A 14-year-old female is admitted with a decreased level of consciousness and abdominal bleeding. She also complains of abdominal pain, diaphoresis, and cramping in the left upper quadrant and periumbilical area. A diagnostic laparoscopy is performed, noting copious bleeding from a hemorrhagic cyst. She experiences hypotension and a decreased hemoglobin and hematocrit. Packed red blood cells are transfused. After fluid and blood resuscitation, an exploratory laparotomy is performed. A 2000ml hemoperitoneum with a small amount of bleeding from the right ovary is discovered.

**ABG:** 7.32/52/68/26 on room air

**CT:** What is happening with the above ABGs?

_This blood gas indicates a potential for respiratory failure. The CO2 level is higher than normal without any form of compensation. This is an acute event._

This patient is intubated to protect her airway. Because of the potential for respiratory failure, it is preferable to intubate as an elective procedure, rather than as an emergency measure during an arrest situation. This patient has a great risk for hemorrhagic shock because of the amount of blood loss from the cyst. Close monitoring of the hematocrit and hemoglobin is important. In addition, it may be necessary to place an arterial catheter for continuous blood pressure monitoring and laboratory draws.

**PRVC:** volume ventilation with minimal pressures | FIO2 1.0 | Vt 350ml | Rate 20

**ABG:** 7.47/31/54/22/+1.0

**CT:** Is this a ventilation or an oxygenation problem?

_Clearly oxygenation_

MD called to bedside. HFOV is initiated

**CT:** Why the need for HFOV at this stage?

_Need to minimize the insult to the lungs and try to recruit more alveoli and improve oxygenation_

**What would be appropriate settings?**

_Initial ventilator settings would be FiO2 100%, Hz 6.0, amp to ensure adequate CW, and MAP 35 (5 above CMV MAP). The amp setting is set just high enough to cause a wiggle from the nipple line to the groin._

**ABG:** 7.32/48/203/25/-1.5.
CT: What is the next move?
   The goal is to decrease the CO2. Increase the amplitude. Hyper-oxygenation is not necessary.
Amplitude is increased and another ABG is drawn after one hour.
ABG: 7.04/113/376/30/-4.8.
RN/RCP: Discuss ABG and plan to suction.
A chest x-ray is taken at this time and reveals rib expansion to the eighth rib. The patient is suctioned for a large amount of thick secretions.
CT: What are some of the consequences of suctioning?
   Air trapping, loss of lung volume
ABG: 7.13/93/225/+1.5
CT: What does this indicate between the CXR and the ABG?
   As the 8th rib is minimal expansion, and the CO2 is 93, the decision would be to either increase the amplitude or decrease the Hz.
What determines which parameter is changed?
   Observe chest wiggle, if it past the groin, then decision would be to decrease the Hz to 5. This will allow a larger tidal volume.
ABG: 7.16/66/314/23/-7.0.
MD at bedside. He is asking your opinion on what to do next.
CT: What changes would you make?
   Create a 5cm cuff leak so that CO2 can escape around the ETT, again, because of more than adequate CWF, decrease Hz to 4.
   Start decreasing the FIO2 first until you get around 50%, then can start decreasing the MAP
ABG: 7.34/50/128/+1
CT: Were the changes above appropriate?
   Yes
Over the next five days, the FiO2 and the MAP are weaned gradually.
CT: When would be an appropriate time to switch to conventional ventilation? Why?
   The goal is to wean the mean airway pressure lower. When the mean airway pressure is about 5 cm H2O over where it was on conventional ventilation, it is time to change ventilation modes. The amplitude setting is another indicator that it is time to switch to conventional ventilation. As the patient recovers, the amplitude is weaned. This indicates that the lungs are healing and recovering. It is then time to change the mode of ventilation to a conventional mode. When the amplitude is weaned to a low number, such as 18 or 20, it also indicates it is time to change to conventional ventilation.
   When placing the patient back on conventional ventilation, the settings might be temporarily higher to allow the patient to compensate for the change in ventilator modes. Also can consider extubation.
**References**


Surfactant was administered at this time—100ml/kg

**ABG:** 7.49/23/44/-3.2 | tcCO2 30 | O2 SAT: 80%

**RN/RCP:** discuss sat goals for patient, assess breath sounds, markedly diminished bilaterally

**MD called:** Rate 50, FIO2 0.7

**CT:** Response to vent order—What is VT? What is the optimum lung inflation?

8 ribs, hyperventilated, ? lung injury???

