Airway, Ventilation, and Sedation in Acute Stroke

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Disclosures/Conflicts of Interest: None
Objectives

• Which stroke/neuro patient needs intubation and ventilation? Select induction medications
• Review ideal sedation for stroke patients in emergency settings
• Outline some initial ventilator settings for stroke patients and those at risk for raised ICP
Clinical Scenario

- 88 yo female driver MVA with LOC
- PMH: unknown
- VS: HR 130, BP 170/45, RR 30, T 37.5°C, SpO₂ 91%
- PE: GCS 6, anisocoria

Questions:
1. When To Intubate?
2. If so, what are the steps, and medications?
Outline
type

Assess

Obtain

Verify

Outline goals for ventilator settings and SPO2 target, and check ABG later

After intubation, verify ETT position with ETCO2 color change

Obtain a brief neuro screen exam prior to intubation

Assess airway anatomy and if NIV (Non-Invasive Intubation) or Invasive intubation (ETT) is most appropriate
Indications for Intubation

- Failure to oxygenate
- Failure to ventilate
- Failure to protect airway
- Anticipated decline requiring transport or immediate treatment
Pre-Intubation Exam

- Level of arousal
- Basic cortical functions
- Cranial nerves
- Motor function
- Sensation
- Tone
- Reflexes
- Evidence of seizure activity
- Cervical spine tenderness
Airway Assessment

MOANS
- Mask seal
- Obesity./Obstruction
- Age > 55 years
- No teeth
- Stiff lungs

LEMON
- Look
- Evaluate mouth opening and airway position
- Mallampati score
- Obstruction
- Neck mobility

Assess for Difficult Bag Mask Ventilation
Assess for Difficult Intubation

Mallampati classification
Pre-Intubation Considerations

• Most experienced provider to the bedside

• Confirm resources to establish emergent surgical airway

• Confirm appropriate airway adjunct equipment
Pre-Intubation Considerations

- Consider awake intubation
- Plan for failed airway
- Pre-oxygenate, apneic oxygenation
- Consider appropriate induction agents
- Cervical spine precautions
- Consider ICP
Special Considerations

Cervical Spine Injury

Intracranial Hypertension

Brain Ischemia
Special Consideration: Unstable Cervical Spine

- Enlist expert help
- Manual in-line stabilization
- No cricoid pressure
- Do not delay emergent intubations
- Awake fiberoptic intubation preferred if time and circumstances allow
- Can also consider video laryngoscopy
Special Consideration: Elevated ICP

- Maintain CPP
  - ICP < 22 mmHg
  - MAP 80 – 110 mmHg
  - CPP > 60 mmHg
- Avoid rises in ICP
  - Patient positioning
  - Reflex sympathetic response
  - Avoid hypoventilation
Careful attention to avoid hypotension

- relative or actual hypotension can dramatically increase brain infarct size

Bolus fluid prior to intubation

Ketamine or Etomidate are preferred

Maintain normocapnia
Intubation

- At least two providers at bedside
  - One experienced provider
- Elevated HOB to 30°
- Preoxygenate
  - HFNC 60-70 L/min, or
  - NPPV FiO₂ 100%, or
  - Nonrebreather mask
Rapid Sequence Induction

- Pretreatment medications mitigate reflex sympathetic response:
  - Lidocaine 1.5 mg/kg; 60 – 90 seconds before
  - Fentanyl 2 – 3 mcg/kg; 30 – 60 seconds before
- Induction agent and paralytic simultaneously
- Allow for full muscle relaxation
  - 45 seconds for succinylcholine
  - 60 seconds for rocuronium
- Administer 6-8 low volume ventilations
### RSI Agents

<table>
<thead>
<tr>
<th>Drugs</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Etomidate</td>
<td>• Minimal hemodynamic effects (CPP)</td>
</tr>
<tr>
<td></td>
<td>• <em>Drug of Choice</em> with elevated ICP</td>
</tr>
<tr>
<td>Propofol</td>
<td>Vasodilator; may require pressor Rx</td>
</tr>
<tr>
<td>Thiopental</td>
<td>• Decreases CMRO2 and CBF</td>
</tr>
<tr>
<td></td>
<td>• Venodilator with risk of hypotension</td>
</tr>
<tr>
<td>Ketamine</td>
<td>With concurrent sedation, safe with elevated ICP</td>
</tr>
<tr>
<td>Succinylcholine</td>
<td>• Depolarizing NMB (hyperkalemia risk)</td>
</tr>
<tr>
<td></td>
<td>• Transient (subclinical) effect on ICP</td>
</tr>
</tbody>
</table>
Intubation

