

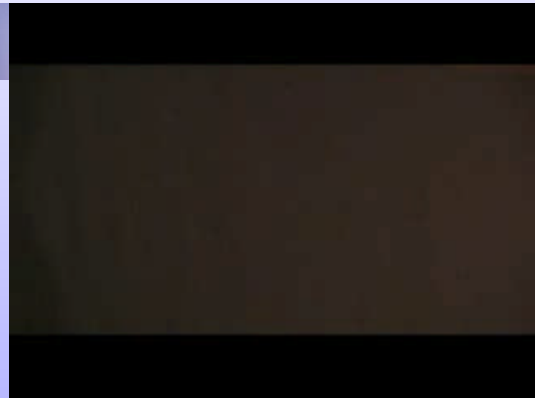
## Respiratory Emergencies



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## Physiologic Oxygenation

- Oxygen Content
  - Available arterial oxygen that binds to hemoglobin
  - $\text{PaO}_2$
- Oxygen Affinity
  - Ability to bind to hemoglobin
  - Fever, acidosis – release oxygen to cells
    - Right shift oxy-hemoglobin curve
  - Alkalosis, hypothermia – hold oxygen to RBC
    - Fetal affinity
    - Left Shift oxy-hemoglobin curve

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## Physiologic Oxygenation

- Oxygen delivery
  - Product of arterial oxygen content and cardiac output
- Oxygen consumption
  - Normal Adult at rest – 250 ml/min
  - Normal Adult with Exercise – 3000 ml/min
  - Delivery doesn't meet demand – anaerobic metabolism occurs
    - Lactic Acidosis

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## Respiratory Changes in Pregnancy

- Respiratory
  - Upper Airways
    - Mucosal edema & friability, Capillary engorgement
    - Obligate mouth breathers
  - Chest Wall
    - Increases in circumference, elevation of diaphragm, increase in diaphragmatic excursion
  - Respiratory Musculature
    - Diaphragm and intercostals accessory muscles contribute equally to tidal volume during pregnancy, max. inspiratory and expiratory pressures unchanged

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## Respiratory Changes in Pregnancy

- Respiratory Rate – normal to slightly  $\uparrow$ 
  - Compensatory Respiratory Alkalosis
- Tidal Volume (air inspired & expired with each breath) -  $\uparrow$  40% (100-200 ml)
- Minute Ventilation (air inspired & expired each minute) -  $\uparrow$  40%
- Vital Capacity (max inhalation) – unchanged
- Residual Volume (amount remaining after max expiration) –  $\downarrow$  20%
- Functional Residual Capacity (volume left at resting expiratory level) -  $\downarrow$  20%
  - Supine positioning -  $\downarrow$  25% in FRC and  $\downarrow$  in  $\text{PaO}_2$
- Inspiratory Capacity -  $\uparrow$  5-10% (100-300 ml)
- Total lung capacity -  $\downarrow$  4% (200-400 ml)

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## Respiratory Changes in Pregnancy

- Increase oxygen consumption by 15 to 20%
- Requirements of the fetoplacental unit
- Increased oxygen consumption by maternal organs
  - Heart, Lungs, and Kidneys
- Progesterone is a central stimulant on ventilation system

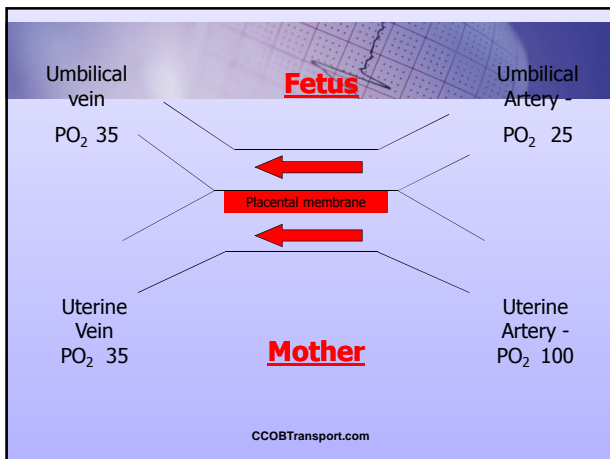
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## Respiratory Changes in Pregnancy

