"ICU EQUIPMENT, LINES & TUBES: LIFELINE OR TRIPLINE?"

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OBJECTIVES
- Identify and state function of basic equipment, lines, and tubes used in the ICU
- Identify different modes of ventilation and ventilator settings
- Synthesize information for use in clinical and academic practice

EVIDENCE-BASED PRACTICE
* Mobilizing patients in ICU is safe, feasible and improves physical function!
* It can reduce length of hospital stay and costs!

- Schweickert WD. Lancet. 2009 May; 373:1874-1882

WHAT DO YOU NEED TO KNOW TO PRACTICE SAFELY IN ICU?
- EKG Monitor
- Ventilator
- Lines
- Catheters
- Tubes
- Dialysis equipment
- Pacemaker
- Mechanical circulatory devices
- Respiratory care equipment

EKG MONITOR
- HR
- RR
- NBP
- O2 Sat
- Rhythm
- ABP
- CVP
- B temp
- PAP
- SvO2
- CO
- CI
- ICP

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EKG LEADS

- **Right side:**
  - White and green
  - “Snow over grass”
- **Left side:**
  - Black and red
  - “Smoke over fire”
- **Middle:** Brown

LINES

CATHETERS

TUBES

VASCULAR CATHETERS

Types and location

**ARTERIAL:**
- Femoral
- Radial
- Axillary
- Brachial
- Dorsalis pedis

**VENOUS:**
- Femoral
- Jugular
- Subclavian

ARTERIAL CATHETERS

- Sheaths
- Hemodynamic monitoring

ARTERIAL CATHETER - SHEATH

- Indwelling sheath is placed in the artery usually during catheterization procedures
- It reduces the local, continuous and repetitive trauma from the catheter rubbing in the arterial wall during catheter manipulation
ARTERIAL CATHETER - SHEATH
CLINICAL CONSIDERATIONS

- STRICT BEDREST
  - As long as sheath remains in place
  - Several hours after catheter is removed
  - After sheath removal:
    - How many hours prior to any activity???
    - Hospital policy???

ARTERIAL CATHETERS
FOR HEMODYNAMIC MONITORING

PURPOSE:
- Continuous monitoring of blood pressure
- Access for drawing arterial blood gas

LOCATION:
- Radial
- Femoral
- Brachial
- Axillary
- Dorsalis Pedis

RADIAL ARTERY LINE

BRACHIAL ARTERY LINE

FEMORAL ARTERY LINE

FEMORAL ARTERY CATHETERS FOR HEMODYNAMIC MONITORING
CLINICAL CONSIDERATIONS

- The transducer should be positioned at the level of the right atrium to assure accurate pressure values
  - If transducer too low: BP will read high
  - If transducer too high: BP will read low
- If arterial line accidentally comes out, apply pressure immediately and notify RN

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IS IT SAFE TO MOBILIZE PATIENTS WITH FEMORAL ARTERIAL CATHETERS?

CLINICAL CONSIDERATIONS FOR PATIENTS WITH FEMORAL ARTERIAL LINES

Should patients be on bed rest ????

Should they be allowed to:
- Sit on side of bed?
- Sit in a chair?
- Walk?
- Perform exercises involving hip flexion?

- Risk-to-benefit ratio
- Carefully examine potential risks
- Carefully examine potential benefits for improved outcomes

EVIDENCE-BASED PRACTICE ???

Early Mobility and Walking for Patients with Femoral Arterial Catheters in Intensive Care Unit: a Case Series.
J. Acute Care Phys Ther 2011;Vol 2, Number 1-pg 30-34

Perme C, Masud F.
Mobilizing Patients with Femoral Arterial Catheters during Physical Therapy Interventions Did Not Lead to Catheter Related Complications

CLINICAL CONSIDERATIONS- ALWAYS INSPECT CATHETER SITE PRIOR TO ANY THERAPEUTIC INTERVENTION!!!!!!!