- Continue apneic oxygenation
  - NC at 15 L/min
  - HFNC at 60-70 L/min
- 2-3 attempts if SpO₂ > 95%
- BMV between attempts
- Change operator and/or technique between attempts

- Most experience provider
- Continue apneic oxygenation
- Consider video laryngoscopy
Unsuccessful Intubation

Attempt Supraglottic Airway

- Tracheal intubation through supraglottic airway
- Urgent tracheostomy (surgical or percutaneous)

Successful

Unsuccessful

Emergent Cricothyroidotomy (Surgical or Percutaneous)
Post-Intubation

- Secure the ETT
- Confirm tube position
- Set cuff pressure 20-30 cmH₂O
- SpO₂ and ETCO₂ monitoring
- Arterial blood gas
- Sedation while NMB in effect
Mechanical Ventilation: Outline

- Target \( \text{SpO}_2 > 94\% \)
- Target pre-morbid \( \text{pCO}_2 \)
- Target pH 7.3-7.4
- Hyperventilate ONLY for herniation
- Prevent lung injury
- Normalize work of breathing
- Address ventilator-patient dyssynchrony
Basic Ventilator Settings

- Choose a Control mode
  - Normalize the work of breathing
  - Set tidal volume at 6-8 cc/kg IBW
  - Set rate to keep post – intubation minute ventilation ($V_E$) at or near pre-intubation $V_E$
  - ABG after a steady state
    - 10-20 minutes
Oxygenation

- **Hyperoxia** (PaO$_2$ > 300 mmHg): poor outcomes
  - inflammation
  - direct epithelial toxicity
  - absorption atelectasis

- **Hypoxia**
  - major cause of secondary brain injury

- **Goals**
  - Provide FiO$_2$ at 0.5 and titrate to the lowest FiO$_2$ (FiO2 < 0.5 if possible) to keep SpO$_2$ > 94%
Ventilation

- Hyperventilation
  - Cerebral vasoconstriction and decreased CBF
  - Poor outcomes with TBI
- Hypoventilation
  - Cerebral vasodilation and increased ICP
- Chronic hypercarbic patients (COPD, sleep-disorders)
  - Altered baseline set-point for CNS vascular tone
  - Use pH (not PCO₂) as target
- Neuromonitoring may be needed to assess brain perfusion

<table>
<thead>
<tr>
<th>Admission bicarbonate</th>
<th>45</th>
<th>42</th>
<th>39</th>
<th>36</th>
<th>33</th>
<th>30</th>
<th>27</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted “usual” pCO₂</td>
<td>92.5</td>
<td>85</td>
<td>77.5</td>
<td>70</td>
<td>62.5</td>
<td>55</td>
<td>47.5</td>
<td>40</td>
</tr>
</tbody>
</table>
Special Considerations: Therapeutic Hyperventilation

- Decreases ICP by decreasing CBF, but may increase brain ischemia
- Maximal cerebral vasoconstriction at pCO₂ near 20 mmHg
- Less than 20 mmHg, no further therapeutic advantage and may ↓ cardiac preload and cardiac output
- Hyperventilation is a temporizing measure
- Recommend EtCO₂ monitoring
- If use is prolonged, requires special neuromonitoring to verify adequate CBF
Special Considerations: Spontaneous Hyperventilation

- Metabolic acidosis
- Spontaneous hyperventilation of brain injury

*Suppression is NOT recommended* unless hyperventilation is shown to be causing brain ischemia
Special Considerations: ARDS

• ARDS patients treated with lung protective ventilation
  • $V_t$ 4-6cc/kg
  • $P_{PLAT} \leq 30$ cm H$_2$O
  • Optimal PEEP
  • $F_1O_2 < 0.6$
  • Safety of permissive hypercapnea in brain injured patients unknown

VENTILATOR INDUCED LUNG INJURY

- Barotrauma
- Volutrauma
- Atelectrauma
- High $FiO_2$

High levels of circulating inflammatory cytokines
Sedation

- Target light sedation
  - RASS 0 to -2
- Consider analgesia-based sedation
- Consider intermittent sedation
- Dexmedetomidine or propofol when continuous sedation is needed
- Deep Sedation for ICP control, seizure management or NMB use
- Routine sedation interruptions unless contraindicated
The Sedation Conundrum

- Obliterates the neurological examination, makes monitoring difficult, prolongs ventilation and hospitalization, causes delirium, and renders prognostication inaccurate.

