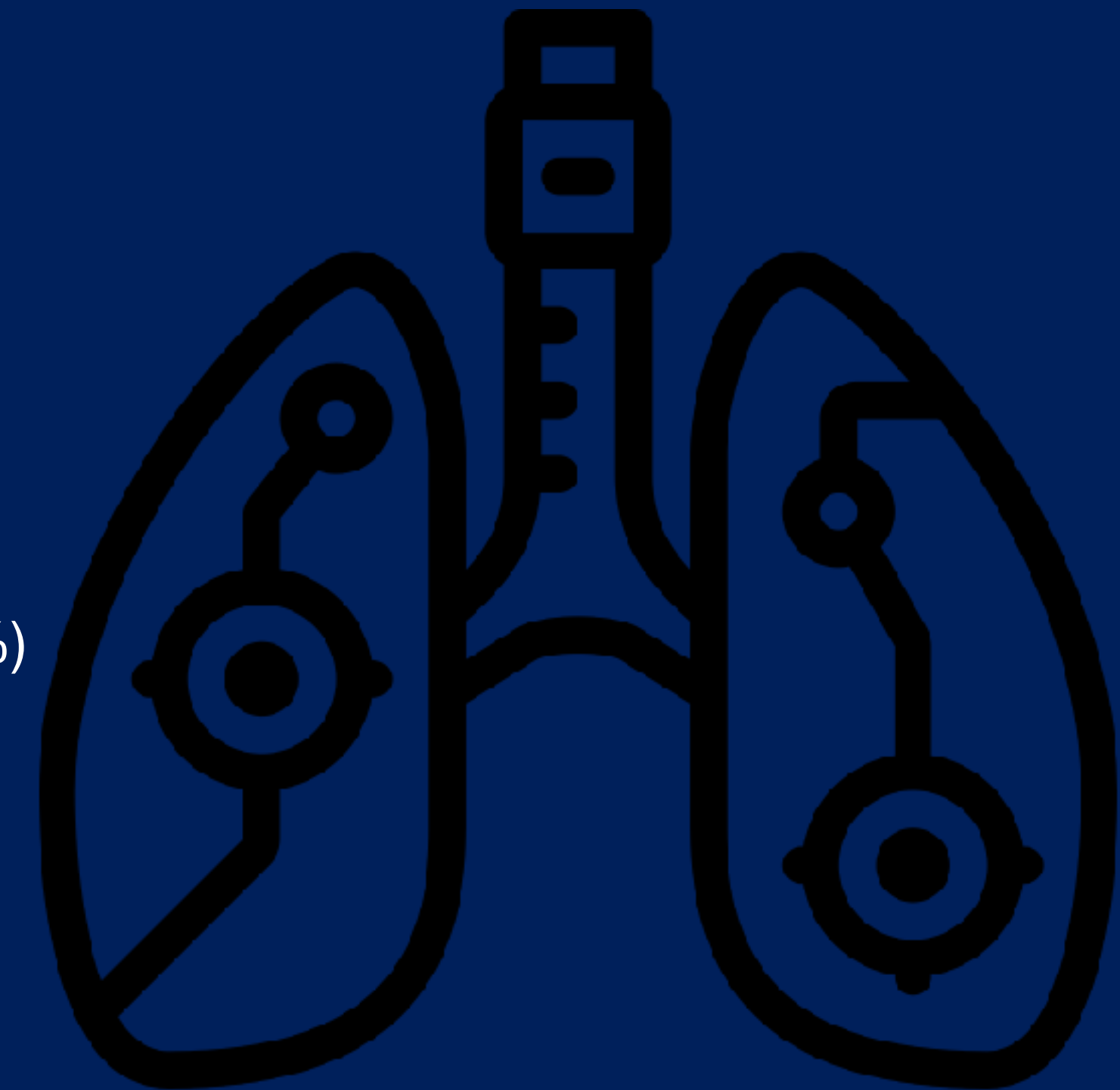
- COPD or asthma, uncertain symptom or disease control

- PFT = **Tool** to **optimize preoperative pulmonary function** (FEV $<70\%$) via preoperative physiotherapy

- **SpO2 on air :**

- Only good predictor of PPCs (SpO2 : 91-95% x2 risk, $< 90\%$ x10 risk)

- **Minimal cost**



Fisher BW, Majumdar SR, McAlister FA. Predicting pulmonary complications after nonthoracic surgery: a systematic review of blinded studies. *Am J Med* 2002; 112: 219-25

Routine preoperative tests for elective surgery. NICE guidelines [NG45] April 2016. Available from <https://www.nice.org.uk/guidance/ng45> (accessed 27 January 2017)

Canet J, Sabate S, Mazo V, et al. Development and validation of a score to predict postoperative respiratory failure in a multicentre European cohort. A prospective, observational study. *Eur J Anaesthesiol* 2015; 32: 458-70

McAlister FA, Bertsch K, Man J, Bradley J, Jacka M. Incidence of and risk factors for pulmonary complications after nonthoracic surgery. *Am J Respir Crit Care Med* 2005; 171: 514-7

Canet J, Gallart L, Gomar C, et al. Prediction of postoperative pulmonary complications in a population-based surgical cohort. *Anesthesiology* 2010; 113: 1338-50

Preventing PPCs : The Role of Surgeon, **Pre-operative**

- **Preoperative physiotherapy session**

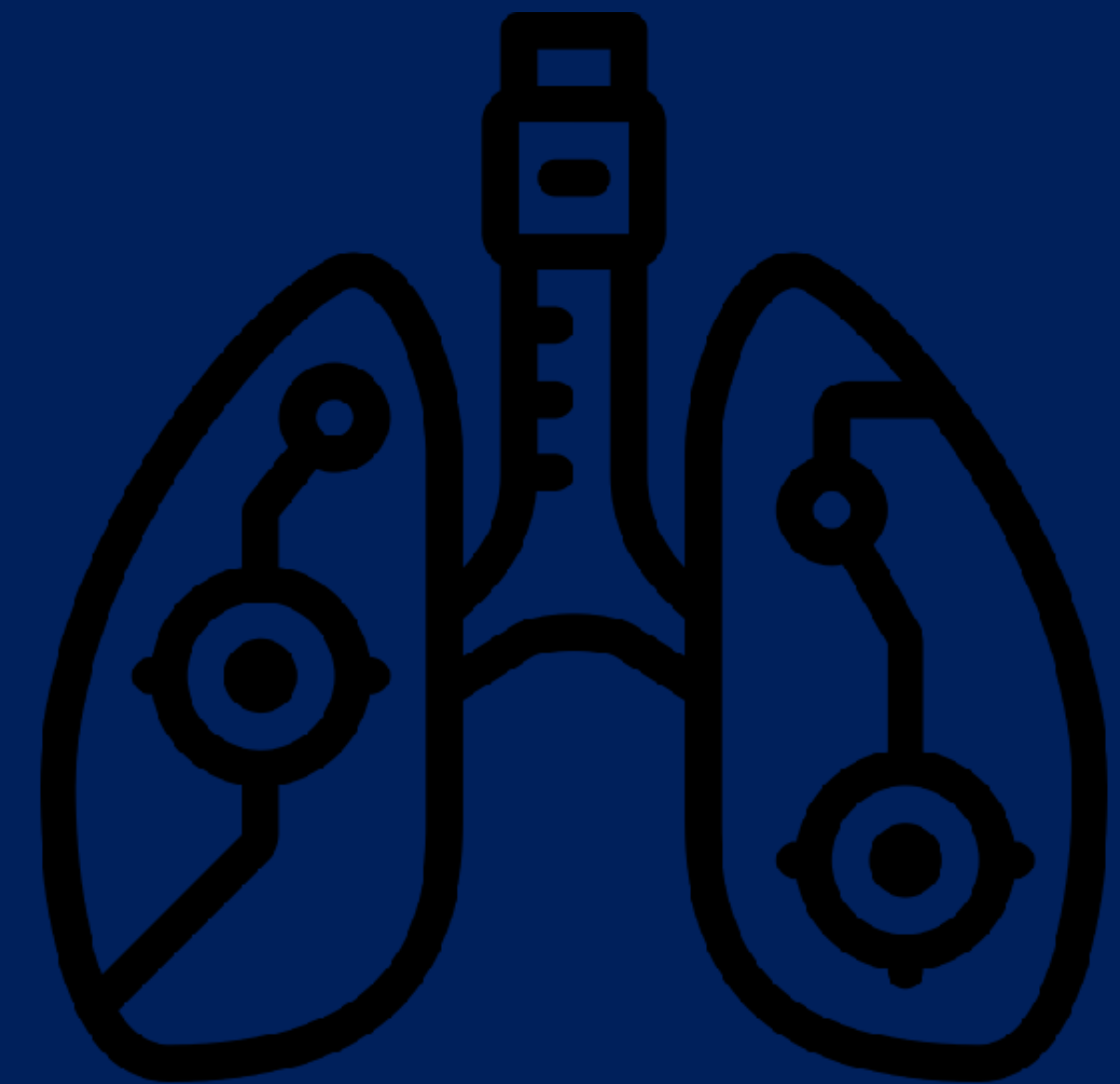
- **Prophylactic lung expansion techniques :**

