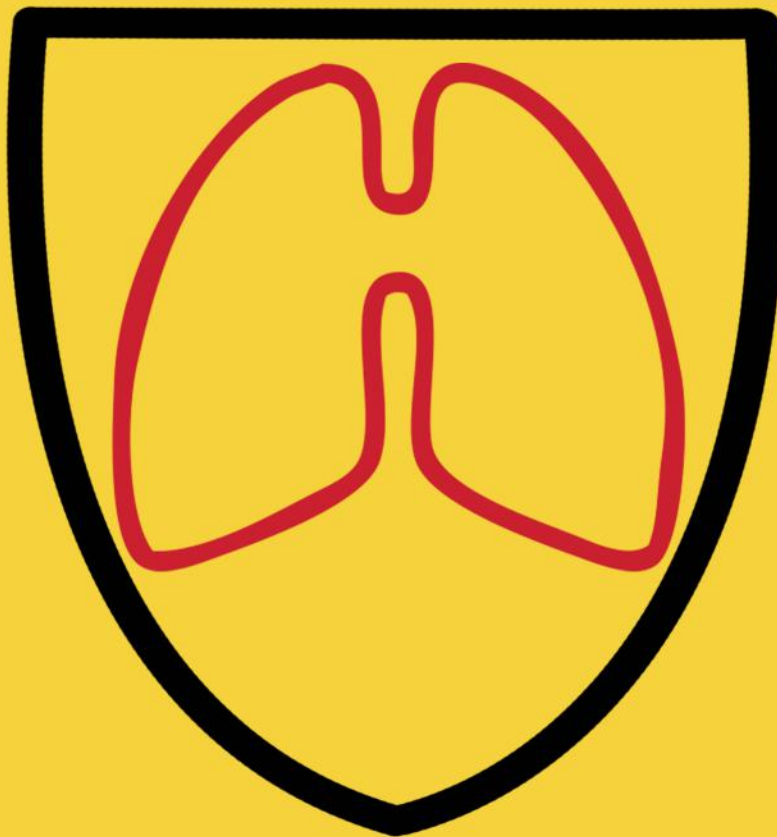


# THORACIC CRISIS MANUAL

From The Canadian Thoracic Taskforce



Hypoxemia During OLV	1
Massive Hemorrhage	2
Mediastinal Mass	3
Tracheobronchial Disruption	4
Massive Hemoptysis	5
Esophageal Disruption	6
Cardiac Herniation	7
Acronyms	8



Thoracic Crisis Manual © 2021 by Canadian Thoracic Taskforce is licensed under CC BY-NC-SA 4.0. To view a copy of this license, visit <http://creativecommons.org/licenses/by-nc-sa/4.0/>



UNIVERSITY OF  
CALGARY



v1.0

# 1 Hypoxemia During One-Lung Ventilation

$SpO_2 < 90\%$  or  $PaO_2 < 60$  mmHg despite 100%  $FiO_2$

## START

- ① Increase to 100%  $FiO_2$
- ② Confirm position of lung isolation device
- ③ Recruit the ventilated lung
- ④ Optimize PEEP to the ventilated lung
- ⑤ Suction secretions from ventilated lung
- ⑥ Consider bronchodilator therapy to ventilated lung
- ⑦ Decrease volatile anesthetic or consider TIVA
- ⑧ Ensure normal cardiac output
- ⑨ Ensure adequate hemoglobin level
- ⑩ Notify surgeon of severe or refractory hypoxemia:
  - ▶ Call for help
  - ▶  $O_2$  insufflation/CPAP/HFJV to nonventilated lung
  - ▶ Resume two-lung ventilation
  - ▶ Consider pulmonary artery clamp to nonventilated lung
  - ▶ Consider inhaled nitric oxide (10-40 ppm)
  - ▶ Consider ECMO/CPB

## RISK FACTORS

Right-sided surgery  
Prior contralateral lung resection  
Supine position  
Normal  $FEV_1$   
Low  $PaO_2$  on two-lung ventilation  
High A-a gradient for  $CO_2$

## OXYGENATION TECHNIQUES

$V_T$  4-6 ml/kg IBW  
I:E ratio 1:2 (routine)