- Decreases CMRO$_2$, ICP, and systemic metabolic stress, protects against ischemia, provides comfort and amnesia, and facilitates procedures
## Sedative & Analgesia Agents

<table>
<thead>
<tr>
<th>Drug</th>
<th>Comments</th>
</tr>
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<tbody>
<tr>
<td>Propofol</td>
<td>Short acting, ↓ ICP, hypotension, lipid load, propofol infusion syndrome</td>
</tr>
<tr>
<td>Benzodiazepines (Midazolam)</td>
<td>Antiepileptic, amnestic, accumulates with renal failure and prolonged administration, delirium</td>
</tr>
<tr>
<td>Dexmedetomidine</td>
<td>Not respiratory suppressant, hypotension, bradycardia, less delirium</td>
</tr>
<tr>
<td>Barbiturates</td>
<td>Antiepileptic, ↓ ICP, immunosuppression, cardiovascular depression</td>
</tr>
<tr>
<td>Fentanyl or Remifentanil</td>
<td>Analgesics that are short-acting; used alone for pain or in combination with sedative</td>
</tr>
</tbody>
</table>
Sedation Targets

- Minimize sedation
- Treat pain and anxiety as separate entities
- Titrate sedation to effect
- Short acting sedatives preferred with daily awakening, if clinically appropriate
  
  Validated Scales
# Sedation Targets

**Richmond Agitation and Sedation Scale**

<table>
<thead>
<tr>
<th>Score</th>
<th>Descriptor</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>+4</td>
<td>Combative</td>
<td>Combative, violent, immediate danger to staff</td>
</tr>
<tr>
<td>+3</td>
<td>Very agitated</td>
<td>Pulls or removes tube(s) or catheter(s); aggressive</td>
</tr>
<tr>
<td>+2</td>
<td>Agitated</td>
<td>Frequent nonpurposeful movement, fights ventilator</td>
</tr>
<tr>
<td>+1</td>
<td>Restless</td>
<td>Anxious, apprehensive but movements not aggressive or vigorous</td>
</tr>
<tr>
<td>0</td>
<td>Alert and calm</td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td>Drowsy</td>
<td>Not fully alert, but has sustained awakening to voice (eye opening and contact &gt;10 seconds)</td>
</tr>
<tr>
<td>-2</td>
<td>Light sedation</td>
<td>Briefly awakens to voice (eye opening and contact &lt;10 seconds)</td>
</tr>
<tr>
<td>-3</td>
<td>Moderate sedation</td>
<td></td>
</tr>
<tr>
<td>-4</td>
<td>Deep sedation</td>
<td>Movement or eye opening to voice (but no eye contact)</td>
</tr>
<tr>
<td>-5</td>
<td>Unarousable</td>
<td>No response to voice, but movement or eye opening to physical stimulation</td>
</tr>
</tbody>
</table>
Daily Interruption of Sedation?

- Interruption facilitates a systematic daily assessment of individualized sedation needs and target goals and may limit sedative doses
- Not validated in a NCC population
- May lead to cerebral metabolic distress
  - caution with RSE or elevated ICP
- May need to be more frequent than daily for neurologic examination
- Possible role for BIS monitoring
Pediatric Considerations

- Criteria for intubation are similar to adults albeit use Pediatric GCS ≤ 8
- Children have anatomical differences that must be considered in preparation and during intubation
- Assume full stomach and c-spine injury
- For hemodynamically unstable patients, etomidate and rocuronium are often used for intubation
- Fentanyl and ketamine are IV alternative sedatives
- Propofol (especially >24 hours) avoided in children for concern of propofol infusion syndrome
<table>
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<tr>
<th>Handoff Checklist</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Mental status (GCS, FOUR) &amp; neuro exam prior to intubation</td>
</tr>
<tr>
<td>☐ Vitals pre and post intubation, drugs used</td>
</tr>
<tr>
<td>☐ Ease of intubation &amp; ETT position confirmation</td>
</tr>
<tr>
<td>☐ Ventilation targets and ETCO$_2$ when appropriate</td>
</tr>
<tr>
<td>☐ Analgesia and sedation strategy</td>
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Thanks!

Questions?