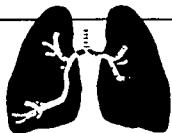


**CRITICAL CARE/EMERGENCY NURSING COURSES
BROOKE ARMY MEDICAL CENTER
FORT SAM HOUSTON, TEXAS 78234**

MECHANICAL VENTILATION

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MAJ, AN



OBJECTIVES

- Identify the indications for ventilatory support
- Define the types/modes of mechanical ventilation
- State ventilator parameters
- Discuss alarms and appropriate actions
- List potential complications



OUTLINE

- Indications for mechanical ventilation
- Types of mechanical ventilators
- Ventilator modes/settings
- Alarms
- Complications
- Weaning
- Documentation
- Nursing Diagnosis



MECHANICAL VENTILATION

The process by which ventilation is maintained by artificial or extrinsic means

Required when the pulmonary system fails to meet the demands of the body



PHYSIOLOGIC OBJECTIVES

- Improve pulmonary gas exchange
 - Alveolar ventilation
 - Arterial oxygenation
- Increase lung volumes
 - Prevent atelectasis
 - Increase FRC
- Reduce work of breathing



CLINICAL OBJECTIVES

- Reverse hypoxemia
- Reverse respiratory acidosis
- Relieve respiratory distress
- Decrease O₂ consumption
- Permit sedation/paralyzation
- Stabilize chest wall



INDICATIONS

- Respiratory Failure
 - 2 Types
 - Acute/Chronic
- Major Surgery
- **Head Injury



RESPIRATORY FAILURE

- Hypoxemic Respiratory Failure
 - Failure to oxygenate
- Hypercapneic Respiratory Failure
 - Failure to ventilate



HYPOXEMIC RESPIRATORY FAILURE

- Failure to oxygenate despite administration of supplemental oxygen
 - $\text{PaO}_2 < 60 \text{ mmHg}$
- Causes:
 - Pneumonia
 - ARDS
 - Pulmonary edema
 - Pulmonary embolus
 - Atelectasis
 - Pulmonary fibrosis



HYPERCAPNEIC RESPIRATORY FAILURE

- Inability to adequately expire carbon dioxide leading to progressive hypercarbia and acidosis.
 - $\text{PaCO}_2 > 50\text{mmHg}$, $\text{pH} < 7.25$
- Causes:
 - Sedation/Drug overdose
 - Head injury
 - Neuromuscular disease
 - Emphysema, asthma, bronchitis
 - Chest wall deformity



V/Q DISTURBANCE

- Most Common cause of hypoxemia



VENTILATION/PERFUSION (V/Q)

- Ventilation (V)
 - 4L/min
- Perfusion (Q)
 - 5L/min
- $\text{V}/\text{Q}=0.8$
- Normal Unit
 - Ventilation=Perfusion



VENTILATION/PERFUSION (V/Q) MISMATCH

- **Dead Space Unit**
 - Ventilation>Perfusion
 - *pulmonary emboli, cardiogenic shock
- **Shunt**
 - Ventilation<Perfusion
 - normal shunt- 2-5% of CO
 - pneumonia, ARDS, Atelectasis, septal defect
- **Silent Unit**
 - No ventilation or perfusion



VENTILATORS



VENTILATOR TYPES

- **Negative Pressure Ventilators**
 - Generates a negative pressure gradient that pulls air into the lung
 - Iron Lung
- **Positive Pressure Ventilators**
 - Achieves lung inflation by the application of intermittent or continuous positive pressure to the airway



CYCLING MECHANISM

- **Volume Cycled**
 - Inspiration terminated when preset volume is delivered
- **Pressure Cycled**
 - Inspiration ends when a preset pressure is reached
- **Time Cycled**
 - Delivers gas at a preset time interval



MODES

- **Controlled Mechanical Ventilation (CMV)**
 - Set number of breaths at set volume
- **Assist-Control Ventilation (A/C)**
 - Set number of breaths at set volume, *patient can trigger breath-gets full tidal volume (TV)
- **Synchronized Intermittent Mandatory Ventilation (SIMV)**
 - Set breaths at set volume, *patient can trigger breaths at own TV



MODES (cont.)

- **Pressure Support Ventilation (PSV)**
 - Patient's inspiratory effort is augmented by positive pressure
- **Pressure-Regulated Volume Control (PRVC)**
- **Inverse Ratio Ventilation (IVR)**
 - Reverses inspiratory and expiratory times



Modes (cont.)