ARTERIAL CATHETERS COMPLICATIONS

The major complications associated with the arterial line are:
- Bleeding
- Infection
- Lack of blood flow to the tissue supplied by the artery

VENOUS CATHETERS

- Peripheral IVs
- Peripherally inserted central lines (PICC)
- Temporary central lines (Non-tunneled catheters)
- Temporary dialysis catheters
- Long-term catheters (Tunneled catheters)
- Pulmonary artery catheters
- Transvenous pacemakers
PERIPHERAL IV
• Inserted on a peripheral vessel
• Location: usually in the hand or forearm
• Administration of drugs, fluids, blood transfusion, and to obtain venous blood
• Infiltration is common when the IV fluid goes into the tissue instead of the vein
• Can be inserted by nurse
• Lasts 3-5 days

CENTRAL LINE

INDICATIONS:
• Monitoring of central venous pressure
• Administering drugs, fluids, TPN, blood transfusion
• Obtaining venous blood

CENTRAL LINE-TEMPORARY
• Inserted through a vein and travels to the heart
• Location:
  • Femoral
  • Subclavian
  • Jugular

PERIPHERALLY INSERTED CENTRAL CATHETER (PICC)
• Typically the upper arm is the area of choice.
• Long, slender, small, flexible tube that is inserted into a peripheral vein, and advanced until a large vein in the chest
• The point of entry is from the periphery of the body
• Less invasive, with decreased complication risks, and can remain in place for longer periods

SUBCLAVIAN CENTRAL LINE

DIALYSIS CATHETERS TEMPORARY
• Short term hemodialysis or apheresis
• Large bore with 2 or 3 lumen catheter
• Non-tunneled catheters providing direct access to the vein
• Location:
  • Femoral
  • Jugular
  • Subclavian
FEMORAL VENOUS CATHETERS CLINICAL CONSIDERATIONS

Temporary dialysis catheters (Non-tunneled):
- Larger bore and less flexible
- Can potentially kink
- Generally in place for less than 14 days

Should patients be on bedrest ???

FEMORAL DIALYSIS CATHETER

TUNNELED CATHETERS
LONG-TERM CENTRAL LINES OR DIALYSIS

- Long term catheters that are tunneled under the skin prior to entering a central vein
- Generally placed in the operating room or Interventional radiology
- Lasts months if working properly

TUNNELED CATHETERS – Brand names
- Hickman catheter
- Broviac catheter
- Groshong catheter
- Leonard catheter
- Tesio catheter
- Quinton Permcath

PULMONARY ARTERY CATHETER (PAC)
(SWAN-GANZ CATHETER)

- Usually inserted and removed only by the physician
- Location: Subclavian, Jugular, femoral
PULMONARY ARTERY CATHETER(PAC) OR SWAN-GANZ CATHETER

INDICATIONS FOR PULMONARY ARTERY MONITORING:
- Evaluate volume status
- Evaluate cardiac function
- Guide medical therapy
- Monitor response to fluids, diuretics, vasoactive drugs
- Monitor high risk patients perioperatively

PAC MEASUREMENTS:
- Right atrial pressure
- Pulmonary artery pressure
- Pulmonary artery wedge pressure
- Cardiac output
- Mixed venous oxyhemoglobin saturation

PULMONARY ARTERY CATHETER-CLINICAL QUESTION
- Should patients be mobilized with a PA Catheter ??
- Is it safe to walk patients who have PA Catheter ??

PAC- COMPLICATIONS
- PAC Insertion (2-16%)
  - Arterial puncture
  - Hemothorax
  - Pneumothorax
  - Arrhythmias : PVC and VT
- Significant VT or ventricular fibrillation requiring treatment (<1%)
- Knotting of the PAC on itself or on intracardiac structures (<1%)
- Pulmonary artery rupture *Most catastrophic, mortality rate 50% (<1%)
- PAC-related infection (up to 45%)
- Pulmonary infarction (<7%)

TUBES
- Artificial airways:
  - ET tube
  - Tracheostomy tube
- Ventriculostomy catheter
- Nasogastric tube (NG tube)
- Dobhoff
- PEG tube
- Chest tubes
- Hemovac/Drains

