Case Study

- B.A., a 73-year-old female, arrives in the ED in acute decompensated heart failure (ADHF).

- RR 30 beats/minute
- + accessory muscles to breathe
- Bilateral crackles to her lung apices.
- $\text{SpO}_2$ is 85% on non-rebreather mask.
Case Study

• The health care provider orders STAT ABGs on B.A.

• ABG results:
  • pH 7.28,
  • PaCO₂ 55 mm Hg,
  • PaO₂ 60 mm Hg,
  • HCO₃ 25 mEq/L.

• How would you interpret these ABGs?
Artificial Airways

Placement of a tube into the trachea to bypass upper airway and laryngeal structures

- Endotracheal (ET) intubation
  - Via mouth or nose past larynx

- Tracheostomy
  - Via stoma in neck

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Endotracheal Tube
Artificial Airways

• Oral ET intubation
  • Procedure of choice
  • Airway can be secured rapidly
  • Larger-diameter tube can be used
    • Decreases work of breathing (WOB)
    • Easier to remove secretions and perform bronchoscopy

• What are the Associated risks?
Artificial Airways

- Nasal ET intubation
  - Blind procedure
  - head and neck manipulation is risky or cranial sx
  - Contraindicated: facial and basilar skull fractures

What are the associated risks?
Case Study

• The health care provider identifies the need to immediately intubate B.A. and place her on a mechanical ventilator.

How would you prepare for this procedure?
ET Intubation Procedure

- Rapid sequence intubation (RSI)
  - concurrent administration of sedative and paralytic agents

- Decreases risks of aspiration and injury to patient

- Contraindications: cardiac arrest or difficult airway
ET Intubation Procedure

• Before intubation
  • Sniffing position vs. ramp position
  • Preoxygenate using BVM with 100% O₂ for 3–5 minutes
  • Limit each intubation attempt to <30 seconds
  • Ventilate between successive attempts BVM with 100% O₂
Case Study

- The health care provider successfully inserts an oral endotracheal tube into B.A.

- *How would you confirm proper placement of the ET tube?*

- *What nursing interventions would you plan to prevent complications associated with intubation?*
ET Intubation Procedure

• Following proper ET tube placement

• Connect tube to $O_2$ source
• Secure airway
• Suction ET tube and pharynx
• Insert bite block
• Obtain chest x-ray
  • 2–6 cm above carina

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ET Intubation Procedure

- Following intubation:
  - Record and mark position of tube
  - Cut off excess tubing
  - Obtain ABGs
  - Continuously monitor pulse oximetry and end-tidal CO$_2$
Nursing Management
Artificial Airway

- Maintaining correct tube placement
  - Continuously monitor
  - Confirm exit mark on ET tube remains constant
  - Observe chest wall movement
  - Auscultate bilateral breath sounds
Nursing Management
Artificial Airway

- Incorrect tube placement = emergency
  - Stay with patient and maintain airway
  - Support ventilation
  - Secure help immediately
  - If necessary, ventilate with BVM and 100% O₂
• Maintaining proper cuff inflation:
  
  • Serves to stabilize and “seal” ET tube within trachea
  • Excess volume $\rightarrow$ tracheal damage
  • Cuff pressure 20–25 cm H$_2$O

• Measure and record on routine basis
  • Minimal occluding volume (MOV) technique
  • Minimal leak technique (MLT)
Nursing Management: MOV

Mechanically ventilated patients:

• Place stethoscope over trachea
• Inflate cuff to MOV by adding air until no air leak is heard at peak inspiratory pressure

Spontaneously breathing patients:

• Inflate cuff until no sound is heard after a deep breath or after inhalation with a BVM

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Nursing Management:

Minimal leak technique (MLT)

- **Exception:**
  - Small amount of air is removed from cuff until a slight leak is auscultated at peak inflation
Nursing Management
Artificial Airway

• Maintain cuff inflation

  • Measure with manometer
  • If cannot maintain pressure or need higher volumes → cuff leaking or tracheal dilation
    → notify MD
• Monitoring oxygenation:
  • ABGs
  • $\text{SpO}_2$
  • $\text{SvO}_2/\text{ScvO}_2$
  • Clinical signs of hypoxemia

Table 66-4
Nursing Management
Artificial Airway

- Monitoring **ventilation:**
  - PaCO$_2$
  - Continuous partial pressure of end-tidal CO$_2$ (PETCO$_2$)
  - Respiratory rate and rhythm
  - Use of accessory muscles
Nursing Management

