

Title: Why is the endtidal carbon dioxide 96 mmHg during one-lung ventilation in a two year old undergoing VATS for empyema?

Moderator 1: Uma Parekh, MBBS, FRCA
Penn State Milton S Hershey Medical Center, PA

Moderator 2: Julie Drobish, MD
Penn State Milton S Hershey Medical Center, Hershey, PA

GOALS:

- a. Discuss the methods for one- lung ventilation, their advantages and disadvantages in young children.
- b. Differential diagnosis in children with increasing ETCO₂ during thoracoscopic surgery.
- c. Discuss the modes of perioperative analgesia in children undergoing open and minimally invasive thoracotomy
- d. Communication with surgeons during difficult surgical situations. (At what point do you insist the surgeon terminate the procedure?)

Case Stem:

A 2 year old, 15kg, previously healthy boy with necrotizing pneumonia/empyema was scheduled for a right VATS decortication.

Preoperative assessment and management:

The patient was admitted to the hospital 5 days prior to surgery and had been on antibiotics for a week. On arrival to OR patient was saturating well (97%) on room air and did not show any signs of respiratory distress, significant expiratory wheeze, rhonchi, and decreased breath sounds in RUL. CXR showed there was airspace opacity involving the majority of the right lung with cystic lucencies.

You agree to proceed with surgery. The patient has a 24G peripheral intravenous access insitu.

What are the problems anticipated with this case scenario? What is the plan for anesthetic management of this case? What are your options for airway management in a VATS/thoracotomy case? What type of ventilation strategy would you choose: Single vs Double lung ventilation(DLV)? What are available options for single lung ventilation (SLV)? How does age play a role in your clinical decisions? What are complications and challenges during placement of a double lumen tube?

What is the plan for analgesia? Would you consider an epidural? Would a VATS is for empyema or infection change your management? What other modes of analgesia can be considered? Is this patient appropriate for a PCA? What are the Risks/Benefits of these options?

An intravenous induction was done with fentanyl, lidocaine, propofol, and rocuronium. Initial direct laryngoscopy uneventful with a 4.0 cuffed endotracheal tube (ETT) and both lungs were ventilated during placement of epidural catheter. Blind left endobronchial intubation with the head turned to the right was attempted without success. The ETT was advanced under fiberoptic bronchoscopic guidance into left mainstem bronchus. Initial attempts with the 4.0 cuffed ETT unsuccessful. The ETT was replaced with a 3.5 cuffed ETT which advanced easily into bronchus.

Intraprocedure management:

Patient was positioned to left lateral decubitus position and decortication and debridement were performed over the next two and a half hours.

What ventilator settings would you choose for this patient? What are possible challenges and complications of single lung ventilation?

Approximately one hour after positioning the end title carbon dioxide (ETCO₂) and peak airway pressures (P_{peak}) increased and the tidal volumes (TV) decreased which coincided with insufflation of the thorax. Gradually over the next hour and a half the ETCO₂ and P_{peak} increased and the TV decreased.

During the last half an hour of surgery the ETCO₂ ranged between 70-96 mmHg. Tidal volumes of 30 -60 ml were achieved with peak pressures of 40 – 50 mmHg. Oxygen saturation was maintained in mid 90% until last 15 minutes of surgery where it intermittently dropped to 74-85%. The child was tachycardic but blood pressure was within normal limits.

What is the differential diagnosis? What is your approach? Should surgery be continued?

As the ETCO₂ and P_{peak} increased several measures were taken to investigate the cause and improve ventilation. Manual ventilation improved TV but had a decreased efficacy as the surgery progressed. The ETT was suctioned several times. Suction catheter could be advanced to what appeared to be the length of the tube. There was no kink in the ET tube. No significant secretions were suctioned from the ETT. Endotracheal albuterol puffs were administered with no improvement. The difficult ventilation was communicated to the surgeon who agreed to rapidly conclude the surgery.

What is your post-operative plan for this patient?

Post procedure course:

At the conclusion of surgery, the patient was turned supine and the 3.5 ETT was exchanged for a 4.5 cuffed ETT. Upon removal of the ETT a large clot was occluding the majority of the lumen. EtCO₂, peak pressures and tidal volume returned to normal values after the ETT exchange. Approximately ten minutes after ETT exchange a venous blood gas was drawn showing: pH 7.26/pCO₂ 60.5/pO₂ 48/HCO₃ 25.7. The patient remained intubated and was transferred to PICU. The baby was extubated a few days later had an uneventful recovery.

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