ARTIFICIAL AIRWAY

“Endotracheal or tracheostomy tube displacement in the ICU is a life-threatening emergency that may result in significant morbidity or may be fatal in some cases”
ENDOTRACHEAL TUBE (ET TUBE)

- Used for short term mechanical ventilation
- Location:
  - Oral
  - Nasal

TRACHEOSTOMY

- Used for long term ventilation
- Allows for improved comfort and oral hygiene
- Potential for speech and oral nutrition
- Reduced need for sedation
- Improved weaning from mechanical ventilation

COMPLICATIONS OF TRACHEOSTOMY:
- Misplacement of tube
- Hemorrhage
- Pneumothorax, Hemothorax
- Infection
- Tracheoesophageal fistula

FRESH TRACH PRECAUTIONS

- It takes ~ 5 to 7 days before a well-defined track between the trachea and the skin is formed
- Always follow facility policies for “fresh trach”

DIFFICULT AIRWAY

- “Clinical situation in which a conventionally trained anesthetist experiences difficulty with mask ventilation of the upper airway, tracheal intubation, or both”
- Adverse events: airway injury, hypoxic brain injury, and death
- Difficult airway in critical care is common
PASSY-MUIR VALVE

• Passy-Muir valve is a one-way valve
• Some patients may not be able to tolerate increased levels of activity with the valve in place
• Tracheostomy cuff MUST be deflated before valve is applied

TRACHEOSTOMY BUTTON

VENTRICULOSTOMY CATHETER

Spinal catheter

CHEST TUBE

• Indications:
  – After surgical opening of pleural space
  – Pleural effusion
  – Pneumothorax, hemothorax, clyothorax, or empyema
• Water seal or suction
CHEST TUBES - CLINICAL CONSIDERATIONS

- Always keep chest tube drainage system below the chest level
- Air bubbles in the underwater seal compartment is usually indicative of an air leak
- Always discuss with MD/RN prior to disconnecting suction

OTHERS

- Dialysis equipment
- Temporary pacemakers
- Mechanical circulatory device
- Respiratory care equipment

TEMPORARY PACEMAKERS

Methods of temporary pacing:
- External transcutaneous patches
- Transvenous or endocardial leads
- Atrial or ventricular epicardial leads placed during surgery

TRANSVENOUS PACEMAKER - IJ

Bispectral index (BIS) Monitor

- Measure of the level of consciousness by algorithmic analysis of a patient’s EEG
- 0 to 100 (equivalent to fully awake and alert)
- 40-60 indicates an appropriate level for sedation
MECHANICAL CIRCULATORY DEVICES

- ECMO
- LVAD
- IABP

EXTRA-CORPOREAL MEMBRANE OXYGENATION (ECMO)

- Provides both cardiac and respiratory support
- ECMO is most commonly used in neonatal ICUs for newborns, but it is also used for adults
- Veno-arterial (VA) and veno-venous (VV)
- In VV ECMO, no cardiac support is provided


Heartmate LVAD

INTRA‐AORTIC BALLOON PUMP (IABP)

• Inflates during diastole
• Deflates during systole

IABP – FEMORAL ARTERY

INTRA-AORTIC BALLOON PUMP (IABP)

• Indications:
  – Cardiogenic shock
  – Weaning from cardiopulmonary bypass

• Complications:
  – Aortic dissection
  – Arterial perforation
  – Limb ischemia
  – Dislodgment of atherosclerotic emboli
INTRA-AORTIC BALLOON PUMP (IABP)
Clinical considerations

- Patients with an IABP on the femoral artery are on complete bed rest.
  ***NO EXCEPTIONS!
- Do not flex the involved hip
- Should patients receive any therapy when an IABP is in place???