**2000**

CMV: PIP 20 | PEEP 5 | Rate 40 | IT 0.4 | FIO2 0.7 | tcCO2 70 | O2 SAT 60%

**RN/RCP:** Discuss possibilities of sudden change in vital signs

**MD called to bedside**

**CT:** Possible diagnosis?

*Tension pneumothorax*

**2015**

**CXR:** Right sided Pneumothorax

![CXR Image]

**2025**

One chest tube placed. Four hours later, the patient developed acute distress requiring chest compressions, IV sodium bicarbonate and epinephrine was administered through the ETT.

**ABG:** 7.0/65/27/-8 | tcCO2 80 | O2SAT 56%

**CT:** What’s happening with this patient. Note the acute onset of the code and follow up ABG.

*Another Pneumothorax, acute respiratory acidosis*
CXR: Left sided tension Pneumothorax that has partially re-expanded after chest tube placement.

2045  MD: Order for HFOV
CT: What would be the appropriate initial HFOV settings? Why?
   Low lung volume strategy for air leak
   MAP should be 1-2cm lower than CMV MAP.
   AMP should be adjusted for adequate CWF (clavicles to umbilicus) Hz appropriate for patient weight
What are potential complications of HFOV?
   Air trapping/hyperinflation/hemodynamic compromise
What do we need before switching to HFOV?
   Vital Signs/Assessment
   Heightened awareness of safety and stable airway; positioning and immobility; firm mattress, suctioning, assess BP

2100  HFOV: FIO2 1.0 | MAP13 | Amp 20 | Hz 15
CT: Response to HFOV?
   Assess CWF, Bp, O2 SAT, how is CWF assessed?

2210  CXR reveals changes consistent with pulmonary interstitial emphysema and bilateral pneumothoraces.

0100  ABG: 7.44/46/89/+1 | tcCO2 49 | O2 SAT 91%
   RN/RCP discuss the need for suctioning
   MD: Wean FIO2 for sats <92%, adjust amp to keep PCO2 50 and for adequate CW
CT: How long since surfactant was given?
   Refrain from suctioning up to four hours post dosing except for possible airway obstruction.
What are potential adverse effects of suctioning pt. on HFOV?
   Loss of lung volume (especially if the baby does not return to baseline very quickly), atelectasis, ETT dislodgment
Why is the FIO2 being weaned before the MAP?
   Oxygen toxicity
48 hours old:
HFOV: FIO2 0.4 | MAP 10 | AMP 18 | Hz 15
The patient was positioned with left side down because the air leak appeared on CXR to be worse there. Follow up CXR 12 hours later reflected dramatic improvement in the air leak and healing PIE.

ABG: 7.46/41/80/+1
CT: What assessments are needed at this time? What ventilatory changes should be made?
Decrease MAP by 1cm increments, decrease amp 2-5 cm increments Q1 hour, maintain Hz as long as CW is to umbilicus.

76 hours old:
CXR indicated almost complete resolution of the air leak on the left side. HFOV continues to be weaned.

CT: When do we start thinking about changing back to conventional ventilation? What vent settings would you choose?
When the MAP is 10-15, amp is low, pt is stable and able to tolerate touch, suctioning, etc.
Settings: FIO2 25% | Rate 30 | PIP 20 | PEEP 4 | IT 0.4

The use of a lower airway pressure with HFOV provided significant advantages for this patient. HFOV may be suggested not only to prevent, but also to resolve, air leak syndrome in neonatal patients with RDS. Perhaps the greatest lesson learned in HFOV research, to date, is the critical importance of proper ventilator-management strategy. Through their work with more than 400 critically ill neonates, Clark et al, identified four categories of illness to be supported using HFOV: diffuse homogeneous lung disease, non-homogeneous lung disease, lung hypoplasia syndrome, and air leak syndrome. Based on their experience, they advocated the use of a low-pressure management strategy for patients with severe air leak.

References


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These case studies are for reference only. Each patient is unique and may require different care.