

## **C-52 Anesthetic Management of Severe Pulmonary Hypertension in Non-Cardiac Surgery**

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### **Objective**

After completion of this session, the participant will be able to:

- Implement an appropriate anesthetic management plan for a patient with severe pulmonary hypertension of different etiologies.

### **Case Stem Question**

A 67-year-old male with a past medical history significant for scleroderma and severe pulmonary arterial hypertension (WHO Group 1) presents for a left hip revision and antibiotic cement spacer placement due to recurrent prosthetic infection. His home medications included treprostinil 85 ng/kg/min subcutaneous infusion, riociguat 2.5 mg TID, and torsemide 20 mg BID.

TTE showed moderate dilatation of the right ventricle with moderately reduced systolic function, preserved left ventricular EF, and an estimated PASP of 80-90 mmHg. Right heart catheterization resulted in PAP 82/28, RVSP 85, RAP 5/6, CO 4.4 l/min, and CI 2.2 L/min. The airway exam was remarkable for limited mouth opening of less than 3 cm and a Mallampati score of 3.

The patient was brought to the operating room and standard ASA monitors were applied. Vital signs were BP 118/68, HR 90, and SaO<sub>2</sub> 94%. The patient was placed on oxygen via a non-rebreathing face mask at 10L/min and a right radial arterial line was inserted. The decision was made to proceed with combined spinal-epidural (CSE) anesthesia. Midazolam 2 mg was given as sedation for the procedure. CSE was placed at the L4-L5 interspace and bupivacaine 0.75% 1.2 ml was injected intrathecally. During right lateral decubitus positioning, the patient rapidly became hypotensive (SBP 60s/ DBP 30s), and small boluses of epinephrine 10 mcg were administered with no response in blood pressure.

The patient then became unresponsive. He was immediately placed in the supine position and ACLS protocol was initiated. Mask ventilation was moderately difficult requiring two-person mask ventilation. Initial direct laryngoscopy with a regular blade only yielded a grade 3 view, and the patient was subsequently intubated with a video laryngoscope. Nitric oxide (NO) started at 40 ppm. A TEE probe was inserted and revealed severe RV dilatation and dysfunction.

ACLS was continued with intermittent ROSC. A cardiac surgeon was summoned for emergent ECMO rescue. VA ECMO was placed via the left femoral artery and right femoral vein access. Right IJ central venous line with Swan-Ganz catheter was placed and the patient was started on epinephrine 4 mcg/min, norepinephrine 4 mcg/min, and vasopressin 2 units/h. The patient was transferred to the CTICU. The patient's home dose of treprostinil infusion was continued.

On hospital day 2, ECMO was revised to the left axillary artery and right femoral vein access in anticipation of left hip revision surgery. On hospital day 3, left hip revision was

completed with the patient on ECMO under general anesthesia and NO support. Epinephrine 4 mcg/min and vasopressin 2 units/h infusions were maintained. Four units of PRBCs were given to maintain hematocrit greater than 30%. Intra-operative TEE and serial CTICU bedside TTE examinations revealed improvement of RV function and the patient was successfully weaned from ECMO support on hospital day 5.

### **Guiding Questions for Discussion**

1. What are the WHO types of pulmonary hypertension and the key diagnostic criteria?
2. What are the main perioperative anesthetic considerations for pulmonary hypertension?
3. How would you evaluate a patient with pulmonary hypertension undergoing non-cardiac surgery?
4. What will you propose as anesthetic management for the patient and procedure?
5. How would you monitor this patient during the intraoperative period?
6. What are the most likely causes of hypotension?
7. How would you treat intraoperative hemodynamic instability in a patient with pulmonary hypertension?
8. What is ECMO and what are the key perioperative considerations for ECMO?
9. What are the complications in patients placed on ECMO?

### **References**

1. Kaplan JA. Cardiac Anesthesia, 7th ed. Philadelphia, PA: Elsevier; 2017:994-1019.
2. Smilowitz NR, Armanious A, Bangalore S, Ramakrishna H, Berger JS. Cardiovascular Outcomes of Patients With Pulmonary Hypertension Undergoing Noncardiac Surgery. *Am J Cardiol.* 2019 May 1;123(9):1532-1537.
3. Memtsoudis SG, Ma Y, Chiu YL, Walz JM, Voswinckel R, Mazumdar M. Perioperative mortality in patients with pulmonary hypertension undergoing major joint replacement. *Anesth Analg.* 2010 Nov;111(5):1110-6.
4. Stepan J, Heerdt PM. Preoperative Assessment and Perioperative Management of the Patient with Pulmonary Vascular Disease. *Clin Chest Med.* 2021 Mar;42(1):133-141.
5. Krakowski JC, Arora H. Con: General Anesthesia Is Not Superior to Regional Anesthesia for Patients With Pulmonary Hypertension Undergoing Noncardiac Surgery. *J Cardiothorac Vasc Anesth.* 2021 Jun;35(6):1888-1891.
6. Smeltz AM, Kumar PA. Pro: General Anesthesia Is Superior to Regional Anesthesia for Patients with Pulmonary Hypertension Undergoing Noncardiac Surgery. *J Cardiothorac Vasc Anesth.* 2021 Jun;35(6):1884-1887.
7. Hofer CK, Zollinger A, Rak M, Matter-Ensner S, Klaghofer R, Pasch T, Zalunardo MP. Therapeutic impact of intra-operative transoesophageal echocardiography during noncardiac surgery. *Anaesthesia.* 2004 Jan;59(1):3-9.
8. Ferré F, Martin C, Bosch L, Kurrek M, Lairez O, Minville V. Control of Spinal Anesthesia-Induced Hypotension in Adults. *Local Reg Anesth.* 2020 Jun 3;13:39-46.
9. Foong TW, Ramanathan K, Chan KKM, MacLaren G. Extracorporeal Membrane Oxygenation During Adult Noncardiac Surgery and Perioperative Emergencies: A Narrative Review. *J Cardiothorac Vasc Anesth.* 2021 Jan;35(1):281-297.

10. Min JJ, Tay CK, Ryu DK, Wi W, Sung K, Lee YT, Cho YH, Lee JH. Extracorporeal cardiopulmonary resuscitation in refractory intra-operative cardiac arrest: an observational study of 12-year outcomes in a single tertiary hospital. *Anaesthesia*. 2018 Dec;73(12):1515-1523..
11. Michels G, et. al. Recommendations for extracorporeal cardiopulmonary resuscitation (eCPR): consensus statement of DGIIN, DGK, DGTHG, DGfK, DGNI, DGAI, DIVI and GRC. *Clin Res Cardiol*. 2019 May;108(5):455-464.
12. Berrio-Valencia MI, Mcfarling MR. Perioperative management of a patient on VA-ECMO undergoing noncardiac surgery. Case report. *Rev Colomb Anesthesiol*. 2018;46:84-87.
13. Meng ML, Bacchetta MD, Spellman J. Anesthetic management of the patient with extracorporeal membrane oxygenator support. *Best Pract Res Clin Anaesthesiol*. 2017 Jun;31(2):227-236.
14. Taghavi S, Jayarajan SN, Mangi AA, et al. Examining Noncardiac Surgical Procedures in Patients on Extracorporeal Membrane Oxygenation. *ASAIO J*. Sept-Oct 2015; 61(5):520-5.
15. Ortuno S, Delmas C, Diehi JL, et al. Weaning from veno-arterial extra-corporeal membrane oxygenation: which strategy to use? *Ann Cardiothorac Surg*. 2019 Jan; 8(1): E1-E8.