- ◆ 1:1-1:2 (restrictive deficit)
- ◆ 1:4-1:6 (obstructive deficit)

Ventilated Lung:

- ◆ Recruitment maneuver
- ◆ PEEP 3-10 cm  $H_2O$

Nonventilated Lung:

- ◆ CPAP 5-10 cm  $H_2O$
- ◆  $O_2$  insufflation 2-3 L/min

HFJV: 100-200 RR, DP 15-30 psi, I:E 1:1-1:2

## HYPOXEMIA & RIGID BRONCHOSCOPY

- ▶ Manual ventilation via bronchoscope
- ▶ Reposition bronchoscope above carina
- ▶ Suction secretions
- ▶ Retrieve tumor fragments
- ▶ Achieve pulmonary hemostasis
- ▶ Consider and manage pneumothorax

# 2 Massive Hemorrhage During Thoracic Surgery

Significant intraoperative bleeding with various definitions (e.g., > 150 ml/min, hemodynamic instability)

## START

- ① Call for help
- ② Call for blood
- ③ Consider code cart in room
- ④ Increase to 100% FiO<sub>2</sub>
- ⑤ Paralyze patient to decrease venous air embolism risk
- ⑥ Treat hypovolemic shock:
  - ▶ Ask surgeon for manual compression of bleeding site
  - ▶ Temporize with IV fluid boluses and vasoactive drugs
  - ▶ Secure large-bore IV access
  - ▶ Secure arterial access
  - ▶ Obtain a rapid transfusion device
  - ▶ Transfuse blood products, as indicated
  - ▶ Consider cell salvage early
  - ▶ Place Foley catheter, when able
- ⑦ Consider ECMO/CPB to facilitate surgical repair
- ⑧ Anticipate potential need for postoperative ICU care:
  - ▶ Beware RV dysfunction with unplanned lung resection
  - ▶ Exchange DLT to SLT, if able

## VATS

- ▶ Secure lower limb IV access for SVC or brachiocephalic vein disruption
- ▶ Anticipate conversion to thoracotomy

## MEDIASTINOSCOPY

- ▶ Secure lower limb IV access
- ▶ Anticipate conversion to thoracotomy or sternotomy; may require lateral decubitus repositioning
- ▶ Achieve lung isolation if required for surgical approach

# 3 Mediastinal Mass

Tumor with potential to cause fatal cardiorespiratory collapse

## START

- ① Assess for high-risk features
  - ▶ Routine IV induction safe for low-risk mass
- ② Consider preoperative mass-reducing treatment
- ③ Local or regional anesthesia, if able
- ④ Stepwise induction for high-risk mass:
  - ▶ Consider preoperative ECMO/CPB cannulation
  - ▶ Semi-Fowler's position
  - ▶ Secure large-bore lower limb IV access
  - ▶ Secure arterial access
  - ▶ Consider IV fluid bolus
  - ▶ Prepare in-line vasoactive drugs
  - ▶ Spontaneous breathing induction (awake/asleep)
  - ▶ Intubate beyond region of airway compression
  - ▶ Trial supination after intubation
  - ▶ Trial PPV after supination
  - ▶ Trial paralytic after PPV

## HIGH-RISK FEATURES

Supine dyspnea  
Supine cough  
Syncope  
SVC syndrome  
Pericardial effusion  
> 50% tracheal compression (pediatric)

## CARDIORESPIRATORY COLLAPSE

- ▶ Call for help
- ▶ Call for code cart
- ▶ Revert to prior stage of stepwise induction
- ▶ Increase to 100% FiO<sub>2</sub>
- ▶ Temporize with IV fluid boluses and vasoactive drugs
- ▶ Perform rescue position maneuver
- ▶ Consider rigid bronchoscopy
- ▶ Prepare for emergent sternotomy or thoracotomy
- ▶ Initiate ECMO/CPB

# 4 Tracheobronchial Disruption

Pathologic communication between the airway and either the pleural space, mediastinum, or esophagus