### Arterial Blood Gases

Parameter	Pregnancy	Adults
pH	7.40 - 7.45	7.35 - 7.45
pO <sub>2</sub> (mm Hg)	104 - 108	80 - 100
pCO <sub>2</sub> (mm Hg)	27 - 34	37 - 40
HCO <sub>3</sub> (meq/L)	18 - 22	22 - 26
PAO <sub>2</sub>	20	14
Base Deficit	3	1

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## Dyspnea in pregnancy

- 50% of all pregnant women report at 20 weeks
- Reaches maximum at 28/31 weeks
- Always a worrisome symptom
  - rule out pulmonary emboli
- O<sub>2</sub> saturation should be normally > 92% at altitude and > 95% at sea level
- Fatigue
- Decreased exercise tolerance

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## Clinical Implications

- Pregnant patients are prone to:
  - Hypoxemia
    - Decreased FRC, Increased alveolar ventilation, Increased oxygen consumption
  - Aspiration
    - Slow gastric emptying, functional displacement of lower esophagus
  - Anesthetic overdose
    - Induction and emergence from anesthesia occurs more rapidly in pregnant patients

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## Respiratory Emergencies

- Complaints
  - Shortness of Breath
  - Cough
  - Hemoptysis
- Require prompt evaluation
  - ABG
  - Chest X-Ray

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## Normal Chest X-Ray Findings

- Apparent cardiomegaly
  - Enlarged transverse diameter
- Enlarged left atrium
  - Lateral views
- Increased vascular markings
- Straightening of left cardiac border
- Postpartum pleural effusion
  - Right sided

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## Oxygen Delivery

- NC
  - 2-6 L/min
  - 24-40% oxygen concentration
- Simple mask
  - 5-10 L/min
  - 35-50% oxygen concentration
- Partial rebreather
  - 6-10 L/min
  - 40-70% oxygen concentration
- NRB
  - 10-15 L/min
  - 60-80% oxygen concentration

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## Indications for Intubation

- Respiratory Failure
  - Respiratory rate > 35, PaO<sub>2</sub> < 70, PaCO<sub>2</sub> > 55
- Indications for Intubation
  - Airway Protection – aspiration
  - Obstruction
  - Respiratory Arrest
  - Decreased mental status
  - Difficulty managing secretions

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## Pearls for Respiratory

- Upper Airway edema
- Early oxygenation and intubation
- High risk for aspiration - cricoid pressure and gastric tube may be beneficial
- Failed intubation rates are 8 times higher in pregnancy than rates of adults

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## Pearls for Respiratory

- Decreased lung volumes and increased oxygen metabolism lead to rapid desaturation
  - 60 sec of apnea results in a decreased in PaO<sub>2</sub> of 29% compared to 11% in non-pregnant patients
  - PaCO<sub>2</sub> of 30 is normal in pregnancy
- Pre-oxygenate and hyperventilate for 3 minutes or more
- Shorter anesthesia induction times
- Calculate tidal volumes on ideal body weight

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## RSI

- Medications
  - Sodium Thiopental in reduced doses
  - Etomidate is safe in pregnancy
  - Ketamine (in reduced doses) is safe in pregnancy in the absence of head injury
    - Produces less neonatal depression
  - Propofol associated with significant hypotension
  - Succinylcholine is the preferred paralytic for laryngoscopy and intubation
  - Rocuronium is indicated when succinylcholine is contraindicated (i.e. hyperkalemia, major burns greater 36 hours, crush injury, and potential cardiac arrest)

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## Vent Pearls

- Avoid High Inspiratory Peak Pressures
- Use PEEP in diffuse lung injury to support Oxygenation and reduce the FiO<sub>2</sub>
- Set triggers/sensitivity low to minimal patient effort to initiate inspiration
- Avoid vent settings that limit expiratory time
  - Causes or worsens auto PEEP
- High Peak Inspiratory Pressures can be indicator of inadequate sedation

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## Indications for Extubation

- PaO<sub>2</sub> > 80
- PaCO<sub>2</sub> < 45
- Respiratory rate < 35
- Tidal Volume > 5 ml/kg
- Minute Ventilation < 10 ml/kg

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## ASTHMA

- Retrospective study - 100 cases
- 48% no change with pregnancy
- 29% improve
- 23% deteriorate with intermittent hypoxia
  - increased risk of IUGR

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## Risk of Death due to Asthma