- Physiotherapy education & treatment
- Breathing exercise (Respiratory Muscle Training : RMT)
- Directed cough
- Incentive spirometry



- **Information on prevention of PPCs**

- **↓ Atelectasis & Pneumonia**



Valkenet K, van de Port IG, Dronkers JJ, de Vries WR, Lindeman E. The effects of preoperative exercise therapy on postoperative outcome: a systematic review. *Clin Rehabil* 2011; 25: 99–111

Katsura M, Kuriyama A, Takeshima T, Fukuhara S, Furukawa TA. Preoperative inspiratory muscle training for postoperative pulmonary complications in adults undergoing cardiac and major abdominal surgery. *Cochrane Database Syst Rev* 2015; 10: CD010356

Can reduce PPCs for patients at risk

Preventing PPCs : The Role of Surgeon, **Pre-operative**

• **Smoking : Quit or reduce drastically**

- **Non > Ex > Current** smoker : ↑PPCs Risk
- **PPCs & Morbidity** ↑ if current smoker & ↑ number pack/year
- Role of anesthesiologist & surgeon
- **Stop ASAP** : 4-8 weeks before surgery (23 to 47% ↓PPCs)
- **Help the patient with :**
 - **Pharmacological** therapy (Nicotine patch, Champix, vaping...)
 - **Behavioural** therapy (Tobacologist, hypnosis, acupuncture...)
 - Tobacco cessation clinic
 - NICE 2013 Perioperative smoking cessation recommendations



Mills E, Eyawo O, Lockhart I, Kelly S, Wu P, Ebbert JO. Smoking cessation reduces postoperative complications: a systematic review and meta-analysis. *Am J Med* 2011; 124: 144–54

Wong J, Lam DP, Abrishami A, Chan MTV, Chung F. Shortterm preoperative smoking cessation and postoperative complications: a systematic review and meta-analysis. *Can J Anaesth* 2012; 59: 268–79

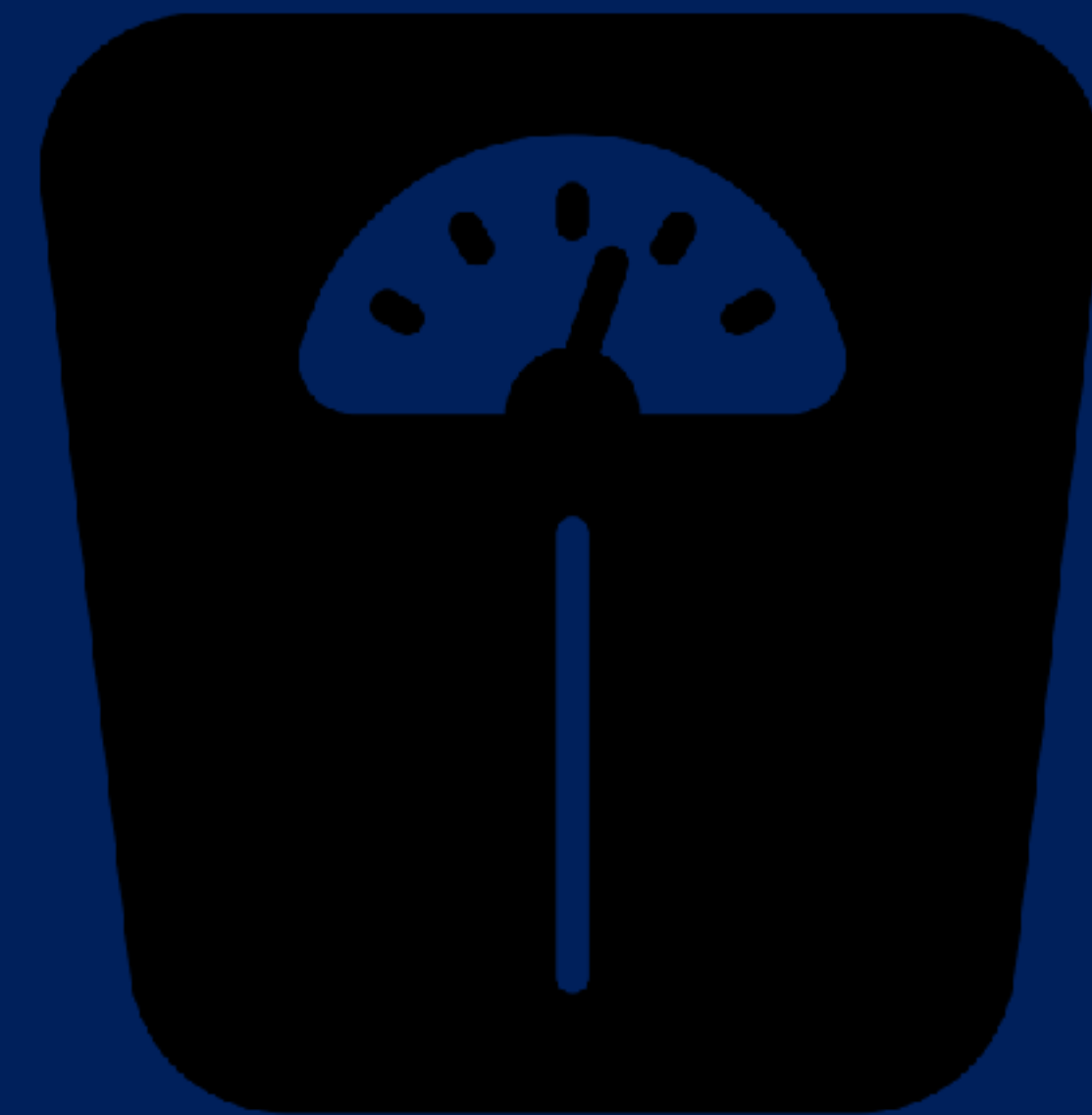
Schmid M, Sood A, Campbell L, et al. Impact of smoking on perioperative outcomes after major surgery. *Am J Surg* 2015; 210: 221–9

Smoking cessation in secondary care: acute, maternity and mental health services (NICE public health guidance 48). November 2013. Available from <http://www.nice.org.uk/guidance/ph48> (accessed 27 January 2017)

Preventing PPCs : The Role of Surgeon, **Pre-operative**

• **Weight, lose some!** :

- Obesity increases **atelectasis** PPCs (BMI>50)
- Obesity linked to **asthma, hypoventilation, OSA**
- Need for higher pneumoperitoneum pressure, longer procedure
- If laparotomy : delayed skin closure, higher risk of infection
- Weight loss effect preop on PPCs controversial



Created by Vectors Point
from Noun Project

J Laparoendosc Adv Surg Tech A

. 2019 Nov;29(11):1456-1461. doi: 10.1089/lap.2019.0459. Epub 2019 Sep 19.