Artificial Airway

• Maintaining tube patency
  • Do not routinely suction patient

• Assess for:
  • Visible secretions in ET tube
  • Sudden onset of respiratory distress
  • Suspected aspiration of secretions
  • ↑ Peak airway pressures
  • Adventitious breath sounds
  • ↑ Respiratory rate and/or coughing
  • ↓ in \( \text{PaO}_2 \) and/or \( \text{SpO}_2 \)
Nursing Management
Artificial Airway

• Open suction technique

• Closed-suction technique (CST)
  • Enclosed in a plastic sleeve connected directly to patient-ventilator circuit
  • Maintains oxygenation and ventilation
  • Decreases exposure to secretions
Nursing Management
Artificial Airway

• Potential complications of suctioning
  • Hypoxemia, bronchospasm
  • Increased intracranial pressure
  • Dysrhythmias
  • ↑ or ↓ BP
  • Mucosal damage
  • Bleeding, pain, infection

• What nursing interventions can you implement?
Nursing Management
Artificial Airway

• Managing thick secretions by:
  • Adequate hydration
  • Supplemental humidification
  • No saline instillation
  • Antibiotics PRN
  • Mobilization, etc.
Nursing Management
Artificial Airway

• Oral care
  • Brush teeth BID
  • Oral swabs with 1.5% hydrogen peroxide
  • Chlorhexidine oral rinse
  • Moisturizer
  • Oropharyngeal suctioning
  • Reposition and retape ET tube every 24 hours
Nursing Management
Artificial Airway

- Fostering comfort and communication
  - ↑ Anxiety
  - Use variety of methods to communicate
  - Sedatives
  - Relaxation therapy
Complications of ET intubation:

- Unplanned extubation
  - Patient vocalization
  - Activation of low-pressure alarm
  - Diminished or absent breath sounds
  - Respiratory distress
  - Gastric distention
Nursing Management
Artificial Airway

• Preventing unplanned extubation:
  • adequate securement of ET tube
  • Support ET tube during repositioning and procedures
  • Provide sedation and analgesia as ordered
  • Use standardized weaning protocols
  • Use soft wrist restraints

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Nursing Management
Artificial Airway

• If extubation occurs:
  • Stay with patient
  • Call for help
  • Manually ventilate patient with 100% O₂
  • Provide psychological support
Nursing Management
Aspiration risk & prevention:

• Cannot protect airway with ET tube: Why?
  • Inflate cuff
  • Continuous epiglottic suctioning

• ↑ Salivation
  • Suction oral cavity frequently

• Prevent vomiting
  • Orogastric or NG tube and connect to low, intermittent suction
  • HOB ↑ 30 to 45 degrees
Continuous Subglottal Suctioning
Mechanical Ventilation

• Process by which fraction inspired oxygen (FIO$_2$) at ≥ 21% (room air) is moved into and out of lungs by a mechanical ventilator
Mechanical Ventilation

• **Indications:**
  • Apnea or impending inability to breathe
  • Acute respiratory failure
  • Severe hypoxia
  • Respiratory muscle fatigue

• **Considerations:**
  • *Not curative*
  • +/- types
  • *May be ethical decision to use or not*
Mechanical Ventilation: Negative Pressure

- Non-invasive
- Encases chest or body
- Intermittent negative pressure pulls chest outward → air rushes in → passive expiration
- Similar to normal ventilation

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Mechanical Ventilation: Positive Pressure (PPV)

- Invasive
- Delivers air into lungs under positive pressure during inspiration → intrathoracic pressure ↑ during lung inflation
- Expiration occurs passively
Case Study

• The health care provider orders B.A. to be placed on a mechanical ventilator using positive pressure ventilation.

• *How does this type of ventilation compare to “normal” breathing?*
Case Study

- B.A. is placed on a mechanical ventilator with the following settings:
  - A/C mode
  - VT 500 ml
  - FIO₂ 50%
  - RR 18
  - PEEP 5 cm

Describe these settings?
Mechanical Ventilation: Modes of PPV

• Volume ventilation

  • Most common
  • Predetermined tidal volume ($V_T$) delivered with each inspiration

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Mechanical Ventilation: Modes

- Controlled ventilation (CV)
  - Ventilator does all the WOB for paralyzed patients (spinal injuries or neuromuscular disease)

- Assisted control (A/C)
  - Ventilator and patient share WOB
Mechanical Ventilation = Volume

- Assist-control (A/C) ventilation
  - Preset RR, Vt, PEEP
  - Vt is deliver when patient initiates breaths
  - Able to breathe faster the preset rate
  - Risk for hypo/hyperventilation
Mechanical Ventilation = Volume