- History of sudden severe exacerbations
- Prior intubations
- Prior ICU admission for asthma
- >2 hospitalizations
- >3 ED visits
- ED visit in last 30 days
- Illicit drug use
- Use of > 2 inhalers per month
- Current use of steroids
- Comorbidity (Cardiac or COPD)
- Serious psychiatric illness
- Low socioeconomic status
- Sensitivity to mold

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## Treatment

- Oxygen to keep Sats > 92% at altitude and > 95% at sea level
- Inhalers
  - Albuterol
- Nebulizers
  - A&A
  - Intermittent or continuous
- IV steroids
  - Decadron 10 mg IV or IM

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## Medications

- Beta-agonists
  - Albuterol 0.5 ml in 2.5 ml NS
  - Epinephrine 0.3 ml (1:1000) SQ every 20 min X 3 doses
- Anticholinergics
  - Ipratropium bromate 0.5 mg nebulized

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## Treatment

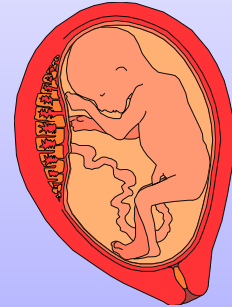


- Theophylline
  - 5 mg/kg IV over 30 minutes
  - 0.4 mg/kg/hr drip
- Magnesium Sulfate
  - 40 mg/kg IV up to 2 gms
- Heliox
  - 80/20, 70/30, 60/40 NRB
- C-Section

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## FETAL RESPONSE

- Maternal PaO<sub>2</sub> < 60 - rapid, profound decrease in fetal oxygen saturation and fetal hypoxia
- Must increase mom's O<sub>2</sub> saturation
- Fetal monitoring in acute episodes of asthma
- Fetal outcomes - preterm delivery, low birth weight or IUFD



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## Labor implications for Asthma

- Very uncommon to have attacks in labor possibly due to increased adrenal secretion of cortisol.
- No Morphine- may cause bronchospasm
- Demerol reduces bronchospasm
- Epidural analgesia reduces O<sub>2</sub> consumption and minute ventilation

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## Ventilator Management

- Severe Airflow Obstruction
  - Asthma
  - Settings
    - ACV/SIMV
    - FiO<sub>2</sub> – 0.5-1.0
    - TV – 5-7ml/kg
    - RR – 12-15/min
    - Inspiratory flow – 40-60L/min, end expiratory lung volumes < 20 ml/kg
    - Keep plateau pressures 15 – 30
    - PEEP less than 10

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## Ventilator Management

- Acute or Chronic Respiratory Failure
  - Status Asthmaticus
  - Settings
    - SIMV/ACV
    - FiO<sub>2</sub> – 0.4 - 0.6
    - TV – 5-7 ml/kg
    - RR – 24-28/min
    - Inspiratory flow – 40-60L/min

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Really?

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## SARS

- Severe Acute Respiratory Syndrome
  - Moderate Respiratory Illness
    - Temp > 100.4
    - Cough, SOB, difficulty breathing, hypoxia
  - Severe Respiratory Illness
    - Temp > 100.4
    - Cough, SOB, difficulty breathing, hypoxia
    - X-Ray confirmation pneumonia or Respiratory Distress Syndrome
  - Probable cause – exposure
    - Travel within 10 days of onset – China, Hong Kong, Hanoi, Singapore, Toronto, or Taiwan
    - Close contact with person known or suspected SARS

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## Pulmonary Edema

- Progressive SOB
- Desaturation
- Tachypnea
- Occasional hypertension
- Bilateral Crackles
- May hear an S3 Gallop

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## Pulmonary Edema

- Risk Factors
  - Fluid overload
  - Preeclampsia
  - Tocolytic Therapy
  - Uncontrolled HTN

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## Pulmonary Edema

- Management
  - Semi-Fowler's
  - Oxygen – 10-15L/min NRB, CPAP or intubation
  - Continuous pulse ox and cardiac monitoring
  - IV
    - Limit fluids to 30-50 ml/hr
  - Identify predisposing factors

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## Pulmonary Edema

- Pharmacology
  - Morphine
    - 3-5 mg IV
    - Avoid with AMS, ICP, or COPD
  - Lasix
    - 20-40 mg IV to max of 120 mg/hr
  - NTG 0.4 mg SL
    - Use cautiously
  - Antihypertensive
    - Apresoline
    - Labetalol