Identifying Patients at High Risk of Having Pulmonary Dysfunction Before Laparoscopic Bariatric

Surgery and Its Impact on Postoperative Pulmonary Complications

Preventing PPCs : The Role of Surgeon, **Pre-operative**

• **Obstructive Sleep Apnea (OSA)** :

• Diagnosis :

- **STOP-BANG** (Sneeze, Tired, Observed apnea, Pressure, Bmi, Age, Neck, Gender) or **Epworth Sleepiness scale**

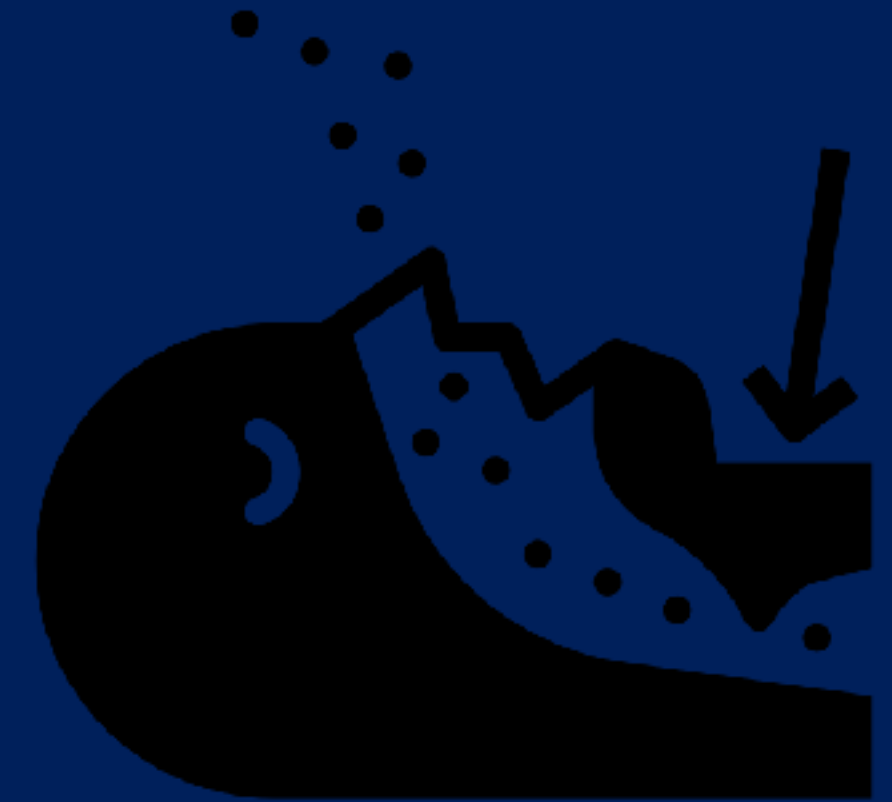
- **Polysomnography** (5-8 points STOP-Bang or 2 points with male or BMI>35)

- **Untreated** : OSA ↑ postop desaturation, reintubation, respiratory failure and ICU transfer

• Severe OSA :

- **CPAP** 3 months preoperatively
- **USI** if OSA suspected and untreated

- **Remind the patient to take his CPAP!** (Benefit not proven : Cochrane review 2014)



Kaw R, Chung F, Pasupuleti V, Mehta J, Gay PC, Hernandez AV. Meta-analysis of the association between obstructive sleep apnoea and postoperative outcome. *Br J Anaesth* 2012; 109: 897–906

Ireland CJ, Chapman TM, Mathew SF, Herbison GP, Zacharias M. Continuous positive airway pressure (CPAP) during the postoperative period for prevention of postoperative morbidity and mortality following major abdominal surgery. *Cochrane Database Syst Rev* 2014; 8: CD008930

Glossop AJ, Shephard N, Bryden DC, Mills GH. Non-invasive ventilation for weaning, avoiding reintubation after extubation and in the postoperative period: a meta-analysis. *Br J Anaesth* 2012; 109: 305–14

Preventing PPCs : The Role of Surgeon, **Pre-operative**

- **Don't Operate!** No surgery No PPC!

- Some surgeries can be **delayed** or **avoided** :

- **Patient related** :

- Recently infected, frailty, handicapped, cancer patients

- Discuss with the patient & family

- Patient NTBR

- **Surgery related** :

- Does benefit outweigh harm?

- Other non surgical option?



“Good surgeons know how to operate, better ones when to operate, and the best when not to operate.”

Preventing PPCs : The Role of Surgeon, **Pre-operative**

• **Don't Operate!**

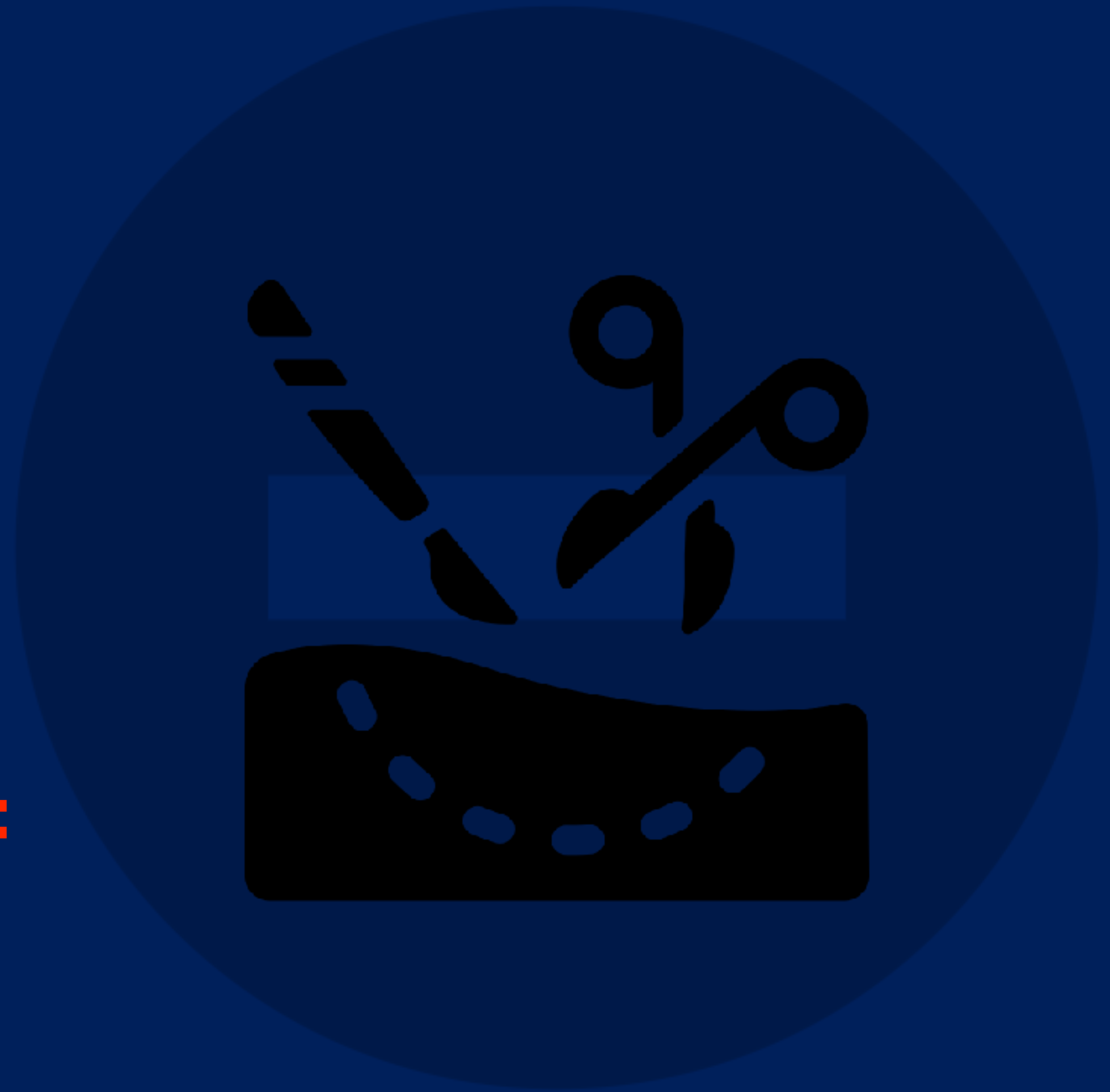
- **Medical** treatment :
 - **AB** : Diverticulitis, cholecystitis, appendicitis...
 - **Naso-gastric tube** : GI tract occlusion
 - **Corticoids** : GI tract occlusion in cancer patient
 - **Palliative treatment vs aggressive surgery**
- **Radiological** procedure :
 - **Drainage** (collections, cholecystitis...)
 - **Embolization** (GI tract, spleen, liver bleeding)
- **Endoscopic** procedure :
 - **Fistula** (stent, pigtail...)
 - **Cancer** (stent, laser,...)