• Synchronized intermittent mandatory ventilation (SIMV)
  • Preset Vt, RR, inspiratory time, sensitivitiy and PEEP
  • Delivers mandatory breath at preset $V_T$ at preset RR in synchrony with pt
  • Between ventilator-delivered breaths, patient is able to breathe spontaneously
Mechanical Ventilation

• SIMV
  • Patient receives preset FIO$_2$ but self-regulates rate and volume of spontaneous breaths

• Potential benefits
  • Improved patient-ventilator synchrony
  • Lower mean airway pressure
  • Prevention of muscle atrophy

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Mechanical Ventilation: Modes of PPV = Pressure

• Generates flow until a preset peak inspiratory pressure is reached
• $V_T$ varies
• Careful attention needed to prevent hyper/hypoventilation
Mechanical Ventilation: Pressure Modes

- Pressure support ventilation (PSV)
  - Augments inspiration for *spontaneous breathing* patients
  - Preset pressure, PEEP and sensitivity
  - Breaths are delivered at preset pressure level and maintained throughout inspiration
  - Patient determines Vt, RR, and inspiratory time
Mechanical Ventilation: Pressure Modes/PSV

- continuous ventilation and weaning

- Advantages
  - ↑ Patient comfort
  - ↓ WOB
  - ↓ Oxygen consumption
  - ↑ Endurance conditioning
Mechanical Ventilation: Pressure Modes

• Pressure-controlled/inverse ratio ventilation (PC-IRV)

  • Combines pressure-limited ventilation with an inverse ratio of inspiration (I) to expiration (E)
  • Normal I/E is 1:2
  • I/E ratio set at 1:1 - 4:1; PEEP
Mechanical Ventilation: Pressure Modes

• PC-IRV
  • Progressively expands collapsed alveoli/PEEP-like effect
  • Requires sedation with/out paralysis

• Tx: ARDS and continuing refractory hypoxemia despite high levels of PEEP
• Auto Peep acceptable
Mechanical Ventilation: Pressure Modes

- Airway pressure release ventilation (APRV)
  - Permits spontaneous breathing
  - Preset CPAP (high P, high T alternates with low P, low T)
  - Inflates lungs and eliminates CO₂ then opposite
  - $V_T$ varies
  - tx: ARDS or acute lung injury
Mechanical Ventilation: PEEP

• Positive end-expiratory pressure (PEEP)
  • Positive pressure applied during exhalation, preventing alveolar collapse
  • ↑ Lung volume and functional residual capacity (FRC) improves oxygenation
Mechanical Ventilation: PEEP

- Maintain or improve oxygenation while limiting risk of $O_2$ toxicity

- Contraindications
  - highly compliant lungs (eg. COPD)
  - Unilateral or non-uniform disease
  - Hypovolemia
  - Low cardiac output
Mechanical Ventilation: PEEP

- Optimal or best PEEP
  - PEEP titrated to point oxygenation improves without compromising hemodynamics

- Physiologic PEEP = 5 cm H$_2$O
  - Replaces glottic mechanism
  - Maintains normal FRC
  - Prevents alveolar collapse

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Mechanical Ventilation: PEEP

• Auto-PEEP
  • Result of inadequate exhalation time
  • Additional PEEP over what is set
• Results
  • ↑ WOB
  • Barotrauma
  • Hemodynamic instability

What nursing interventions can you implement?
Mechanical Ventilation: Continuous positive airway pressure (CPAP)

- Pressure delivered continuously during spontaneous breathing
- Restores FRC
- Tx: obstructive sleep apnea (OSA); weaning
- Non-invasively mask
- ↑ WOB: caution with myocardial compromise

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Mechanical Ventilation: Bilevel positive airway pressure (BI-PAP)

- Delivers oxygen and two levels of pressure support:
  - Higher inspiratory positive airway pressure
  - Lower expiratory positive airway pressure
Mechanical Ventilation: Bi-PAP

• Noninvasive
  • Via tight-fitting face mask, nasal mask, or nasal pillows
• Similar to PSV
• Spontaneously breathing and cooperation

• Indications/contraindications?
Prone Positioning

- Improves lung re-expansion
  - Gravity
  - Pressure
- Nurse-intensive therapy
Complications of PPV

- Cardiovascular system
- Barotrauma
- Pneumomediastinum
- Volutrauma
- Alveolar hypo/hyperventilation
Case Study

• B.A. is admitted to the critical care unit for monitoring and treatment of her heart failure.

