Monitoring of Respiratory System

Ventilation & Oxygenation Adequacy

A. Shahrokhi, MSc.
Qazvin Nursing & Midwifery School
Fall 2016
Learning Objectives:

- Describe the importance of a comprehensive assessment of a critically ill patient
- Describe how to assess the efficacy of breathing, work of breathing and adequacy of ventilation
- Discuss the principles of pulse oximetry
- Discuss the principles of blood gas analysis (ABG, VBG, Mixed Venous)
Continued...

Learning Objectives:

- Discuss the principles of ETCO2
- Discuss the monitoring priorities of a mechanically ventilated patient
- Discuss the monitoring priorities of an intubated patient (ETT, TT)
- Discuss the monitoring priorities of a patient with a chest drainage system
Sources for
MONITORING RESPIRATORY FUNCTION

- History Taking: * Biographic Data
  * Current Health
  * ROS

- Physical Examination & Periodic Assessment

- Diagnostic Evaluations & Lab Tests
CURRENT

HEALTH
SIGNS & SYMPTOMS and SYMPTOM ANALYSIS
SIGNS & SYMPTOMS

- Dyspnea
- Respiratory pattern changes
- Coughing
- Sputum production
- Abnormal sounds (wheezing, crackle, rattle, stridor, gargling, snoring, friction rub)
- Asymmetrical chest movements
- Chest pain (non-cardiac/cardiac)
- Cyanosis
- Clubbing
DYSPNEA

- Onset
- Duration
- Timing
- Constant vs. Episodic
- Relieved by body position or medication
- Other manifestations (Chest Pain, Cough, Nausea, Sputum, Weakness)
- Specific aggravating or alleviating factors (Exertion/Activity, Stress/Anxiety, Position, Allergens, Medications)
Cough

- Onset
- Duration
- Timing
- Relieved by medications, Fluids, rest?
- Is cough dry, hacking, wheezy?
- Other Manifestations (Chest Pain, fever, Dyspnea, Sputum)
- Specific aggravating or alleviating factors (Fever, Position, Allergies, Medication)
SPUTUM

- Duration
- Sudden vs Gradual onset
- Amount
- Appearance (Bloody, Purulent, Frothy, ...)
- Color
- Anticoagulant or Immunosuppressive drugs use?
Abnormal Sounds

- **Crackle(rale):** atelectasis
- **Wheeze:** bronchospasm
- **Rhonchus:** partial obstruction of Bronchus
- **Rattle:** sputum retention, pulmonary edema
- **Stridor:** laryngeal or tracheal obstruction
- **Friction rub:** Pleurisy
- **Snoring:** obstruction in URT(nose and mouth)
- **Gargling:** fluid in upper airway
WHEEZING

- **Onset** *(Sudden vs Gradual)*
- **Duration*
- **Timing*
- **Severity*
- **Relieved by medications, removal of allergens, ...*
- **Other Manifestations** *(Chest Pain, Cough)*
- **Specific aggravating or alleviating factors** *(Exertion/Activity, Stress/Anxiety, Allergies/Irritants, Medications)*
STRIDOR

- Difficulty Swallowing
- Early Morning Headache
- Excessive Sleepiness
- Risk of Aspiration
- Heart Failure
- Voice Change
NONCARDIAC CHEST PAIN

- Location
- Duration
- Timing
- Radiation
- Previous Episodes
- Client Description (Burning, Sharp, Aching)
- Specific Aggravating or Alleviating Factors (Exertion, Movement, Breathing, Coughing)
CYANOSIS

- **Location**: *Peripheral*  
  *Central*

- **Severity**
PHYSICAL EXAMINATION
PHYSICAL EXAMINATION

- Inspection
- Palpation
- Percussion
- Auscultation
MONITORING IN PATIENT WHO HAS ARTIFICIAL AIRWAY
NURSE MUST NOTICE TO:

1) Monitor tube placement (be in right place)
2) Monitor airway patency
3) Monitor secretions viscosity
4) Monitor artificial airway fixation
5) Monitor cuff pressure how?
6) Monitor oral cavity BRUSHED?
7) Monitor S&S of complications
Breathing Sounds

