Airway, Ventilation, and Sedation in Acute Stroke

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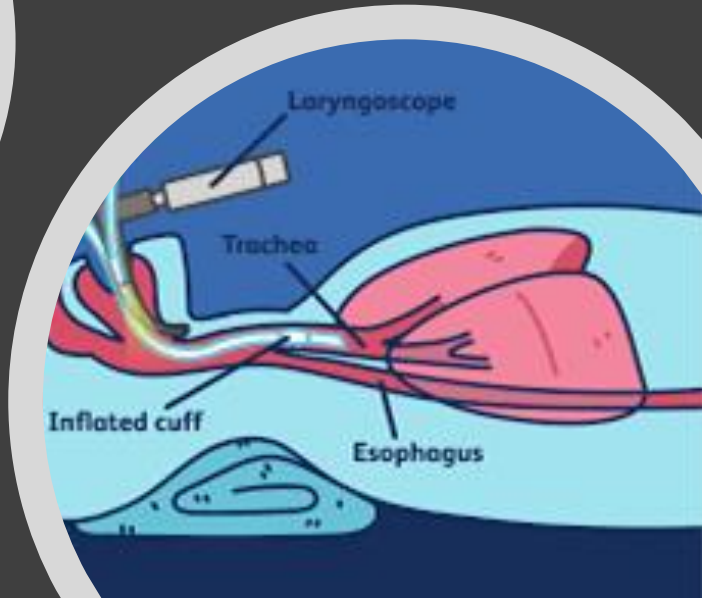
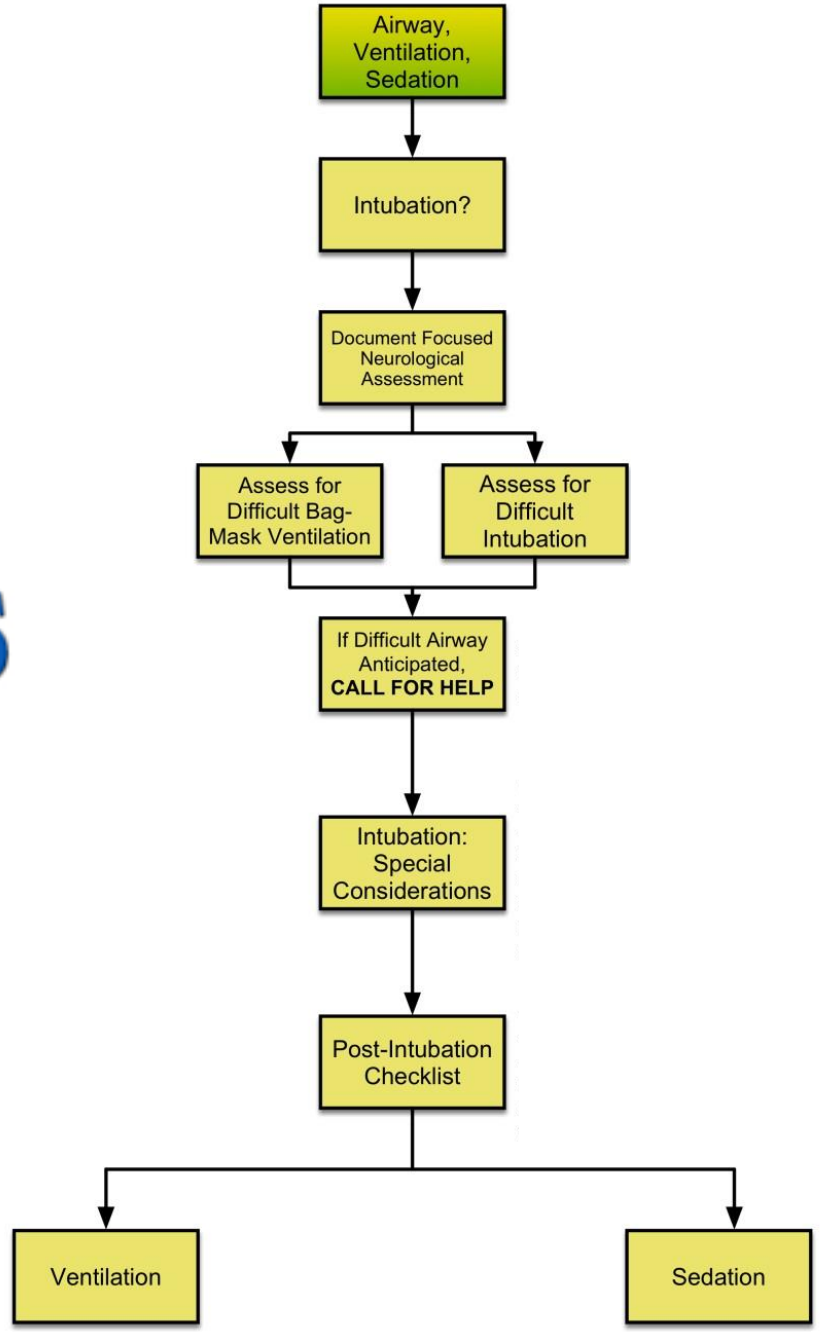
Disclosures/Conflicts of Interest: None



