Virtual Clinical – Melba's Acute Respiratory Failure Case Study – *KEY* **Adapted from Evolve Resources for Medical-Surgical Nursing, 10th Edition**

Only the instructor has the answers/rationales

Explain the pathophysiology of Acute Respiratory failure in your own words:

The major function of the respiratory system is gas exchange. Acute respiratory failure (ARF) occurs when oxygenation, ventilation, or both are inadequate. ARF is not a disease. It is a symptom that reflects lung function. For example, not enough O2 is transferred to the blood or inadequate CO2 is removed from the lungs (Fig. 67.1). ARF occurs because of disorders involving the lungs or other body systems (Table 67.1). Conditions that interfere with adequate O2 transfer result in hypoxemia. This causes a decrease in arterial O2 (PaO2) and saturation (SaO2) to less than the normal values. Insufficient CO2 removal results in hypercapnia. It causes an increase in arterial CO2 (PaCO2). Arterial blood gases (ABGs) are used to assess changes in pH, PaO2, PaCO2, bicarbonate, and SaO2. We use pulse oximetry to assess arterial O2 saturation (SpO2). We classify ARF as hypoxemic or hypercapnic (Fig. 67.2). Hypoxemic respiratory failure is a PaO2 less than 60 mm Hg when the patient is receiving an inspired O2 concentration of 60% or more.1 In hypoxemic respiratory failure (also called oxygenation failure), the main problem is inadequate exchange of O2 between the alveoli and pulmonary capillaries. The PaO2 level shows inadequate O2 saturation. A less than optimal PaO2 level exists despite supplemental O2. Hypercapnic respiratory failure (or ventilatory failure) is a PaCO2 greater than 50 mm Hg with acidemia (arterial pH less than 7.35).2 The main problem is insufficient CO2 removal. This causes the PaCO2 to be higher than normal. For whatever reason, the body is unable to compensate for the increase. This allows acidemia to occur. Patients may have both types of respiratory failure at the same time. For example, a patient with chronic obstructive pulmonary disease (COPD) who has pneumonia could have "acute-on-chronic" respiratory failure. From Lewis 10th ed Chapter 67

<u>Hypoxemia Respiratory Failure</u>
Hypoxemic respiratory failure has 2 main causes
1. The lungs are adequately ventilated but not perfused
(dead space ventilation) i.e. Pulmonary embolus
AND/OR
2. The lungs are perfused but inadequately ventilated
i.e atelectasis, pneumonia
Gas exchange and oxygen exchange do not occur
Defined by Pao2 < 60 mmHg with a normal or low Paco2
Disease processes that cause V/Q mismatch or impaired diffusion at the alveolar level
i.e. pulmonary edema, pneumonia, pulmonary embolus
<u>Hypercapnic Respiratory Failure</u>
Decreased ventilation or carbon dioxide removal
PaCO2 > 50 mmHg + pH < 7.35 with or without hypoxemia
Diseases that impair ventilation or cause hypoventilation
i.e. asthma, narcotic overdose, nervous system diseases that impair chest wall movement

List signs and symptoms:

RR > 35 bpm
Nasal flaring
Tri-pod position
Use of accessory & intercostal muscles
Paradoxical breathing
Snoring or grunting

Diaphoresis
Unable to verbally communicate (early or late sign)
AVOID late signs: confusion or lethargy, stupor, cyanosis, bradypnea, bradycardia, hypotension, dysrhythmias

Treatment

Respiratory Therapy

O2 therapy

Mobilization of secretions

Positioning, Effective coughing, Chest physiotherapy, Suctioning of the airway
Oral and/or IV hydration, Humidification (of O2) , Ambulation (early mobility)
Positioning: head of bed elevated

Positive pressure ventilation (PPV)

Noninvasive positive pressure ventilation (e.g. CPAP, BiPAP)
Intubation with positive pressure ventilation Drug Therapy

Drug Therapy

Reduce airway inflammation (e.g., corticosteroids), Relief of bronchospasm (e.g., albuterol)
Reduce pulmonary congestion (e.g., furosemide [Lasix], morphine)
Treat pulmonary infections (e.g., antibiotics)
Reduce anxiety, pain, and restlessness (e.g., lorazepam, fentanyl, morphine)

Supportive Therapy

Management of the underlying cause of respiratory failure, Monitor hemodynamic status
Optimize balance between activity and rest, Monitor for deterioration in patient condition

Read Melba's Case Study and complete the following questions and activities

Melba B., a 75-year-old female, is admitted to the critical care unit (CCU) in acute respiratory failure. M.B. has a 15-year history of chronic obstructive pulmonary disease (COPD). She smoked 2 packs of cigarettes/day for over 50 years. She quit just 4 years ago after suffering a myocardial infarction (MI) and undergoing a triple coronary artery bypass graft (CABG) surgery. Her past medical history is positive for hypertension, glaucoma, type 2 diabetes, and coronary artery disease. She also suffers from atypical musculoskeletal chest pain occurring after her CABG surgery. Her current medications include metoprolol 100 mg bid, fluticasone/salmeterol (Advair) one inhalation bid, albuterol/ipratropium (Combivent) 3 mL via nebulizer every 4 hours prn, metformin 500 mg bid, codeine 30 mg PO prn pain, lorazepam (Ativan) 1 mg PO prn anxiety, and betaxolol ophthalmic drops (Betoptic).