- **Normal:**
  - *Tubular*(Bronchial)
  - *Bronchovesicular*
  - *Vesicular*

- **Abnormal:**
  - *Crackle*
  - *Wheezeing*
  - *Friction rub*
  - *Ronchous*
OXYGENATION & VENTILATION MONITORING
OXYGENATION & VENTILATION MONITORING

is necessary to assess ADEQUACY of

LUNG VENTILATION & TISSUE OXYGENATION
DIAGNOSTIC TESTS
Functional Assessment:

- **Pulmonary Function Test (PFT)**
- **Electrical Impedance Tomography/EIT**
- **Lab Tests** (ABG analysis, α1 Anti-Tripsin, pleural fluid analysis, sputum examination, …)
- **Pulse Oximetry**
- **SvO2 Monitoring** (PA Cath, Transbronchial)
- **Capnography** (EtCO2 Monitoring)
- **Respiratory Waveform Analysis**
PULMONARY FUNCTION TEST (PFT)
Pulmonary Function Test

- Normal
- Pulmonary fibrosis
- Emphysema
- Asthma-bronchitis
- Upper airway obstruction
- FEF 50%
- FEF 75%

Graph showing flow vs. volume of various conditions.
Pulse Oximetry
# Normal Blood Gas Values

<table>
<thead>
<tr>
<th></th>
<th>Arterial</th>
<th>Mixed Venous</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PH</strong></td>
<td>7.35-7.45</td>
<td><strong>PH</strong></td>
</tr>
<tr>
<td><strong>PaO2</strong></td>
<td>80-100 mmhg</td>
<td><strong>PaO2</strong></td>
</tr>
<tr>
<td><strong>SaO2</strong></td>
<td>$\geq 95%$</td>
<td><strong>SaO2</strong></td>
</tr>
<tr>
<td><strong>PaCO2</strong></td>
<td>35-45 mmhg</td>
<td><strong>PaCO2</strong></td>
</tr>
<tr>
<td><strong>HCO₃⁻</strong></td>
<td>22 - 26 mEq/lit</td>
<td><strong>HCO₃⁻</strong></td>
</tr>
<tr>
<td><strong>BE</strong></td>
<td>-2 to +2 “</td>
<td><strong>BE</strong></td>
</tr>
</tbody>
</table>

*ABG vs. VBG??*

Evidences\VBG vs ABG 2014 sys rev.pdf
## Acid - Base Disorders

<table>
<thead>
<tr>
<th>Disorder</th>
<th>pH</th>
<th>[H⁺]</th>
<th>Primary disturbance</th>
<th>Secondary response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metabolic acidosis</td>
<td>↓</td>
<td>↑</td>
<td>↓ [HCO₃⁻]</td>
<td>↓ pCO₂</td>
</tr>
<tr>
<td>Metabolic alkalosis</td>
<td>↑</td>
<td>↓</td>
<td>↑ [HCO₃⁻]</td>
<td>↑ pCO₂</td>
</tr>
<tr>
<td>Respiratory acidosis</td>
<td>↓</td>
<td>↑</td>
<td>↑ pCO₂</td>
<td>↑ [HCO₃⁻]</td>
</tr>
<tr>
<td>Respiratory alkalosis</td>
<td>↑</td>
<td>↓</td>
<td>↓ pCO₂</td>
<td>↓ [HCO₃⁻]</td>
</tr>
</tbody>
</table>
End Tidal CO2
ET Co2

Inspiratory
Expiratory
Colorimetric ETco2(ETco2)

End Tidal CO² Detection

Easy Cap II CO2 Detector

- The normal values are 5% to 6% CO²
- Equivalent to 35-45 mmHg (pressure)

http://www.medicscribe.com/capnography
Figure 5: Comparing Normal & Bronchospastic Waveforms

**Normal Waveform**

- A: End of inhalation
- B: Beginning of exhalation
- B-D: Exhalation of alveolar gas
- D: End exhalation and point of maximal or highest CO₂ concentration (end-tidal CO₂ [EtCO₂])
- D-E: Inhalation

**Bronchospasm Waveform**

- “Shark-fin” appearance

Time (sec.)
Transcutaneous PCo2 Monitoring
PA CATHETER SVO2 MONITORING

- Proximal Port
- Port to the Thermistor
- Port to the Balloon
- Distal Port

- Superior Vena Cava
- Right Atrium
- Right Ventricle
- Pulmonary Artery
Transbronchial SvO2 Monitoring