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## Pulmonary Edema

- Monitor at least every 15 minutes
  - I&O
  - BP
  - FHR

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## ARDS – Risk Factors

- Trauma
- Shock
- Sepsis
- Amniotic Fluid Embolus
- Pneumonia
- Seizures
- Overdose
- Pancreatitis
- Blood transfusions
- Drug induced
- Abruption
- Fetal Demise/Stillborn
- DKA
- Eclampsia

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## ARDS

- Acute onset
- History
- Exclusion cardiogenic pulmonary edema
  - PCWP < 18 mm Hg
  - Field ?
- Respiratory distress
- Diffuse patchy opacities chest X-Ray

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## ARDS - Treatment

- Oxygenation
- Avoid barotrauma
  - High pressures with ventilation
- Avoid cardiovascular compromise
- Management
  - Semi-Fowler's
  - Oxygen
  - Continuous pulse ox and cardiac monitoring
  - IV
  - Identify predisposing factors and correct them

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## Management

- Pharmacology
  - Nitric oxide
  - Pulmonary vasodilators
  - Steroids
  - Surfactant
  - Prone ventilation
  - ECMO
- Monitor
  - I&O
  - BP
  - FHR

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## Ventilator Management

- Acute Hypoxemic Respiratory Failure
  - ARDS
  - Settings
    - ACV/PCV
    - FiO<sub>2</sub> – 1.0
    - TV – 5-7 ml/kg
    - RR – 24-28/min
    - Inspiratory flow – 40-60L/min
    - Minimal PEEP to keep sats > 90%

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## Pulmonary Embolism

- Classic Triad Symptoms
  - SOB, chest pain, hemoptysis
  - Occurs in only 25% of patients
- Hypercoagulable state
- Other symptoms
  - Cyanosis, tachypnea, syncope, diaphoresis, fever, pleural friction rub, fixed S2
  - Pulse ox < 90%
  - EKG Changes – RBBB, right axis shift, Q wave or T wave inversion in III, aVF, new atrial fib

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## Virchow's Triad

- Venous Stasis
  - 50% reduction in venous flow velocity by 25 – 29 weeks gestation
  - Takes 6 weeks to return to normal postpartum
- Hypercoagulable State
- Vascular Damage
  - Inevitable during delivery, especially if cesarean

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## Thrombophilias

- Autosomal Dominant or gene mutations
- Responsible for approximately 50% of maternal thromboembolism
- Collectively present in 15% of Western European populations
- Often multiple exist in same patient

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## Thrombophilias: Prevalence

Factor V Leiden HZ	2-9%
Prothrombin G20210A mutation	2-4%
Antithrombin III deficiency	0.3-0.6%
Protein C deficiency	0.2-0.3%
Protein S deficiency	<0.1%
Hyperhomocystinemia (homozygous MTHFR)	10%

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## Additional Risk Factors for Thrombosis During Pregnancy

- Artificial heart valves
- Current atrial fibrillation
- Chronic anticoagulation for recurrent thromboembolic disease

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## PE Pathophysiology

- Obstruction of pulmonary arterial blood flow
- Vasoconstriction of small arterial vessels
- Progressive loss of alveolar surfactant

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## Diagnosis of PE

- VQ Scan
- CT
- Nondiagnostic scans in patients with high probability – Color Doppler compression ultrasound
- Nondiagnostic – pulmonary angiogram

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## Management

- Option # 1: Continue LMWH until labor / ROM
- Option # 2: Switch LMWH to UFH at 36 weeks
- Option # 3: Schedule induction or CS 12 - 24 hours after last LMWH
- **Considerations:**
  - Epidural / spinal should not be used within 12 hours prophylactic and 24 hours therapeutic LMWH.
  - VTE & hemorrhage risk **significantly** increased with CS compared to a vaginal delivery.
  - Induction of labor increases labor time & risk of CS.

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## Management

- IVC Filters
- Thrombolytic therapy
  - Massive PE
  - Hemodynamic instability
  - Maternal mortality rate 1.2 %
  - Fetal loss rate 6%
- Maternal hemorrhage 8 %
- Prevention!!!