## START

- ① Determine fistula size and location (e.g., CT, FOB)
- ② Secure large-bore IV access
- ③ Secure arterial access
- ④ If septic, manage with IV fluids and vasoactive drugs
- ⑤ Perform thorough preoxygenation
- ⑥ Avoid PPV prior to fistula exclusion:
  - ▶ Awake FOB intubation, or
  - ▶ Asleep spontaneously breathing FOB intubation, or
  - ▶ RSI with FOB and immediate fistula exclusion.
  - ▶ Achieve OLV if required for fistula exclusion or surgical approach
  - ▶ Consider HFJV or ECMO if ventilation fails
- ⑦ Suction pulmonary contents (e.g., secretions, aspirate)
- ⑧ Anticipate potential need for crossfield ventilation
- ⑨ Assess airway repair with FOB
- ⑩ Anticipate potential need for postoperative ICU care:
  - ▶ Exchange DLT to SLT, if able

## BRONCHOPLEURAL FISTULA

- ▶ Confirm functional thoracostomy tube preoperatively
- ▶ Achieve OLV:
  - ◆ Contralateral DLT,
  - ◆ Contralateral endobronchial SLT, or
  - ◆ Ipsilateral bronchial blocker.

## TRACHEOESOPHAGEAL FISTULA

- ▶ Confirm surgical approach (cervical, sternotomy, or right thoracotomy)
- ▶ Aspirate gastric tube, if present
- ▶ Achieve supracarinal TEF exclusion:
  - ◆ SLT, or
  - ◆ DLT.
- ▶ Achieve carinal TEF exclusion:
  - ◆ Unilateral endobronchial SLT, or
  - ◆ Bilateral endobronchial SLTs.
- ▶ Achieve subcarinal TEF exclusion:
  - ◆ Contralateral DLT,
  - ◆ Contralateral endobronchial SLT, or
  - ◆ Ipsilateral bronchial blocker.

# 5 Massive Hemoptysis

Expectoration of significant pulmonary blood with various definitions (e.g., causing respiratory distress, > 100 ml/hr, > 1,000 ml/day)

## START

- ① Call for help
- ② Apply supplemental oxygen
- ③ Secure large-bore IV access
- ④ Secure arterial access
- ⑤ Determine the lesion location (e.g., history, CXR, CT, FOB)
- ⑥ Position patient lateral with bleeding lung down
- ⑦ Perform thorough preoxygenation
- ⑧ Achieve lung isolation:
  - ▶ Anticipate difficulty with FOB due to soiled airway
  - ▶ Suction pulmonary clot, as able
  - ▶ Ensure rigid bronchoscopy immediately available
- ⑨ After lung isolation confirmed, position patient lateral with bleeding lung up
- ⑩ Temporize with medical management of bleeding:
  - ▶ Consider tranexamic acid
  - ▶ Reverse coagulopathy
  - ▶ Transfuse blood products, as indicated
- ⑪ Facilitate definitive management (i.e., arterial embolization, bronchoscopic interventions, rarely emergent lung resection)
- ⑫ Anticipate potential need for postoperative ICU care

## DIFFERENTIAL DIAGNOSIS

Lung malignancy  
Bronchiectasis  
Pulmonary infection  
Vasculitis  
Arteriovenous malformation  
Pulmonary embolism  
Foreign body  
Tracheoinnominate artery fistula

## TRACHEOINNOMINATE ARTERY FISTULA

- ▶ Overinflate the tracheostomy cuff
- ▶ If fails: place oral ETT and digitally compress artery against sternum via stoma
- ▶ If fails: withdraw oral ETT slowly with overinflated cuff
- ▶ Facilitate definitive therapy with sternotomy or arterial embolization

# 6 Esophageal Disruption

Transmural disruption of the esophageal wall (cervical, thoracic, and/or abdominal level), e.g., esophageal perforation or rupture

## START

- ① Secure large-bore peripheral/central IV access
- ② Secure arterial access
- ③ Correct hypovolemia with IV fluid boluses
- ④ Prepare in-line vasoactive medications to maintain blood pressure
- ⑤ Perform thorough preoxygenation
- ⑥ Avoid PPV prior to intubation:
  - ▶ RSI without bag mask ventilation, or
  - ▶ Awake FOB intubation.
  - ▶ Beware difficult airway if subcutaneous emphysema present
  - ▶ Achieve OLV if required for surgical approach
- ⑦ Avoid esophageal instrumentation (e.g., gastric tube, temperature probe)
- ⑧ Anticipate potential need for postoperative ICU care:
  - ▶ Exchange DLT to SLT, if able