“Good surgeons know how to operate, better ones when to operate, and the best when not to operate.”

Preventing PPCs : The Role of Surgeon, **Pre-operative**

- **Don't delay a mandatory procedure! :**
 - Increase operative time
 - Increase bleeding
- **If occlusion or Ileus :**
 - **Inform** the anesthesiologist (rapid sequence induction)
 - Pre-operative **naso-gastric tube** placement
- **Don't extend a procedure in high risk patient :**
 - Unilateral > bilateral hernia repair
 - Staples > running sutures
 - Ostomy > organ resection



Preventing PPCs : The Role of Surgeon, **Pre-operative**

- **Type of anesthesia :**

- RA > GA (lower risk of PPCs)

- RA : epidural anesthesia (Open groin hernia, sub-ombilical hernia, stomy closure, proctological procedure...) ↓ opioid consumption & PPCs

- Local anesthesia if possible (Implantation chamber, benign subcutaneous tumor...) **eventually with hypnosedation** (Thyroidectomy)



Canet J, Gallart L, Gomar C, et al. Prediction of postoperative pulmonary complications in a population-based surgical cohort. *Anesthesiology* 2010; 113: 1338–50

Arozullah AM, Khuri SF, Henderson WG, Daley J. Development and validation of a multifactorial risk index for predicting postoperative pneumonia after major noncardiac surgery. *Ann Intern Med* 2001; 135: 847–57

Guay J, Choi P, Suresh S, Albert N, Kopp S, Pace NL. Neuraxial blockade for the prevention of postoperative mortality and major morbidity: an overview of Cochrane systematic reviews. *Cochrane Database Syst Rev* 2014; 1: CD010108

Preventing PPCs : The Role of Surgeon, **Pre-operative**

• **Day of Surgery :**

- Limit **fasting** (regular diet 6h and clear liquids 2h before surgery)
- Allow **carbohydrate drink** (Maltodextrin 250ml) **2hours** before surgery (↓ PONV, ↑well being, could ↓ complications)
- No or limited anesthesia **pre-medication** (postoperative effect)
- Insert **IV line** in patient room (reduce stress and time spent in cold environment)
- Have the patient come **on foot** in the theater



CHC Montlegia : admission zone

Preventing PPCs : The Role of Surgeon, **when?**

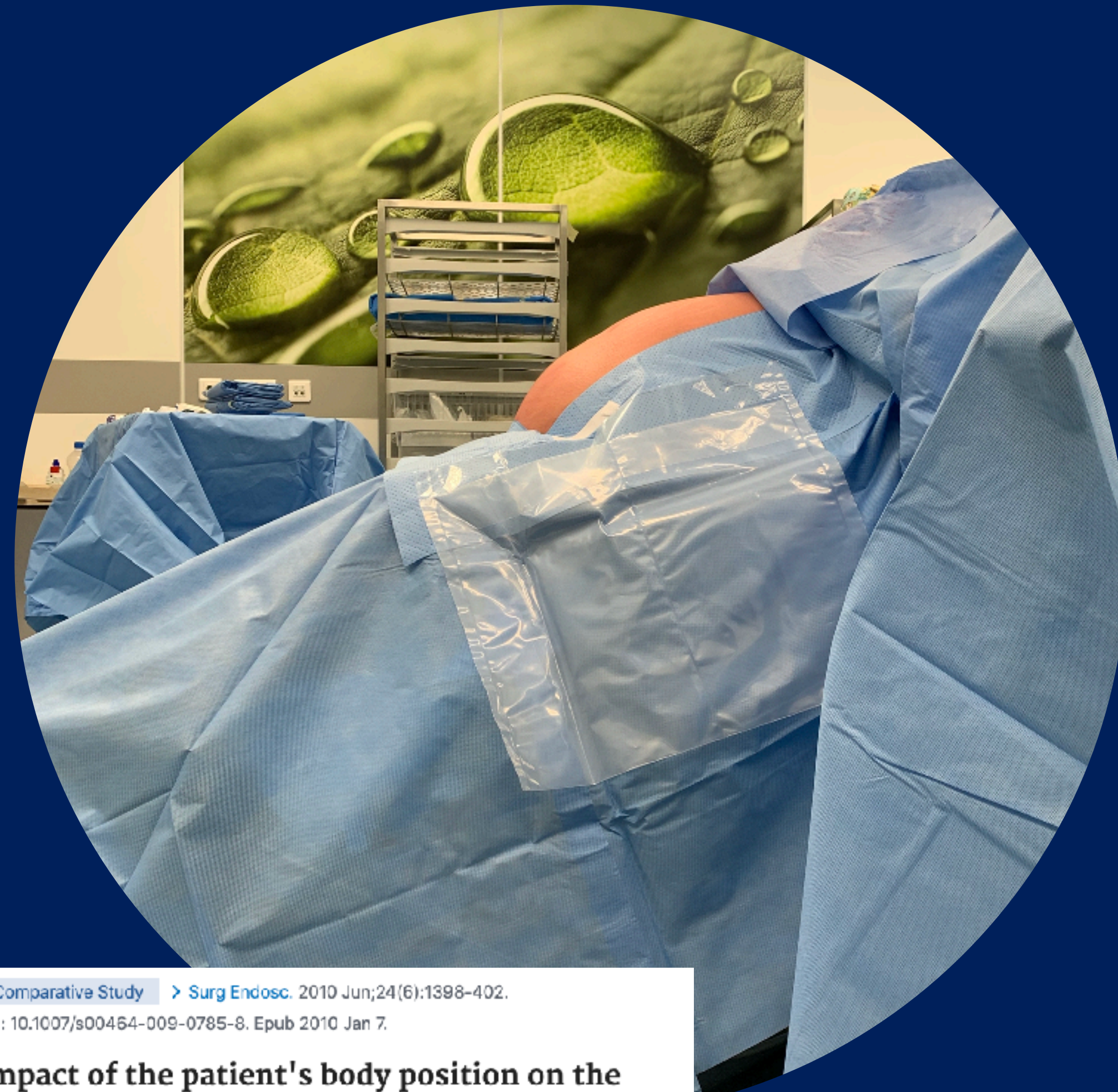
- **Per**-operative



Preventing PPCs : The Role of Surgeon, **Per-operative**

• **Operating Table Position :**

- Surgeon should **position** the patient himself before anesthesia (↓operative time)
- **Reverse Trendelenbourg (20°)**
 - For upper abdominal surgery
 - Flexing at the hips increases workspace (beach chair position)
 - Less risk of PPCs
- **Trendelenbourg (20°)**
 - For lower abdominal surgery
 - Higher risk of PPCs (limit time in position)



Comparative Study > [Surg Endosc.](#) 2010 Jun;24(6):1398-402.
doi: 10.1007/s00464-009-0785-8. Epub 2010 Jan 7.