Melba contracted acute pneumonia 3 weeks ago. She completed a 10-day course of antibiotics, but her dyspnea has become progressively worse. Initially, she was able to function by using her nebulizer treatments every 3 hours. However, this afternoon her husband called 911 when Melba stated, "I can't breathe."

In the following table list a minimum of 3 actual or potential nursing problems appropriate for this patient. Which problem would be the priority? List 3 nursing interventions related to each of the problems.

Nursing Problems and Interventions (Examples for instructor)

1.Impaired gas exchange
a.
b.
c.
2.Chronic pain
a.
b.
c.
3.
a.
b.
c.

Melba's Medications

Drug	Drug class	Reason for med	Patient teaching	Nursing concerns
metoprolol	Beta blocker	HTN, HR control		Monitor HR, BP
fluticasone/salmeterol (Advair)	Long acting beta blocker and steroid	COPD	Must use daily; symptom prophylaxis	Rinse mouth post
albuterol/ipratropium (Combivent)		COPD	For sudden onset symptoms	Report dizziness or blurred vision, or difficulty voiding, bronchospasm
metformin	oral antihyperglycemic; Biguanide	Diabetes type 2; decreases amt of glucose absorbed from food	Take with meals. Swallow tablet whole	Can cause lactic acidosis. No contrast dye
codeine	opioid	Atypical pain post CABG	Drowsiness or dizziness	Potential constipation
lorazepam	benzodiazepine	anxiety	Drowsiness or dizziness	SE: dizziness, drowsiness, lethargy, respiratory depression
betaxolol ophthalmic drops (Betoptic)	Beta blocker ophthalmic drop	Hx glaucoma	May cause blurred vision and light	May cause bradycardia or

			sensitivity	bronchospasm

1. Before planning care for Melba you have reviewed the underlying pathophysiology for her respiratory failure. Realizing that many patients suffer from a combination of hypoxemic and hypercapnic failure, you review both classifications. Place an X in the correct column that corresponds with the condition.

	Hypoxemic (Oxygenation failure)	Hypercapnic (Ventilation failure)
Acute respiratory distress syndrome	X	
COPD		X
Pneumonia	X	
Sedative and opioid overdose		X
Spinal cord injury		X
Pulmonary emboli	X	
Cardiogenic pulmonary edema	X	
Toxic inhalation	X	
Asthma		X
Pain		X
Severe head injury		X
Severe obesity		X

2. Select the *four* factors that may have contributed to Melba's respiratory problem.

COPD

Acute respiratory distress syndrome

Pneumonia

Sedative and opioid overdose

Spinal cord injury

Pulmonary emboli

Cardiogenic pulmonary edema

Toxic inhalation

Asthma

Pain

3. On Melba's admission to the CCU, you review lab work obtained in the emergency department (ED). Baseline (pre-intubation) arterial blood gas (ABG) results on 4 L of O2 were as follows: pH 7.28, PaO2 60 mm Hg, PaCO2 62 mm Hg, HCO3 32 mEq/L, and O2 saturation 84%.

What do these ABG's suggest?

Respiratory acidosis

Hypercapnic Respiratory Failure:

Decreased ventilation or carbon dioxide removal

PaCO2 > 50 mmHg + pH < 7.35 with or without hypoxemia

4. What other diagnostic studies would you also expect the health care provider to have ordered in the ED? There are 7 correct answers.

- Complete blood count (CBC)
- Complete metabolic panel
- Liver enzymes
- 12-lead electrocardiogram (ECG)
- CT scan of the brain
- Urinalysis
- Sputum culture
- Alkaline phosphatase
- Chest x-ray
- Blood culture

5. Melba was intubated in the ED and placed on the ventilator. What other interventions would you anticipate being ordered for Melba? Select all that apply

- Antibiotic therapy
- IV methylprednisolone (Solu-Medrol)
- Bronchodilator therapy
- Fluid Restriction
- IV sedation
- Rationale:
- Position patient with head of bed (HOB) up 30 degrees
- Chest physiotherapy
- IV analgesia
- Position patient with good lung up

Rationale: Melba needs fluids to thin her secretions. The good lung should be placed down to improve ventilation perfusion to the sicker lung. Remember how the prone position for ventilated patients helped improve the lung VQ to the dorsal side of the lungs.

6. Melba's ventilator settings are as follows: Mode: assist/control (ACV), VT 450, FIO2 60%, PEEP 5 cm, & RR 18. Which of the following statements correctly describes the ACV mode setting on the ventilator?

A. The ventilator delivers breaths at a set rate per minute and VT that are independent of patient's ventilatory efforts.