Airway
Breathing
Circulation

The ABCs



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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

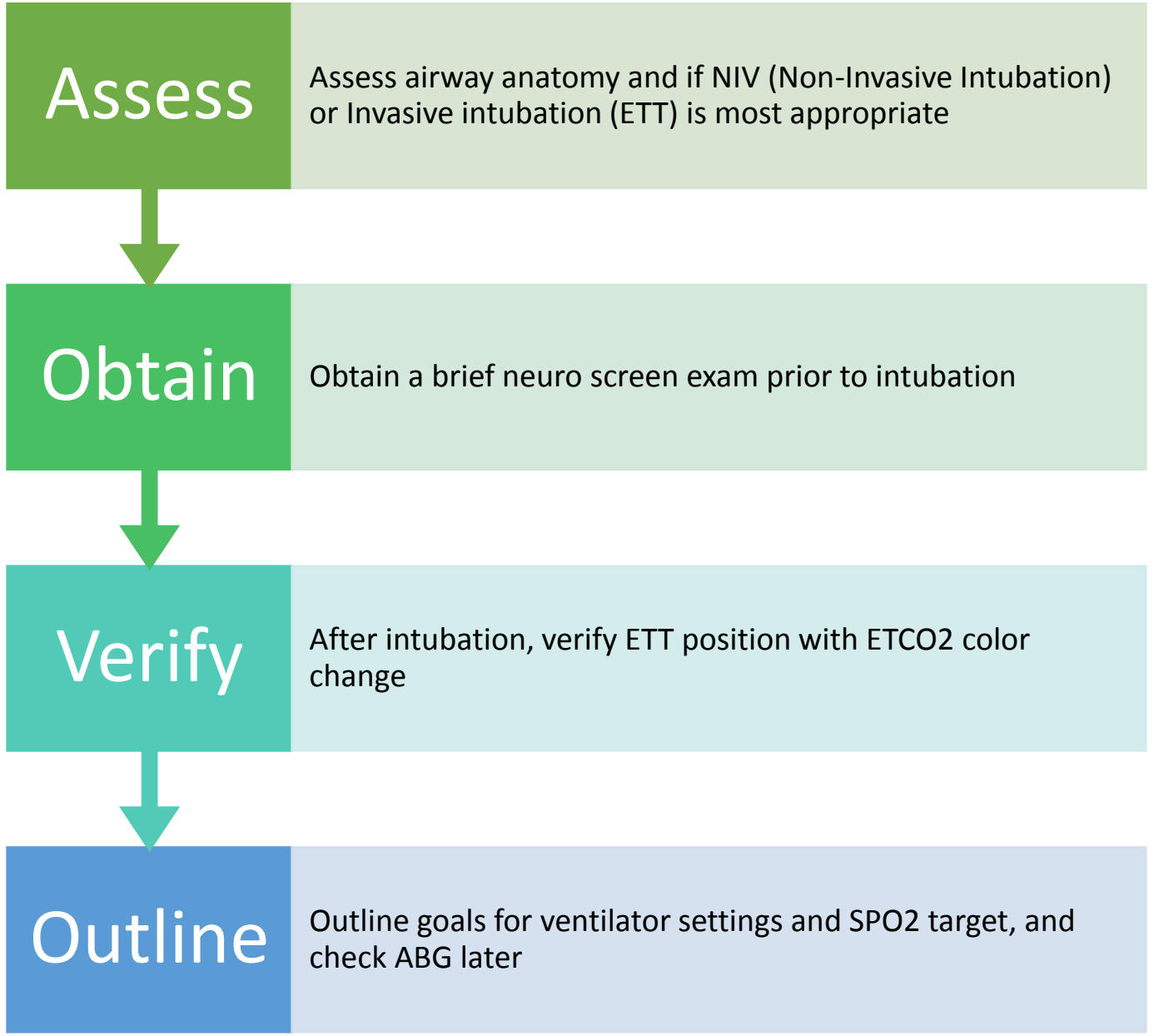
- 88 yo female driver MVA with LOC
- PMH: unknown
- VS: HR 130, BP 170/45, RR 30, T 37.5^{o}C, SpO_2 91%
- PE: GCS 6, anisocoria