Impact of the patient's body position on the intraabdominal workspace during laparoscopic surgery

Jan Paul J Mulier¹, Bruno Dillemans, Sebastiaan Van Cauwenberge

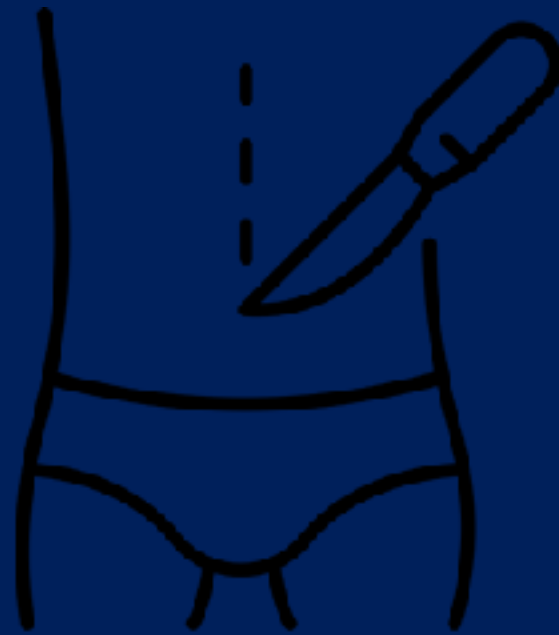
Preventing PPCs : The Role of Surgeon, **Per-operative**

• **Surgical Site & PPCs**

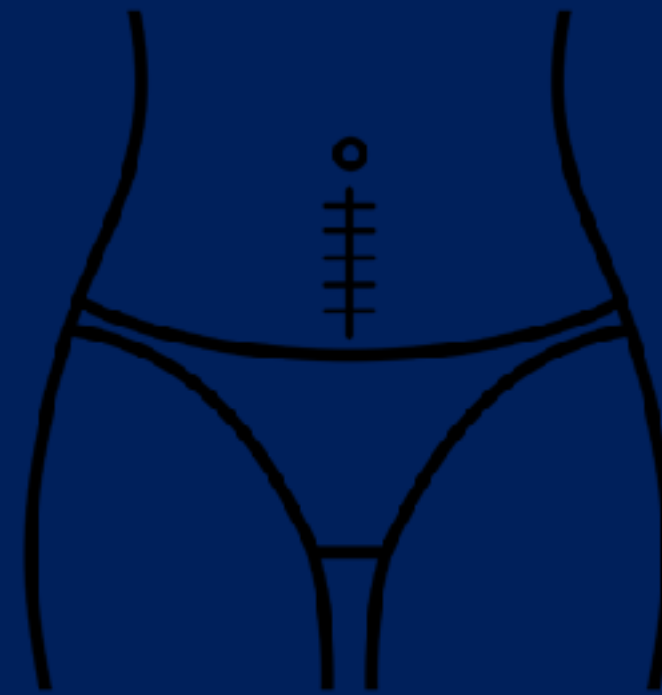
- Peripheral > Upper abdominal > Lower abdominal > Thoracic
- Know it, live with it...



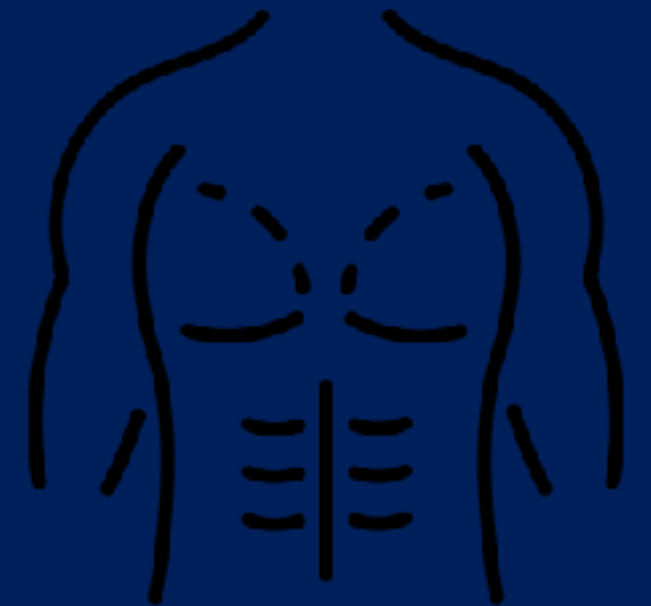
Created by Elicolyp
from Noun Project



Created by Andre Yushchenko
from Noun Project



Created by Olena Panasovska
from Noun Project



Created by Andrei Yushchenko
from Noun Project

Preventing PPCs : The Role of Surgeon, **Per-operative**

• **Skin & muscles incisions :**

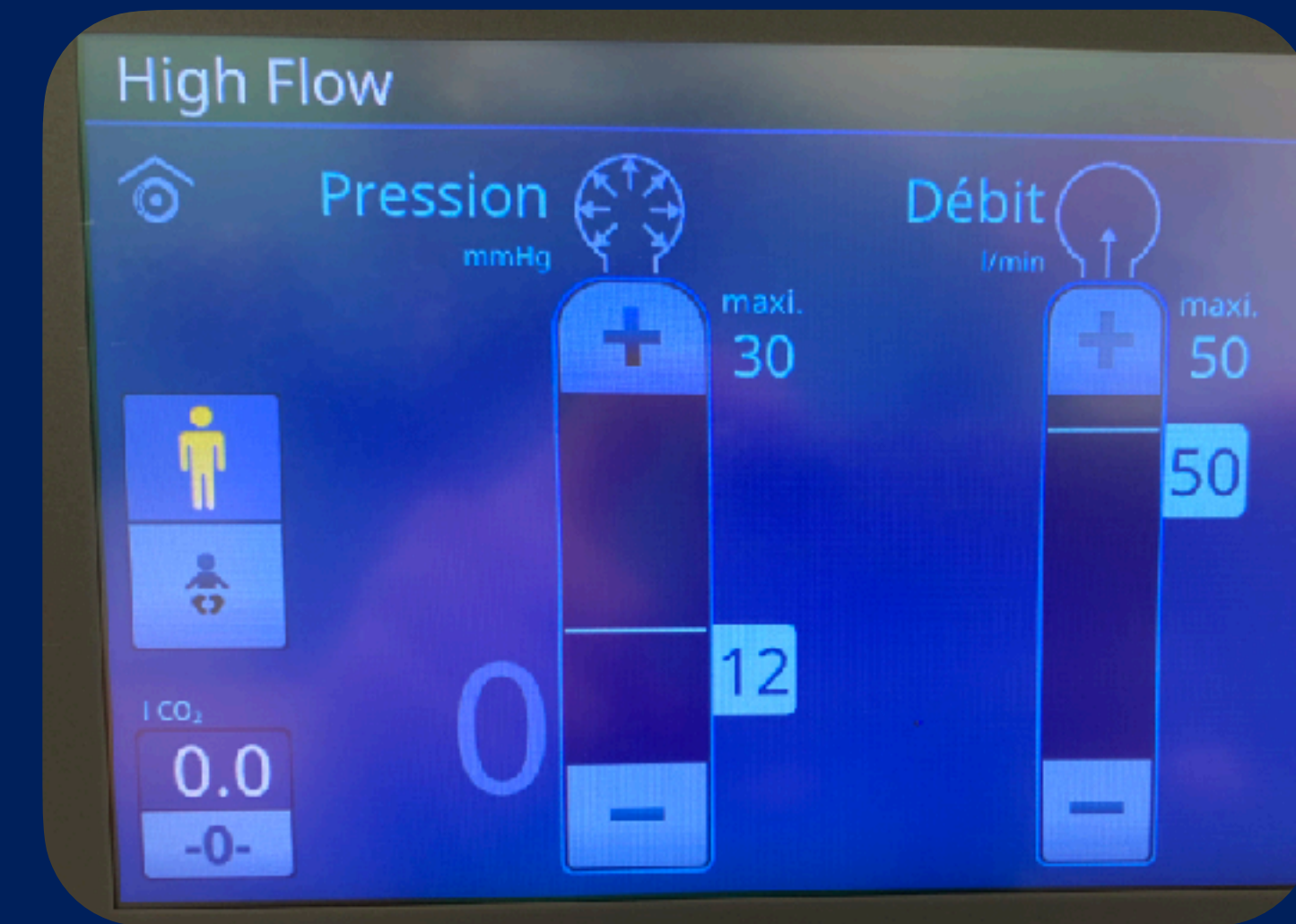
- **Laparoscopy** (thoracoscopy) >>> laparotomy (thoracotomy)
- **Smaller incisions** = great surgeon!
- **Preserve** abdominal muscle (bladeless & small trocars, retracting vs cutting muscles, use previous incision...)
- **Preserve** thoracic muscles and chest ribs
- **Tension free** closure of abdomen
- **Infiltrate** trocars sites (Tap Block : anesthesiologist)



Preventing PPCs : The Role of Surgeon, **Per-operative**

• **Pneumoperitoneum :**

- **Avoid high pressure!** (↓cardiac function, ↓ventilation, ↓renal blood flow)
- Good working space $I_{AV} \gg I_{AP}$:
 - **Lowest IAP** to obtain **initial IAV of 3l CO₂**
 - Depends on abdominal compliance (C_{ab})
 - Deep neuromuscular blockade (NMB) mandatory reversal with Sugammadex
- Ask Dr Mulier...