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## Amniotic Fluid Embolism

- Amniotic Fluid Embolism
  - needs mechanism of entry
    - MVA
    - SROM
    - C-Section
    - Induction – hypertonic uterine contractions with SROM
  - Pt c/o sudden dyspnea or impending doom
  - Anaphylactoid Syndrome of Pregnancy
    - Diffuse SIRS, DIC
  - Maternal mortality rate 60-80%
    - Only 15% survive neurologically intact

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## Amniotic Fluid Embolism

- Hypoxia
- Hemodynamic collapse
  - Acute hypotension
  - Dyspnea, apnea, respiratory arrest
  - Cardiac Arrest
- Disseminated Intravascular Coagulopathy – DIC
  - Hemorrhage with lack of clotting
- Absence of other contributing factors

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## Pathophysiology of AFE

- Foreign substance in maternal bloodstream
- Inflammatory mediators released
- Increased capillary permeability
- Myocardial depression – decreased output
- Pulmonary hypertension
- DIC

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## Diagnosis of AFE

- Detection of debris in maternal circulation
  - Arterial catheter
  - Red top tubes
  - Autopsy
- Recent studies show fetal debris in normal pregnant women 50% arterial catheters and 75% undergoing autopsy

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## Treatment of Amniotic Fluid Embolism

- Supportive if they live through insult
- Treat cardiac dysrhythmias
- Oxygenation
  - Intubation
- Expect Left Ventricular Failure
- Monitor BP, P, CO
- Fluids
- FHR
  - C-Section
- Meds
  - Lasix, Morphine, Steroids, Inotropes
- DIC

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## Pressors

- Dopamine
  - 5-20 mcg/kg/min IV
- Norepinephrine (Levophed)
  - Initial 8-12 mcg/min then titrate to BP

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## Ventilator Management

- NL Lung Mechanics and Gas Exchange
  - Overdose
  - Settings
    - ACV/PSV
    - FIO<sub>2</sub> – 0.5-1.0
    - TV – 8-15 ml/kg
    - RR – 8-12/min
    - Inspiratory flow – 40-60L/min
    - Add Sighs 6/h at 1.5 times Vt or PEEP of 5-7 to prevent atelectasis

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## Sarcoidosis

- Inflammatory disease that affects primarily the lungs and lymph glands.
- Abnormal lumps or nodules (called granulomas) form
- These granulomas change the normal structure and possibly the function of the affected organ
- Can occur with cancer

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## Sarcoidosis



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## Sarcoidosis Signs & Symptoms

- Fatigue unchanged by sleep
- Lack of energy
- Weight loss
- Aches and pains
- Arthritis
- Dry eyes
- Swelling of the knees
- Blurry vision
- Shortness of breath
- Dry hacking cough
- Skin lesions
- Occurs usually before 40
- Peaks at age 20-29
- More frequent in women
- Occurs again in women over 50
- May resolve on its own
- May progress to pulmonary fibrosis

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## Sarcoidosis & Pregnancy

- If well managed, pregnancy in women with sarcoidosis is usually carried to term with no problem.
- There is no specific risk for the embryo-fetus.
- Pregnancy can be contraindicated in case of respiratory failure due to heart failure or central nervous system disorders, a vital capacity less than 100 ml or pulmonary hypertension
- Pregnancy should be discouraged during a period of active disease progression
- Pregnancy in itself does not aggravate sarcoidosis.
- A flare up 3 to 6 months after delivery is not unusual.

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## Sarcoidosis Management

- Observation
- Corticosteroids
- Methotrexate
  - teratogenic effect, particularly between 6 and 8 weeks gestation.
- Azathioprine
  - Immunosuppressant - transplants

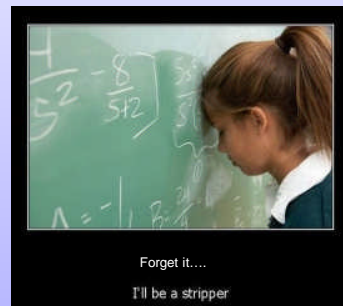
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## Ventilator Management

- Restrictive Lung or Chest Wall Disease
  - Sarcoidosis
  - Settings
    - FiO<sub>2</sub> – 0.5-1.0
    - TV – 5-7 ml/kg
    - RR – 18-24/min

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## Case Studies



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## Case One - Report

- 28 yr old G 2 P 0
- 32 weeks
- Asthmatic
- Difficulty breathing
- VS
  - 110/63, 110, 32, 98.7
- Sats
  - 85% on RA