B. The ventilator delivers a present VT at a preset frequency in synchrony with the patient's spontaneous breathing. The patient self-regulates any additional breaths.

C. The ventilator delivers a preset VT at a preset frequency, and when the patient initiates additional breaths, the preset VT is delivered.

D. The ventilator delivers continuous positive pressure with an initial rapid flow rate whenever the patient initiates a spontaneous breath.

7. With initial application of PEEP, which assessment will be of highest priority?

- Heart rate
- Urinary output
- Peripheral pulses
- Blood pressure

Rationale: Positive end expiratory pressure (PEEP) increases intrathoracic pressure. This results in decreased venous return to the heart, decreased left ventricular end-diastolic volume (preload), decreased cardiac output (CO), and hypotension. Thus the monitoring of the patient's blood pressure would be of highest priority.

8. After you suction Melba and clear the ventilator tubing of fluid, the high-pressure alarm continues to sound, and the patient's respiratory rate increases to 32 breaths/minute. Lung sounds reveal bibasilar crackles and her oxygen saturation is 95%. Which drugs would be appropriate to give at this point? Select all that apply

- lorazepam (Ativan) 0.5 mg IV
- Adenosine 6 mg IV
- methylprednisolone (Solu-Medrol) 120 mg IV
- Sodium bicarbonate 50 mEq IV
- Morphine sulfate 2 mg IV

Rationale: Common causes of high pressure include bronchospasm, secretions, condensation (water) in tubing, biting the endotracheal tube, and fighting the ventilator (ventilator asynchrony). You have cleared secretions and fluid in the ventilator tubing. Adequate oxygenation is evidenced by the patient's oxygen saturation. Bilateral breath sounds rule out any bronchospasm. However, the patient's hyperventilation may be a clinical manifestation of anxiety and/or pain, which can lead to ventilator asynchrony. Therefore it is most appropriate to consider sedation and/or analgesia for the patient at this point. Unless it is contraindicated, many intubated patients require continuous sedation and possibly analgesia. Lorazepam is a benzodiazepine sedative-hypnotic agent.

9. Melba is finally calmer, and you perform a thorough assessment. You recognize the importance of monitoring Melba closely for potential complications of mechanical ventilation. Select potential ventilator-associated complications. There are 6 correct answers

- Barotrauma
- Diarrhea
- Pneumonia
- Fluid volume deficit
- Alveolar hypoventilation
- Alveolar hyperventilation
- Focal seizures
- Sodium and water retention
- Stress ulcers

10. Which of the following interventions are helpful in preventing VAP? Select all that apply

- HOB elevation at a minimum of 30 to 45 degrees
- Change ventilator tubing q48hr
- Put HOB flat whenever turning patient
- Practice effective hand washing before and after suctioning
- Use ET tubes with subglottic secretion drainage port
- Drain condensation in ventilator tubing once a day
- Provide frequent mouth and oral hygiene
- Allow for daily spontaneous awakening trials
- Provide peptic ulcer prophylaxis
- Assess readiness to wean
- Consider early and progressive ambulation

11. You recognize that Melba's history of COPD makes her lungs more compliant and thus increases her risk for injury related to mechanical ventilation. You monitor her closely for which clinical manifestations of barotrauma? Select all that apply

- Hypocapnia
- Subcutaneous emphysema
- Increase in rhonchi and/or crackles
- Unilateral decreased or absent breath sounds
- Bradypnea
- Tachycardia

Rationale: Barotrauma may result from rupture of overdistended alveoli during mechanical ventilation. With barotrauma, alveolar air escapes, leading to pulmonary interstitial emphysema, pneumothorax, and subcutaneous emphysema. Clinical manifestations of barotrauma include decreased breath sounds on the affected side, tachypnea, and tachycardia. Subcutaneous emphysema may be palpable as crepitus under the skin. ABG analysis reveals hypercapnia and hypoxemia

12. Melba responds to antibiotic therapy and her respiratory status improves. She is currently being weaned from the ventilator. During the weaning trial, you monitor her closely for any signs or symptoms of weaning failure that would necessitate returning to previous ventilator settings. Select assessment findings that would indicate intolerance to weaning. There are 11 correct answers.

- Tachypnea
- Dyspnea
- Decreased urine output
- Tachycardia
- Dysrhythmias
- Hypothermia
- Sustained oxygen desaturation
- Hypertension
- Decreased bowel sounds
- Hypotension
- Agitation
- Diaphoresis
- Anxiety

13. During the weaning process, you appropriately delegate which nursing activity to unlicensed assistive personnel (UAP)?

- Explain the weaning process to M.B.'s family
- Assess patient for subtle changes in behavior
- Obtain and document vital signs q15min
- Titrate oxygen according to results of pulse oximetry
- Peripheral pulses

Rationale: UAP may appropriately obtain and document vital signs. It will be your responsibility to evaluate the vital signs regarding M.B.'s tolerance of weaning. It is not appropriate for UAP to assess M.B.'s response to weaning or to teach her family about the process of weaning. Titration of oxygen during the weaning process requires the decision-making skills of a licensed health care provider.