Review > Anaesthesiol Intensive Ther. Nov-Dec 2014;46(5):392-405.
doi: 10.5603/AIT.2014.0062.

The role of abdominal compliance, the neglected parameter in critically ill patients - a consensus review of 16. Part 1: definitions and pathophysiology

Manu L N G Malbrain¹, Derek J Roberts, Inneke De Laet, Jan J De Waele, Michael Sugrue, Alexander Schachtrupp, Juan Duchesne, Gabrielle Van Ramshorst, Bart De Keulenaer, Andrew W Kirkpatrick, Slavash Ahmadi-Noorbakhsh, Jan Mulier, Rao Ivatury, Francisco Pracca, Robert Wise, Paolo Pelosi

Review > Anaesthesiol Intensive Ther. Nov-Dec 2014;46(5):406-32.
doi: 10.5603/AIT.2014.0063.

The role of abdominal compliance, the neglected parameter in critically ill patients - a consensus review of 16. Part 2: measurement techniques and management recommendations

Manu L N G Malbrain¹, Inneke De Laet, Jan J De Waele, Michael Sugrue, Alexander Schachtrupp, Juan Duchesne, Gabrielle Van Ramshorst, Bart De Keulenaer, Andrew W Kirkpatrick, Slavash Ahmadi-Noorbakhsh, Jan Mulier, Paolo Pelosi, Rao Ivatury, Francisco Pracca, Marcelo David, Derek J Roberts

Preventing PPCs : The Role of Surgeon, **Per-operative**

• **Hemostasis :**

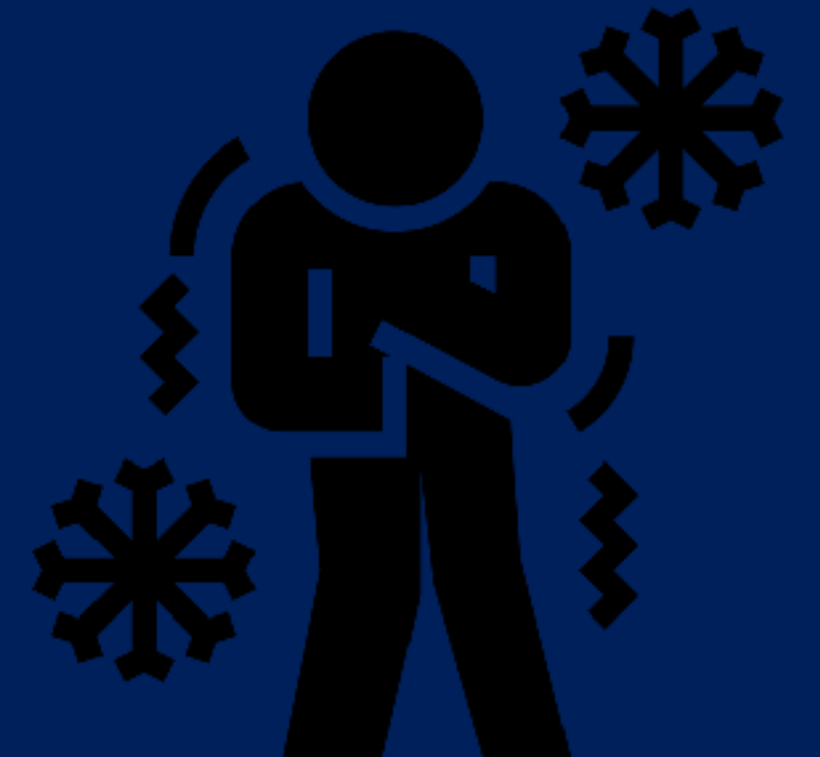
- **Avoid** peri-operative **transfusion :**
 - Careful dissection
 - Cell saver, clips, ultrasonic device, bipolar,

• **Normothermia :**

- Hypothermia ↑ blood loss, ↑ infection, ↑ LOS
- **Heated** blankets, IV fluid, anesthetic gases and CO₂



Created by priyanka
from Noun Project



Created by Becris
from Noun Project

Preventing PPCs : The Role of Surgeon, **Per-operative**

• **Drains and Tubes :**

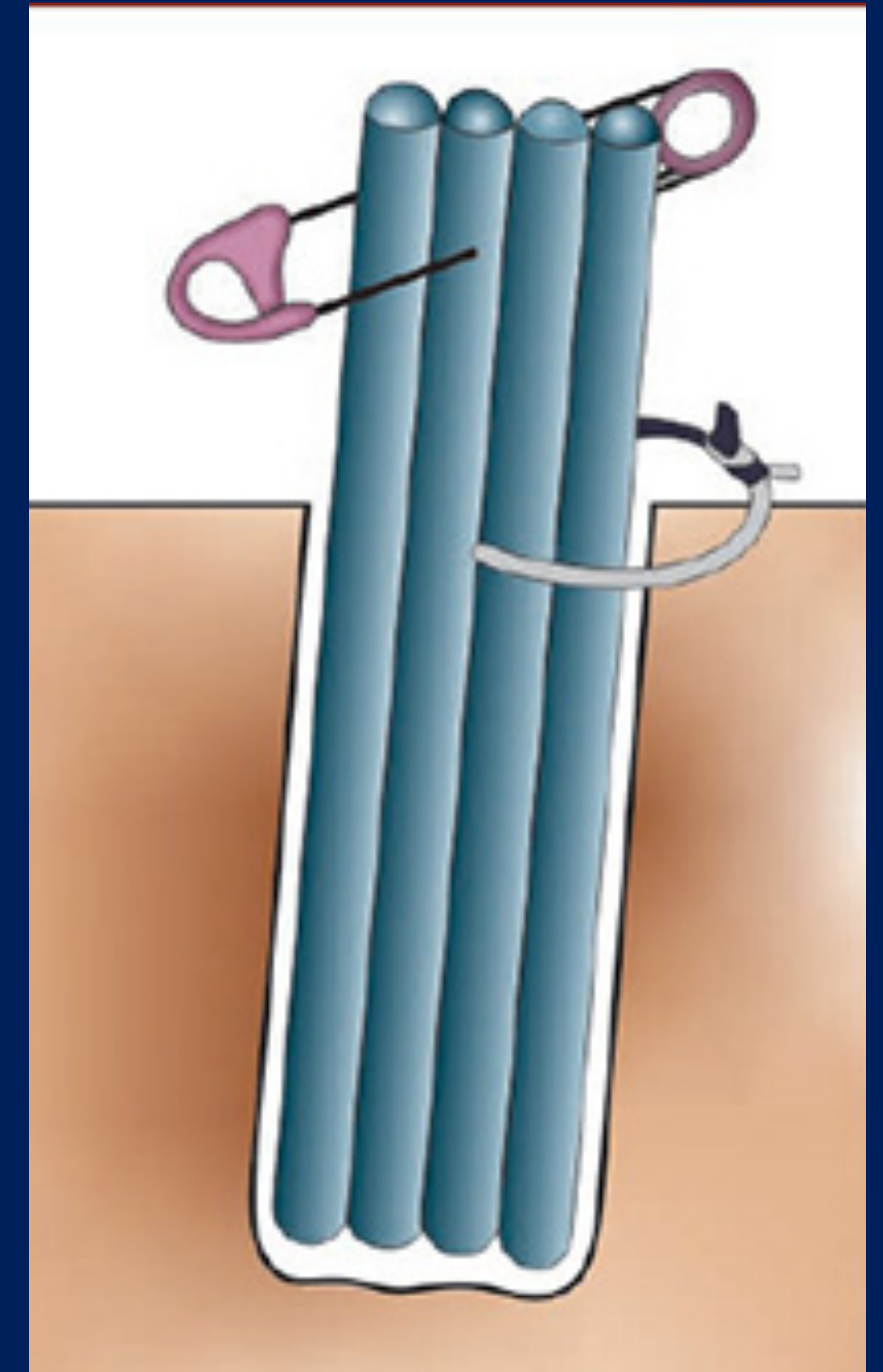
• **Drains :**

- ↑ Pain, ↓ early mobilisation, infection ports
- Do not use or remove ASAP

• **Nasogastric tube :**

- Ineffective coughing, retention of secretions
- ↑ atelectasis & aspiration pneumonia
- ↑ Risk of PPCs x5-8
- No use in routine after elective or emergency abdominal surgery