• What nursing interventions will you plan to specifically prevent ventilator-associated pneumonia (VAP)?
Complications of PPV

• Ventilator-associated pneumonia (VAP); 48 hours or more after intubation
  • Risk factors
    • Contaminated respiratory equipment
    • Inadequate hand washing
    • Environmental factors
    • Impaired cough
    • Colonization of oropharynx
Complications of PPV

- Sodium and water imbalance:
  - Progressive fluid retention
    - \( \downarrow \) Urinary output
    - \( \uparrow \) Sodium retention
  - Etiology
    - Decreased CO
    - Intrathoracic pressure changes
    - Stress response (RASS)
Complications of PPV

• Neurologic system:
  • Impaired venous drainage and ↑ cerebral volume → increased ICP
  • Elevate HOB
  • Keep patient’s head in alignment
  • Sedation vacation/holiday
Complications of PPV

• Gastrointestinal system:

  • Risk for stress ulcers and GI bleeding
  • Peptic ulcer prophylaxis
    • Histamine (H₂)-receptor blocker blockers, proton pump inhibitors
    • Enteral nutrition
Complications of PPV

- GI system:
  - Gastric and bowel dilation
    - NG or orogastric tube for decompression
  - ↓ Peristalsis → constipation
    - Bowel regimen

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Complications of PPV

• Musculoskeletal system:
  • Loss of muscle strength

• Interventions:
  • Adequate analgesia and nutrition
  • Early and progressive ambulation
  • Physical and occupational therapy
Psychosocial Needs

- Physical and emotional stress: *why?*
- Nsg Dx: ?
- Need to feel safe
  - Need to know (information)
  - Need to regain control
  - Need to hope
  - Need to trust
- Involve patients and caregivers in decision making
Psychosocial Needs

• Agitation and anxiety
  • Assess cause
  • Provide sedation and/or analgesia
• Assess for delirium
• Always address patients as if they are awake and alert
Psychosocial Needs

• Induce paralysis – effective synchrony with ventilator and increase oxygenation

• Hear, see, think, feel
  • Sedation and analgesia administered concurrently
Psychosocial Needs

- **Assessment:**
  - Train-of-four (TOF) peripheral nerve stimulation
- **Avoid excessive paralysis**
- **1:4**
Mechanical Ventilation

• Machine disconnection
  • Check tracheal tube and adapter
  • ALWAYS keep ALARMS ON
    • paused alarms during suctioning or removal from ventilator → reactivate before leaving
Mechanical Ventilation

- Ventilator malfunction:
  - Power or oxygen failure

- Intervention:
  - Disconnect patient from ventilator
  - Manually ventilate with 100% O$_2$
Nutritional Therapy

• PPV and hypermetabolism → inadequate nutrition

• Difficulty with oral intake
  • ET tube
  • Tracheostomy

• Consult speech therapist for swallowing study

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Nutritional Therapy

- Nutritional assessment: 24–48 hrs
- Inadequate nutrition can ↓:
  - $O_2$ transport
  - Exercise tolerance
  - Serum protein
  - Weaning
  - Resistance to infection
  - Speed of recovery
Nutritional Therapy

- Enteral gastric or small bowel feeding preferred
- Verify tube placement
  - X-ray
  - Exit site
  - Aspirate
- Limit CHO content lower to CO$_2$ production
Case Study

• B.A. responds well to medical treatment of her heart failure.
• She is ready to be weaned from the ventilator.

• What will you assess before beginning the weaning process?
Case Study

• What is the most common method for weaning a patient who has been on the ventilator for <3 days?

• Explain the process?
Case Study

• B.A. tolerates the SBT trial and is ready to be extubated.

• Explain how you would extubate B.A.?

• What will be your priority assessment of B.A. postextubation?
The ventilator settings for a patient on a volume ventilator include a synchronized intermittent mandatory ventilation (SIMV) mode with 5 cm H₂O PEEP. After 3 hours of ventilation, the patient’s PaO₂ has dropped from 82 mm Hg to 74 mm Hg. The most accurate interpretation of this finding by the nurse is that:

a. The patient’s respiratory rate may be decreasing, lowering the oxygen content of the blood.
b. The ventilator is creating high intrathoracic pressure, suppressing venous return and cardiac output.
c. The tidal volume provided by the ventilator is too high, increasing the amount of CO₂ being exhaled.
d. The pressure applied by PEEP requires an increased fraction of inspired oxygen (FIO₂) to maintain oxygenation.