- **High Frequency Ventilation**
 - Support at rates greater than normal
 - Reduce airway pressure
 - Improve gas exchange
 - High Frequency Jet Ventilation
 - Rates 110-400 breaths/min
 - High Frequency Oscillators
 - Rates 400-2400 breaths/min



MODES (cont.)

- **Differential Lung Ventilation (DLV)**
 - Separate ventilator parameters for each lung
- **Liquid Ventilation**
- **ECMO**



BASIC SETTINGS

- **Rate**
 - Breaths per minute
- **Tidal Volume**
 - Volume per breath *5-15cc/kg
- **Oxygen Concentration (Fio₂)**
 - Between 21-100%
 - *Less than 50% desirable



BASIC SETTINGS (cont.)

- **I:E Ratio**
 - usually 1:2 to avoid air trapping
- **Positive End Expiratory Pressure (PEEP)**
 - Maintains greater than atmospheric pressure in airways at end expiration
- **Flow Rate**
 - Rate required to deliver tidal breath
 - 40-100 L/min



OTHER PARAMETERS

- **Peak Inspiratory Pressure**
 - Measured at end-inspiration
 - Increase indicates compliance/resistance change
 - Keep at <35mm cmH₂O
- **Minute Ventilation**
 - RR x TV
 - 4-8 L/min



ALARMS

- **High Pressure Alarms**
 - Increased airway resistance
 - Secretions
 - Tubing kinked/Biting tube/Coughing
 - Bronchospasm
 - Bucking vent
- Decreased compliance
 - Atelectasis
 - Pulmonary edema
 - Worsening of disease process
 - Pneumothorax



ALARMS (cont.)

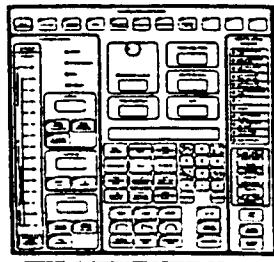
- **Low Pressure Alarms**
 - Patient disconnect
 - Cuff leak
 - Circuit leak
 - Balloon Rupture



Nellcor Puritan-Bennett 7200



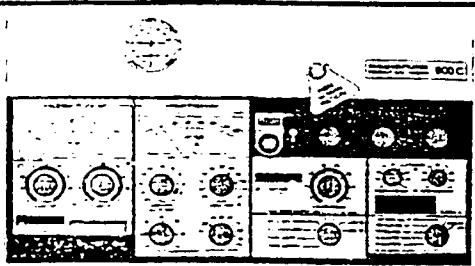
Puritan-Bennett 7200 Control Panel



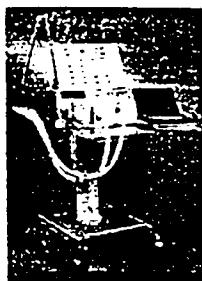
Siemens Servo 900C



Siemens Servo 900C
Control Panel



Siemens Servo 300



COMPLICATIONS

• PULMONARY

- Barotrauma
 - Pneumothorax
 - Pneumopericardium
 - Subcutaneous Emphysema
- O₂ Toxicity
 - >50% FIO₂ x 24 hours
- Tracheal Damage
 - Tracheal-stenosis
 - Tracheomalacia



COMPLICATIONS

• CARDIOVASCULAR

- Increased intrathoracic pressure
- Decreased venous return
- Decreased CO
- Decreased tissue perfusion



COMPLICATIONS

• GASTROINTESTINAL

- Distention-Air swallowing
- Decreased motility-PPV
- Ulcers-Stress



COMPLICATIONS

- **RENAL**

- Kidneys sense decreased CO
- Increased ADH secretion by pituitary
- Retention H₂O



COMPLICATIONS

- **INFECTION**

- Bypasses normal defense mechanisms
- Pneumonia
- Sinus Infection



COMPLICATIONS

- **NUTRITION**

- Malnutrition
- Overfeeding



COMPLICATIONS

- Psychological Problems
 - Anxiety
 - Pain
 - Fighting Ventilator
 - ICU psychosis



ACUTE DETERIORATION

- Pneumothorax
- Mucous plugging
- Reactive airway
- Dislodged ETT
- Embolus
- Ventilator Malfunction



WEANING

- Correct Primary Pathology
 - Hemodynamically stable
 - Airway patent
 - Awake
 - F/E Balance
 - Acid-Base Balance
 - Sedation/Paralytics off
 - Rested



WEANING PARAMETERS

- Minute Ventilation 5-10 L/min
- Negative Inspiratory Force (NIF)
 > -20cmH₂O
- TV 4-5cc/kg
- Rate <30 bpm
- PaO₂ >60 mmHg on 40%