- Use selective nasogastric decompression (nausea, abdominal distension, oral intake impossible) & remove ASAP



Nelson R, Edwards S, Tse B. Prophylactic nasogastric decompression after abdominal surgery. Cochrane Database Syst Rev 2004; 3: CD004929

Rao MK, Reilley TE, Schuller DE, Young DC. Analysis of risk factors for postoperative pulmonary complications in head and neck surgery. Laryngoscope 1992; 102: 45-7

McAlister FA, Bertsch K, Man J, Bradley J, Jacka M. Incidence of and risk factors for pulmonary complications after nonthoracic surgery. Am J Respir Crit Care Med 2005; 171: 514-7

Fisher BW, Majumdar SR, McAlister FA. Predicting pulmonary complications after nonthoracic surgery: a systematic review of blinded studies. Am J Med 2002; 112: 219-25

Smith PR, Baig MA, Brito V, Bader F, Bergman MI, Alfonso A. Postoperative pulmonary complications after laparotomy. Respiration 2010; 80: 269-74

Preventing PPCs : The Role of Surgeon, **Per-operative**

The logo consists of the words 'BE' and 'FAST' in a bold, italicized, sans-serif font. 'BE' is positioned above 'FAST'. The letters are white with a slight shadow effect, giving them a three-dimensional appearance. The background is dark blue.

- Operation time ↑ PPCs (>3hrs)
- Surgeon present at induction
- Procedure correctly planned (check list, SPI, communication with the team...)
- Surgeon experienced with the procedure (get help from colleague if necessary or during learning curve)
- Surgical instrument sets ready
- Plan ahead possible adverse events (check list, extra material or colleague...)

McAlister FA, Bertsch K, Man J, Bradley J, Jacka M. Incidence of and risk factors for pulmonary complications after nonthoracic surgery. *Am J Respir Crit Care Med* 2005; 171: 514-7

Canet J, Gallart L, Gomar C, et al. Prediction of postoperative pulmonary complications in a population-based surgical cohort. *Anesthesiology* 2010; 113: 1338-50

• **Be there, be prepared, be precise and then be FAST!!**

Preventing PPCs : The Role of Surgeon, **when?**

- **Post**-operative



Preventing PPCs : The Role of Surgeon, **Post-operative**

- **Follow ERAS protocol :**
 - **O2** supplementation if needed
 - **Early mobilization**
 - **Early oral intake**
 - **Early removal of drains & tubes** if present
 - **Prevent nausea & vomiting** (inhalation risk)
 - **Multimodal analgesia** (avoid opioids)

World J Surg

. 2019 Mar;43(3):659-695. doi: 10.1007/s00268-018-4844-y.

Guidelines for Perioperative Care in Elective Colorectal Surgery: Enhanced Recovery After Surgery (ERAS ®) Society Recommendations: 2018

U O Gustafsson 1, M J Scott 2 3, M Hubner 4, J Nygren 5, N Demartines 4, N Francis 6 7, T A Rockall 8, T M Young-Fadok 9, A G Hill 10, M Soop 11, H D de Boer 12, R D Urman 13, G J Chang 14, A Fichera 15, H Kessler 16, F Grass 4, E E Whang 17, W J Fawcett 18, F Carli 19, D N Lobo 20, K E Rollins 20, A Balfour 21, G Baldini 19, B Riedel 22, O Ljungqvist 23

Preventing PPCs : The Role of Surgeon, **Post-operative**

• **Lung expansion modalities :**

• **I COUGH :** (↑ lung expansive forces, ↓ atelectasis)

- **I**ncentive spirometry (10 times/h, alone not sufficient)
- **C**oughing & Deep breathing (every 2h)
- **O**ral hygiene (teeth brushing/mouthwash 2x/day, before & after surgery)
- **U**nderstanding / Education
- **G**etting out of bed (mobilization 3 times at least/day)
- **H**ead of bed elevation (30°-45°)
- **Short term Cpap :** useful if inability to perform incentive spirometry or deep breathing exercise



I **INCENTIVE SPIROMETER EXERCISES**
Deep breathing exercises will help keep your lungs healthy.
• Place the mouthpiece in your mouth and seal your lips around it.
• Breathe in (inhale) slowly and deeply.
• Remove the mouthpiece from your mouth and breathe out.
This breathing exercise needs to be done 10 times each hour while awake.

U **UNDERSTAND ICOUGH PRACTICES**
It is important for you and your family to take an active part in your recovery from surgery.
We want your pain to be controlled to help you take deep breaths and cough, do breathing exercises, and make sure that you get out of bed, sit in a chair, and walk.

C **COUGH AND BREATHE DEEPLY**
After surgery, taking deep breaths and coughing will help to clear your lungs.
This helps the lungs do the vital job of delivering oxygen to the tissues in your body.

G **GET OUT OF BED AND WALK THE HALLWAY**
Getting out of bed and walking at least three times per day will help your recovery after surgery and help prevent complications.
Walking will help clear secretions from your lungs and improve your circulation so that you may regain your strength.

O **ORAL CARE**
In addition to brushing your teeth, use mouthwash twice daily to keep your mouth clean from germs.
You should brush your teeth and use mouthwash several days before your surgery and then continue after you are discharged from the hospital.

H **HEAD OF BED ELEVATION**
It is important to keep the head of your bed elevated 30-45 degrees. Being in an upright position after surgery will help your breathing.

Cassidy MR, Rosenkranz P, McCabe K, Rosen JE, McAneny D. I COUGH: reducing postoperative pulmonary complications with a multidisciplinary patient care program. JAMA Surg 2013; 148: 740-5

do Nascimento Junior P, Modolo NS, Andrade S, Guimarães MM, Braz LG, El Dib R. Incentive spirometry for prevention of postoperative pulmonary complications in upper abdominal surgery. Cochrane Database Syst Rev 2014; 2: CD006058

Preventing PPCs : The Role of Surgeon

Thank You!

References

- Jammer I, Wickboldt N, Sander M, et al. Standards for definitions and use of outcome measures for clinical effectiveness research in perioperative medicine: European Perioperative Clinical Outcome (EPCO) definitions: a statement from the ESA-ESICM joint taskforce on perioperative outcome measures. *Eur J Anaesthesiology* 2015; 32: 88–105
- Warner D, Weiskopf R. Preventing Postoperative Pulmonary Complications: The Role of the Anesthesiologist. *Anesthesiology* May 2000; Vol. 92, 1467–1472.
- Canet J, Gallart L, Gomar C, et al. Prediction of postoperative pulmonary complications in a population-based surgical cohort. *Anesthesiology* 2010; 113: 1338–50
- Robinson TN, Wu DS, Pointer L, et al. Simple frailty score predicts postoperative complications across surgical specialties. *Am J Surg* 2013; 206: 544–50
- Arozullah AM, Khuri SF, Henderson WG, Daley J. Development and validation of a multifactorial risk index for predicting postoperative pneumonia after major noncardiac surgery. *Ann Intern Med* 2001; 135: 847–57
- Smith PR, Baig MA, Brito V, Bader F, Bergman MI, Alfonso A. Postoperative pulmonary complications after laparotomy. *Respiration* 2010; 80: 269–74
- Yang CK, Teng A, Lee DY, Rose K. Pulmonary complications after major abdominal surgery: national surgical quality improvement program analysis. *J Surg Res* 2015; 198: 441–9
- Lee CZ, Kao LT, Lin HC, Wei PL. Comparison of clinical outcome between laparoscopic and open right hemicolectomy: a nationwide study. *World J Surg Oncol* 2015; 13: 250
- Bablekos GD, Michaelides SA, Analitis A, Charalabopoulos KA. Effects of laparoscopic cholecystectomy on lung function: a systematic review. *World J Gastroenterol* 2014; 20: 17603–17
- Jiang L, Yang KH, Guan QL, et al. Laparoscopy-assisted gastrectomy versus open gastrectomy for resectable gastric cancer: an update meta-analysis based on randomised controlled trials. *Surg Endosc* 2013; 27: 2466–80
- Johnson RG, Arozullah AM, Neumayer L, Henderson WG, Hosokawa P, Khuri SF. Multivariable predictors of postoperative respiratory failure after general and vascular surgery: results from the patient safety in surgery study. *J Am Coll Surg* 2007; 204: 1188–98
- Antoniou SA, Antoniou GA, Koch OO, Koehler G, Pointner R, Granderath FA. Laparoscopic versus open obesity surgery: a meta-analysis of pulmonary complications. *Dig Surg* 2015; 32: 98–107
- Mazo V, Sabate S, Canet J, et al. Prospective external validation of a predictive score for postoperative pulmonary complications. *Anesthesiology* 2014; 121: 219–31
- Gupta H, Gupta PK, Schuller D, et al. Development and validation of a risk calculator for predicting postoperative pneumonia. *Mayo Clin Proc* 2013; 88: 1241–9