## COMPLICATIONS

Rapid desaturation  
Aspiration  
Sepsis  
Hemorrhage  
Arrhythmia

# 7 Cardiac Herniation

Herniation of the heart into the hemithorax, usually through an incomplete pericardial closure or disrupted pericardial patch

## START

- ① Call for help
- ② Call for code cart
- ③ Position patient lateral with surgical side up
- ④ Increase to 100% FiO<sub>2</sub>
- ⑤ Secure large-bore IV access
- ⑥ Secure arterial access
- ⑦ Temporize with IV fluid boluses and vasoactive drugs
- ⑧ Remove suction from thoracostomy tube
- ⑨ Minimize ventilatory airway pressures
- ⑩ Resume OLV to facilitate surgical reduction of heart
- ⑪ Consider transesophageal echocardiography
- ⑫ Anticipate potential need for postoperative ICU care:
  - ▶ Exchange DLT to SLT, if able

## RISK FACTORS

Intrapericardial pneumonectomy  
Pericardectomy  
Right-sided surgery  
Suction applied to thoracostomy tube  
Rapid lung re-expansion  
High ventilatory pressures  
Coughing on emergence  
Change in patient position  
Lateral decubitus with surgical side down

## OUT-OF-OR PRESENTATION

- ▶ Apply supplemental oxygen
- ▶ Inject up to 1 L of air into the operative hemithorax
- ▶ Prepare for rapid return to OR for thoracotomy/sternotomy
- ▶ Perform RSI in lateral position, if able
- ▶ Intubate with SLT
- ▶ Achieve lung isolation if required for surgical approach only once the heart has been surgically reduced and patient is stable



**DISCLAIMER:** This manual is designed to complement, not replace, clinical judgement. Any incorporation into clinical practice is entirely at the users' risk. The authors are neither liable for any result of incorporating this manual into clinical practice, nor any error or omission that may be present within the manual.

**CPAP** Continuous Positive Airway Pressure  
**CPB** Cardiopulmonary Bypass  
**CT** Computed Tomography  
**CXR** Chest X-Ray  
**DLT** Double Lumen Tube  
**DP** Driving Pressure  
**ECMO** Extracorporeal Membrane Oxygenation  
**ETT** Endotracheal Tube  
**FEV<sub>1</sub>** Forced Expiratory Volume in 1 Second  
**FiO<sub>2</sub>** Fraction of Inspired Oxygen  
**FOB** Fibreoptic Bronchoscopy  
**HFJV** High Frequency Jet Ventilation  
**I:E** Inspiratory:Expiratory  
**IBW** Ideal Body Weight

**ICU** Intensive Care Unit  
**IV** Intravenous  
**OLV** One Lung Ventilation  
**OR** Operating Room  
**PaO<sub>2</sub>** Partial Pressure of Arterial Oxygen  
**PEEP** Positive End Expiratory Pressure  
**PPV** Positive Pressure Ventilation  
**RSI** Rapid Sequence Induction  
**RV** Right Ventricle  
**SLT** Single Lumen Tube  
**SpO<sub>2</sub>** Oxygen Saturation  
**SVC** Superior Vena Cava  
**TIVA** Total Intravenous Anesthesia  
**V<sub>T</sub>** Tidal Volume

**About the Authors:** The Canadian Thoracic Taskforce was founded by Dr. Jayden Cowan and Dr. Julia Haber in 2020 to design and develop this manual.

**Acknowledgements:** Special thank you to Dr. Meredith Hutton, Dr. Alexander Hannenberg, Ariadne Labs, Stanford Anesthesia Cognitive Aid Group, and the SNACC Education Committee for inspiration, as well as to Ariadne Labs for the adapted use of their open-source design template.

**Download** a free, up-to-date copy with CC licencing, supplemental content, and references: [tinyurl.com/2hvu54xu](https://tinyurl.com/2hvu54xu)  
**Provide feedback:** [THORACICMANUAL@GMAIL.COM](mailto:THORACICMANUAL@GMAIL.COM)



**v1.0**