SUBCLAVIAN IABP promotes early mobility and walking

VENTILATOR

- Positive pressure
  - Volume
  - Pressure

AMBU BAG

- An Ambu bag is a proprietary brand of a self-inflating bag-valve-mask (BVM) resuscitator, used to provide artificial ventilation
### TERMINOLOGY

- **A/C**: Assist-control
- **SIMV**: Synchronized Intermittent Mandatory Ventilation
- **CPAP**: Continuous Positive Airway Pressure
- **PSV**: Pressure Support Ventilation
- **PEEP**: Positive End Expiratory Pressure
- **NIPPV**: NonInvasive Positive Pressure Ventilation
- **FiO2**: Fraction of Inspired Oxygen

### VENTILATOR SETTINGS

- **Mode of ventilation**
  - Tidal volume
  - Rate
- **FiO2**
- **PEEP**

### MODES OF MECHANICAL VENTILATION

**Assisted:**
- CMV/AC
- IMV/SIMV

*Ventilator:
- Does the work
- Starts and stops the breath

**Spontaneous:**
- CPAP
- Pressure support

*Patient:
- Does the work
- Starts and stops the breath
OTHER MODES OF MECHANICAL VENTILATION

- Pressure Control Ventilation (PCV)
- Pressure Control-Inverse Ratio Ventilation (PC-IRV)
- Airway Pressure Release Ventilation (APRV)
- Bi-Level Ventilation
- High-frequency oscillatory ventilation (HFOV)
- High-frequency jet ventilation (HFJV)
- Pressure Regulated Volume Control (PRVC)
- Proportional Assist Ventilation (PAV)
- Adaptive Support Ventilation (ASV) – Hamilton ventilator
- Proportional Pressure Support (PPS) – Draeger ventilator
- Tube Compensation (TC 100%)

PEEP (Positive End Expiratory Pressure)

- Increasing airway pressure at the end of expiration forces the alveoli open and maintains greater lung volume- Airway pressure does not return to 0 baseline
- PEEP improves oxygenation allowing for lower levels of oxygen
- PEEP increases FRC (ERV+RV)
- Used to prevent airways from collapsing
- Excessive PEEP may reduce cardiac output and impair systemic oxygen delivery.
**NON-INVASIVE POSITIVE PRESSURE VENTILATION (NIPPV)**

- Uses a mask instead of an artificial airway
- Used when short term ventilation is expected for COPD exacerbation, failed extubation, pneumonia, CHF, pulmonary edema

**NON-INVASIVE POSITIVE PRESSURE VENTILATION (NIPPV) Clinical considerations**

- Will mobility improve or deteriorate clinical status?
- NIPPV prn?
- NIPPV 24/7?
- Oxygen needs?
- Code status?

**PORTABLE VENTILATORS**

**VENTILATOR ALARMS**

- RED or YELLOW
- They alert clinicians that ventilator is functioning outside the parameters set
- It is common for alarms to go off when working with patients on ventilator
- Never stop the physical therapy treatment JUST because of the alarm
CAN YOU IDENTIFY?

- Mode of ventilation
- Rate
- Oxygen
- PEEP
- Respiratory rate
- Alarms

WHAT DO PHYSICAL THERAPISTS NEED TO KNOW TO PRACTICE SAFELY IN ICU?

- Monitoring and life support equipment
- Mechanical Ventilation
- Respiratory equipment
- Basic cardiopulmonary pathophysiology
- Principles of oxygen transport
- Complications of bed rest
- Physiologic changes associated with weakness and deconditioning
- Medications commonly used in ICU
- Clinical implications of lab values
- Emergency procedures
- Roles of all ICU team members

REMEMBER...

...Therapy program should be based on patient’s condition and goals, not on the ICU equipment...

...Limited knowledge and understanding of ICU equipment significantly limit therapy outcomes of ICU patients...

CONCLUSION

- It is rare to have complications directly related to therapy interventions in ICU, despite numerous lines, tubes, monitoring and life support equipment
- A comprehensive orientation program and competency assessment is the key for successful practice in the critical care environment.

CONCLUSION

- In order to provide safe and effective care for critically ill patients, the therapist MUST:
  - Understand equipment used in ICU
  - Understand function of equipment and implications during therapy intervention
  - Understand medical interventions provided in ICU
  - Use strong critical thinking skills

THANK YOU!

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