References

- Brueckmann B, Villa-Urbe JL, Bateman BT, et al. Development and validation of a score for prediction of postoperative respiratory complications. *Anesthesiology* 2013; 118: 1276–85
- Canet J, Sabate´ S, Mazo V, et al. Development and validation of a score to predict postoperative respiratory failure in a multicentre European cohort. A prospective, observational study. *Eur J Anaesthesiol* 2015; 32: 458–70
- Jie B, Jiang ZM, Nolan MT et al (2012) Impact of preoperative nutritional support on clinical outcome in abdominal surgical patients at nutritional risk. *Nutrition* 28:1022–1027
- Baron DM, Hochrieser H, Posch M, et al. Preoperative anaemia is associated with poor clinical outcome in noncardiac surgery patients. *Br J Anaesth* 2014; 113: 416–23
- Fleisher LE, Linde-Zwirble WT. Incidence, outcome, and attributable resource use associated with pulmonary and cardiac complications after major small and large bowel procedures. *Perioper Med* 2014; 3: 7
- Unger EF, Thompson AM, Blank MJ, Temple R. Erythropoiesis-stimulating agents — time for a reevaluation. *N Engl J Med* 2010; 362: 189–92
- Fisher BW, Majumdar SR, McAlister FA. Predicting pulmonary complications after nonthoracic surgery: a systematic review of blinded studies. *Am J Med* 2002; 112: 219–25
- McAlister FA, Bertsch K, Man J, Bradley J, Jacka M. Incidence of and risk factors for pulmonary complications after nonthoracic surgery. *Am J Respir Crit Care Med* 2005; 171: 514–7 Routine preoperative tests for elective surgery. NICE guidelines [NG45] April 2016. Available from <https://www.nice.org.uk/guidance/ng45> (accessed 27 January 2017)
- Valkenet K, van de Port IG, Dronkers JJ, de Vries WR, Lindeman E. The effects of preoperative exercise therapy on postoperative outcome: a systematic review. *Clin Rehabil* 2011; 25: 99–111
- Katsura M, Kuriyama A, Takeshima T, Fukuhara S, Furukawa TA. Preoperative inspiratory muscle training for postoperative pulmonary complications in adults undergoing cardiac and major abdominal surgery. *Cochrane Database Syst Rev* 2015; 10: CD010356
- Mills E, Eyawo O, Lockhart I, Kelly S, Wu P, Ebbert JO. Smoking cessation reduces postoperative complications: a systematic review and meta-analysis. *Am J Med* 2011; 124: 144–54
- Wong J, Lam DP, Abrishami A, Chan MTV, Chung F. Shortterm preoperative smoking cessation and postoperative complications: a systematic review and meta-analysis. *Can J Anaesth* 2012; 59: 268–79
- Schmid M, Sood A, Campbell L, et al. Impact of smoking on perioperative outcomes after major surgery. *Am J Surg* 2015; 210: 221–9

References

- Smoking cessation in secondary care: acute, maternity and mental health services (NICE public health guidance 48). November 2013. Available from <http://www.nice.org.uk/guidance/ph48> (accessed 27 January 2017)
- Sameh Harry Emile et al. Identifying Patients at High Risk of Having Pulmonary Dysfunction Before Laparoscopic Bariatric Surgery and Its Impact on Postoperative Pulmonary Complications. *J Laparoendosc Adv Surg Tech A* 2019 Nov; 29(11):1456-1461. doi: 10.1089/lap.2019.0459. Epub 2019 Sep 19.
- Kaw R, Chung F, Pasupuleti V, Mehta J, Gay PC, Hernandez AV. Meta-analysis of the association between obstructive sleep apnoea and postoperative outcome. *Br J Anaesth* 2012; 109: 897–906
- Ireland CJ, Chapman TM, Mathew SF, Herbison GP, Zacharias M. Continuous positive airway pressure (CPAP) during the postoperative period for prevention of postoperative morbidity and mortality following major abdominal surgery. *Cochrane Database Syst Rev* 2014; 8: CD008930
- Glossop AJ, Shephard N, Bryden DC, Mills GH. Non-invasive ventilation for weaning, avoiding reintubation after extubation and in the postoperative period: a meta-analysis. *Br J Anaesth* 2012; 109: 305–14
- Guay J, Choi P, Suresh S, Albert N, Kopp S, Pace NL. Neuraxial blockade for the prevention of postoperative mortality and major morbidity: an overview of Cochrane systematic reviews. *Cochrane Database Syst Rev* 2014; 1: CD010108
- Mulier J. et al. Impact of the patient's body position on the intraabdominal workspace during laparoscopic surgery. *Surg Endosc.* 2010 Jun; 24(6):1398-402. doi: 10.1007/s00464-009-0785-8
- Malbrain M. et al. The role of abdominal compliance, the neglected parameter in critically ill patients - A consensus review of 16. Part 1: Definitions and pathophysiology. *Anaesthesiol Intensive Ther.* Nov-Dec 2014;46(5):392-405. doi: 10.5603/AIT.2014.0062
- Malbrain M. et al. The role of abdominal compliance, the neglected parameter in critically ill patients - a consensus review of 16. Part 2: measurement techniques and management recommendations. *Anaesthesiol Intensive Ther.* Nov-Dec 2014;46(5):406-32. doi: 10.5603/AIT.2014.0063
- Guptha S. et al. . Perioperative risk factors for pulmonary complications after non-cardiac surgery. *J Anaesthesiol Clin Pharmacol.* 2020 Jan-Mar; 36(1): 88–93. Published online 2020 Feb 18. doi: 10.4103/joacp.JOACP_54_19
- Nelson R, Edwards S, Tse B. Prophylactic nasogastric decompression after abdominal surgery. *Cochrane Database Syst Rev* 2004; 3: CD004929
- Rao MK, Reilley TE, Schuller DE, Young DC. Analysis of risk factors for postoperative pulmonary complications in head and neck surgery. *Laryngoscope* 1992; 102: 45–7
- Gustafsson U et al. Guidelines for Perioperative Care in Elective Colorectal Surgery: Enhanced Recovery After Surgery (ERAS[®]) Society Recommendations: 2018 *World J Surg.* 2019 Mar;43(3):659-695. doi: 10.1007/s00268-018-4844-y.
- Cassidy MR, Rosenkranz P, McCabe K, Rosen JE, McAneny D. I COUGH: reducing postoperative pulmonary complications with a multidisciplinary patient care program. *JAMA Surg* 2013; 148: 740–5
- do Nascimento Junior P, Modolo NS, Andrade S, Guimarães MM, Braz LG, El Dib R. Incentive spirometry for prevention of postoperative pulmonary complications in upper abdominal surgery. *Cochrane Database Syst Rev* 2014; 2: CD006058