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## Case One – Assessment

- Upon EMS arrival
  - Patient is sitting upright
  - Talking in 2-3 word sentences
  - Using accessory muscles to breathe
  - Reports several intubations for asthma prior to pregnancy
  - VS
    - 112/65, 120, 48, 98.7, Sats – 82% on RA
  - Weight – 80 kgs

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## Case One - Priorities

- Airway
- Breathing
- IV
- Meds
- Fetus

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## Case One – Prior to Transport

- IV
- RSI
  - Etomidate 20 mg IV
  - Succinylcholine 160 mg IV
  - Vecuronium 10 mg
- Vent
  - Tidal volume – 400 ml, rate 24, FiO<sub>2</sub> -100%, I:E – 1:1.5
  - ETCO<sub>2</sub> - 50

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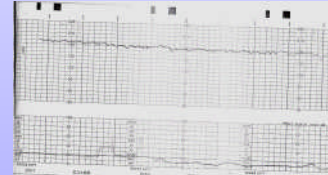
## Case One - Transport

- VS
  - 110/60, 100, 24, 97.2, Sats – 90%
- Inline nebulizer
  - A & A
- Decadron 10 mg IV
- FHR
  - 170's
  - Why?

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## Case One - Outcome

- On arrival to ER
- VS
  - 114/62, 100, 24, 97.2, Sats – 92%
- BBSC & =
- ETCO<sub>2</sub> - 50
- FHR



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## Case One - Outcome

- Continuous EFM
- Admit to ICU
- Sats remain 90-92%
- C-Section 2 days later for decels
- Boy
  - Apgars 5 & 7
  - Weight 4 # 2 oz
  - Cord pH 7.10, Base Deficit - -12
- Mother extubated 4 days post-op, dc'd with baby to home

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## Case Two - Report

- 37 yr old G3 P2 38 wks
- Dx'd with IUFD/stillborn
- Induction 2 days later
- SROM
- Patient reports she "can't breathe"
- Cardiopulmonary Arrest
- What is this?

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## Case Two - Priorities

- Airway
- Breathing
- IV
- Meds
- Fetus

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## Case Two – Assessment

- Upon flight team arrival
  - Patient had CPR for 5 minutes
  - VS
    - 125/80, 150, 16, 97.2, Sats – 90% on vent
  - Vent settings
    - Tidal volume 400 ml, Rate -14, FiO<sub>2</sub> -100%, PEEP – 5 mmHg
  - Levophed – 5 mcg/kg/min
  - Weight – 105 kgs
  - DIC
    - H&H – 5&15
    - PTT - 30
    - Blood
      - 4 units PRBC's, 2 units FFP, 1 unit cryo, 3 L NS
      - EBL – 3000 ml

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## Case Two – Transport

- BP systolics 80's
- Levophed increased to 20 mcg/kg/min
- BP systolics increase to 100's
- Levophed increased to 30 mcg/kg/min
- Vent
  - Tidal Volume 500 ml, Rate – 16, FiO<sub>2</sub> -100%, PEEP – 5 mmHg
- Loss of peripheral pulses on landing
- Levophed increased to 40 mcg/kg/min
  - Systolic BP 80's
- Admit to ICU

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## Case Two - Transport

- Ten minutes after arrival to ICU...
  - Patient cardiopulmonary arrest
  - Patient taken to OR
  - C-Section for fetal demise
  - 3000 ml blood in her belly
  - ? Liver laceration
    - HELLP?
    - CPR
  - Left open and returned to ICU

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## Case Two - Transport

- 24 hrs later...
- Call from ICU to transport to Denver
- Patient had lost 12 L into abdomen
- Taken back into OR
- Liver laceration and needs her right lobe removed
- Opens eyes on command, follows gaze commands

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## Case Two - Transport

- Vent settings
  - TV – 550 ml, Rate – 12, FiO<sub>2</sub> - 50%, PEEP – 8 mmHg
  - Sats – remain 98-100%
- Given 2 units of FFP enroute with stable BP and pulse 120's to 130's
- H&H – 7&21, Platelets – 105, PTT - 38

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## Case Two - Outcome

- Upon arrival to University
  - 75 units of blood products
  - Total EBL – 18 L
  - Total NS – 9 L
  - Liver failure
  - Kidney failure
    - Putting out clear, yellow urine
  - Generalized edema
  - Central lines
    - Art BP – 130-140's/60-80's, CVP – 8
  - OR for liver lobectomy
  - Opens eyes on command

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## Questions?



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