WEANING

- T-Piece
- SIMV
- PSV
- CPAP



UNSUCCESSFUL WEANING

- Increased HR and RR
- Decreased TV
- Anxiety
- Increased WOB
- Arrhythmia
- Diaphoresis
- Decreased Sats
- Decreased LOC



DOCUMENTATION



- Prior to intubation

- Assessment
- Reason for intubation



DOCUMENTATION



- During Intubation

- Toleration
- Medications
- Tube-size/placement
- Confirmation
- Initial settings



DOCUMENTATION



- While on ventilator

- Assessment/Toleration/Meds
- Settings
- Tube size/location
- PIP
- Spontaneous TV/Rate
- SATS/ETCO₂
- Cuff pressure



DOCUMENTATION



- Weaning/Post-Extubation
 - Weaning parameters
 - Time started/toleration
 - Time of extubation
 - Fio₂ post extubation
 - VS/Sats



NURSING DIAGNOSIS

- Ineffective Gas Exchange
- Ineffective Airway Clearance
- Ineffective Breathing Pattern
- Anxiety
- Potential for Infection



EQUIPMENT

- BVM
- Suction set-up/catheters
- Extra Trach

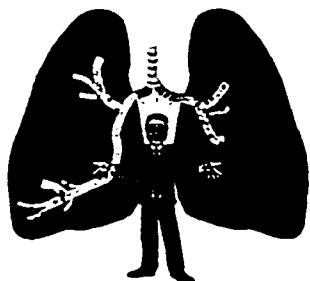


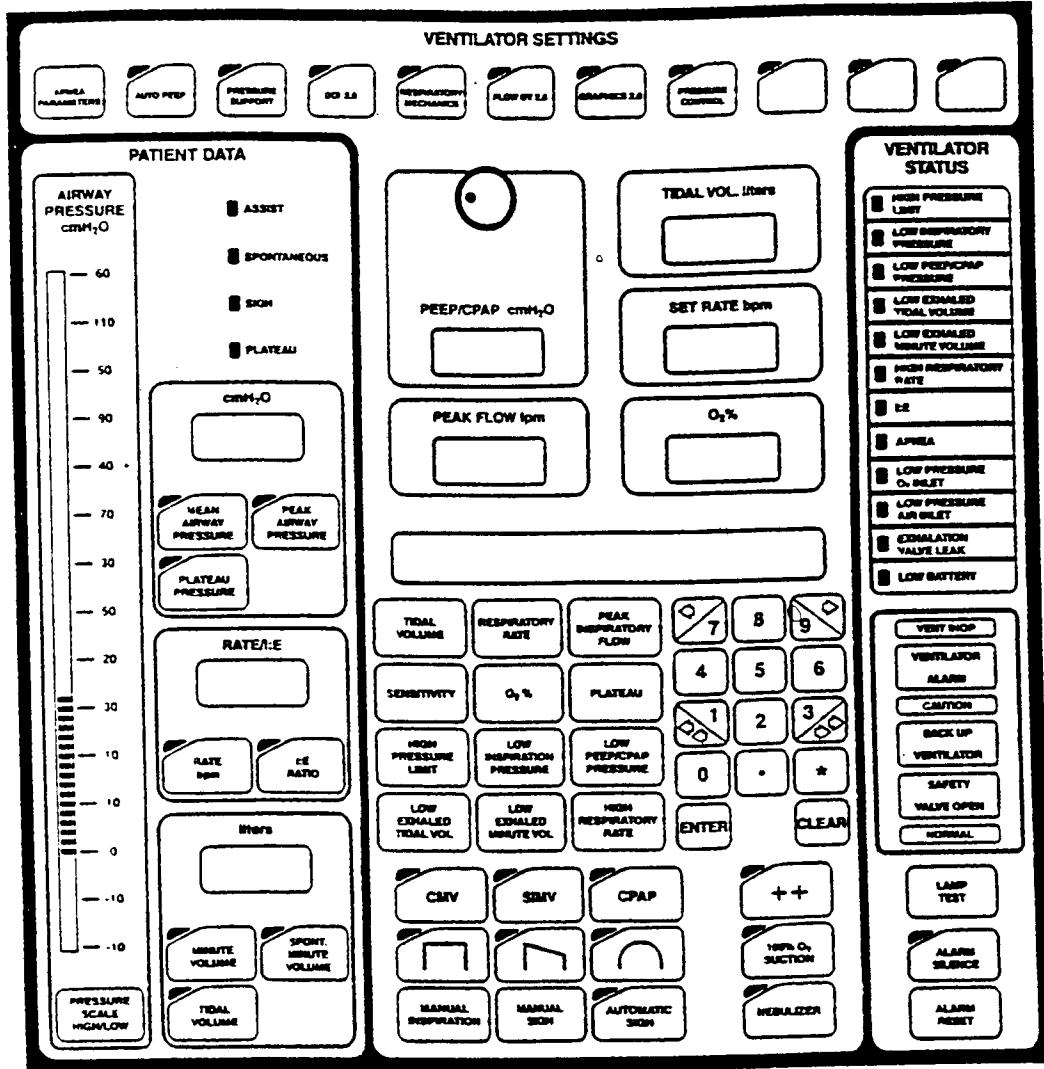
SUMMARY

- Indications
- Types
- Modes/Settings
- Complications
- Weaning
- Documentation

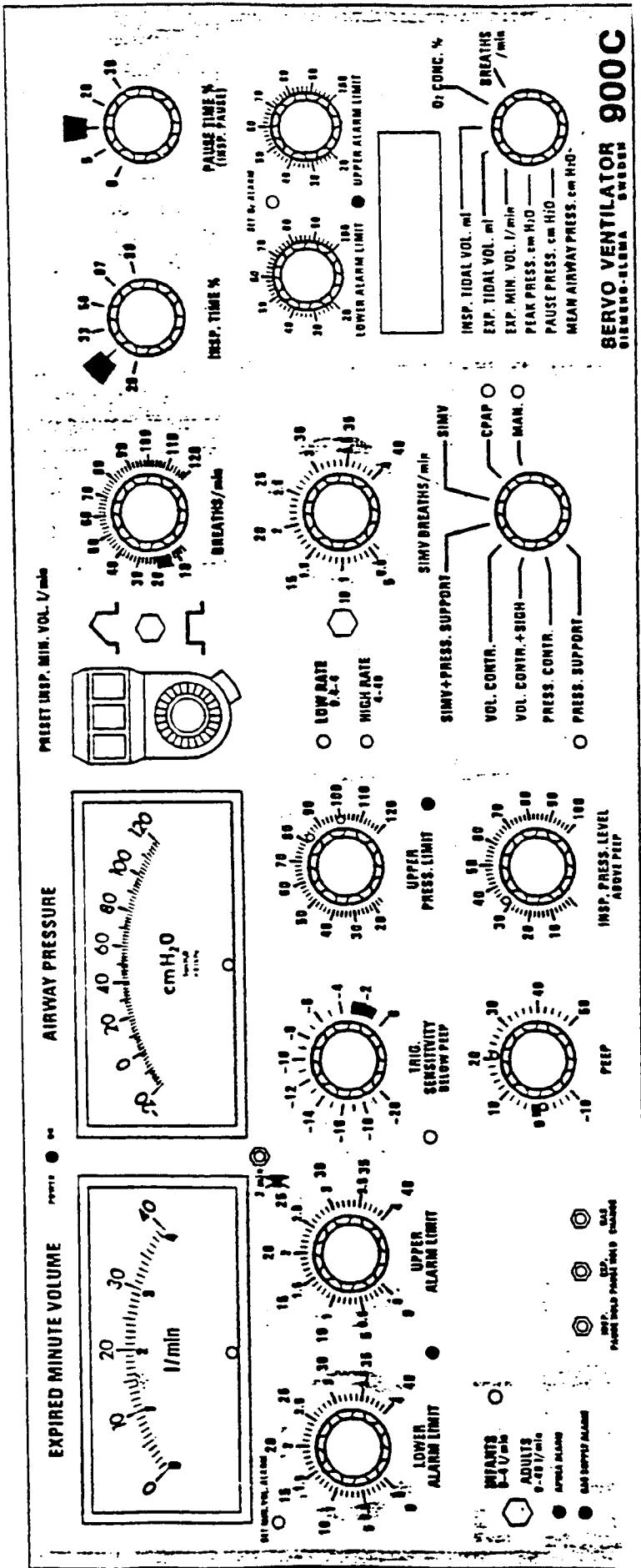


QUESTIONS





Nellcor Puritan-Bennett 7200 Series Micropressor ventilator enhanced (PLUS) control panel. (Courtesy of Puritan-Bennett Corp, Carisbad, CA)



Control panel of the Siemens 900C ventilator. (Courtesy of Siemens Life Support Systems, Iselin, NJ)

SERVO VENTILATOR 300

SIEMENS

Control panel of the Siemens Servo 300 ventilator. (Courtesy of Siemens Life Support Systems, Iselin, NJ)