Endobronchial Blocker (modified with attached fiberoptic cables)

Endotracheal Tube

Endotracheal Tube Cuff

Trachea

Spectrophotometer

Aorta

Right Pulmonary Artery

Left Pulmonary Artery

Left Mainstem Bronchus

Right Mainstem Bronchus

Light Source

Light Detector
Electrical Impedance Tomography (EIT, Pneumotachometry)
Pneumotachometry
ANATOMICAL ASSESSMENT
Chest X-Ray
fiberoptic Bronchoscopy
The bronchoscope is wedged at the desired location for the BAL. Tubing is connected at the instrument channel which is ... BAL

... attached to a syringe containing the saline through a three-way stopcock. The saline is instilled into the bronchoalveolar space from here. The third port of the stopcock is ...

... attached to the trap that will collect the BAL effluent. The effluent is collected when the stopcock is turned off to the syringe which causes suction through the trap ...

... from the suction unit. The typical pressure used during BAL is -80 cm-H₂O. Lower pressures may be used if complete collapse of the bronchus occurs preventing collection of the lavage sample.
THORACETHESES

Patient sitting upright and leaning on table

Pleural space filled with excess fluid

Fluid pushes on left lung

Fluid collects in bag or syringe
A) HEMOTHORAX

B) CHYLOTHORAX

C) HYDROTHORAX
CHEST TUBE
&
CHEST DRAINAGE
SYSTEM
Waterseal System
Chest drainage system should be monitored for:

- Drainage System Patency
- Proper connecting between tube & drainage system
- Keeping drainage system closed
- Functioning the system (water seal, fluid Oscillation)
- Drained secretions (amount, color, quality, …)
- Complication signs & symptoms
- Condition of insertion site (skin & wound, dressing)
Keep Waterseal Intact
Positive Pressure Ventilation
Triggering
• Ventilator
• Patient

Cycling
• Volume
• Pressure
• Time

Limitation
• Volume
• Pressure
Essential Mechanical Ventilatory Modalities

**Volume-Cycled**
- CMV / ACV
- SIMV

**Pressure-Cycled**
- PCV
- PSV(VAPSV)
- APRV

**Dual Control**
- PRVC
Patient – Tailored Modalities

PAV
Proportional Assist Ventilation

ASV
Adaptive Support Ventilation (PS / PC)
Other Ventilatory Modalities

- ILV (DLV)
- IRV (PCIRV)
- HFV: * HFPPV
  * HFJV
  * HFO
OXYGENATION MANEUVERS

- CPAP
- PEEP
- BiPAP
PPV (Alarms)

Volume
Flow
Pressure
Time
Parameters should be monitored during PPV:

* Patient’s Airway (ETT/TT) Condition
* Patency
* Fixation & Length of the tube
* Cuff Pressure
* Secretions
* Oral cavity
* Ventilator Circuit
* Complications

DOPE
Ventilatory parameters should be monitored during PPV:

- **Respiratory Pattern**
  (Rate, Depth, Rhythm)

- **Airway Pressures**
  (PIP, Pplat, Pmean, PEEP, AutoPEEP)

- **Vt & MV**
  (Exp. Vt, Minute Ventilation)

- **I : E Ratio**

- **Compliance (Static, Dynamic)**

- **Airway Resistance**

- **Scalars & Loops**
Minute Ventilation:

80 – 100 ml/kg\(^{(IBW)}\)/min

or

Male: MV = 4 × BSA \((based\ on\ Height&\ Weight)\)
Female: MV = 3.5 × BSA \((based\ on\ Height&\ Weight)\)
Resistance

Resistance = Airway Pressure (Paw) / Flow
(R = P / F)

Normal range: 0.6 – 2.4 CmH2O/lit.sec

With ETT: 5-6 CmH2O/lit.sec
SIMV/PS

- Flow (L/min)
- Pressure (cm H₂O)
- Volume (ml)

Set PS level

Time (sec)
Pressure - Volume Loop

- Tidal volume
- Upper inflection point
- Expiration
- Inspiration
- Lower inflection point
- PIP
- PEEP
- Slope of curve compliance

Volume ml vs Pressure in cm H2O
Compliance Changes  Example: Volume Ventilation

Normal Compliance  Decreased Compliance  Increased Compliance

\[ V_T \]

Paw  Paw  Paw