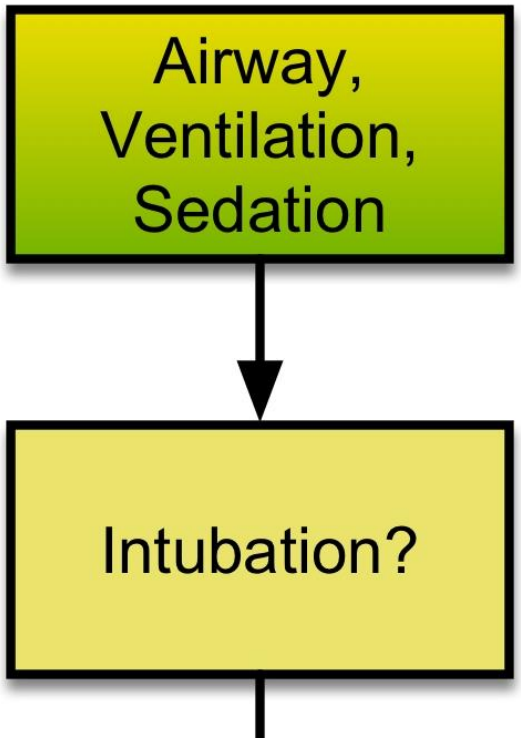
Questions:

1. When To Intubate?

2. If so, what are the steps, and medications?

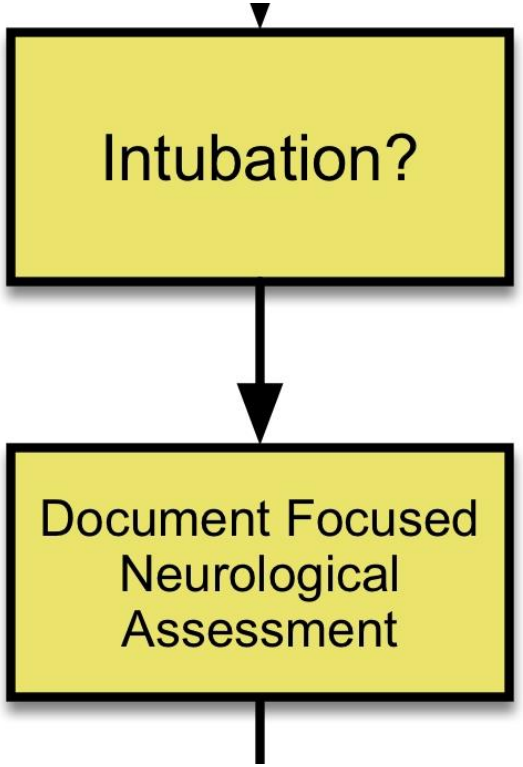
Checklists


Assess
Assess airway anatomy and if NIV (Non-Invasive Intubation) or Invasive intubation (ETT) is most appropriate
Obtain
Obtain a brief neuro screen exam prior to intubation
Verify
After intubation, verify ETT position with ETCO2 color change
Outline
Outline goals for ventilator settings and SPO2 target, and check ABG later



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

Assess for Difficult Bag Mask Ventilation

Assess for Difficult Intubation

Mallampati classification

MOANS

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

LEMON

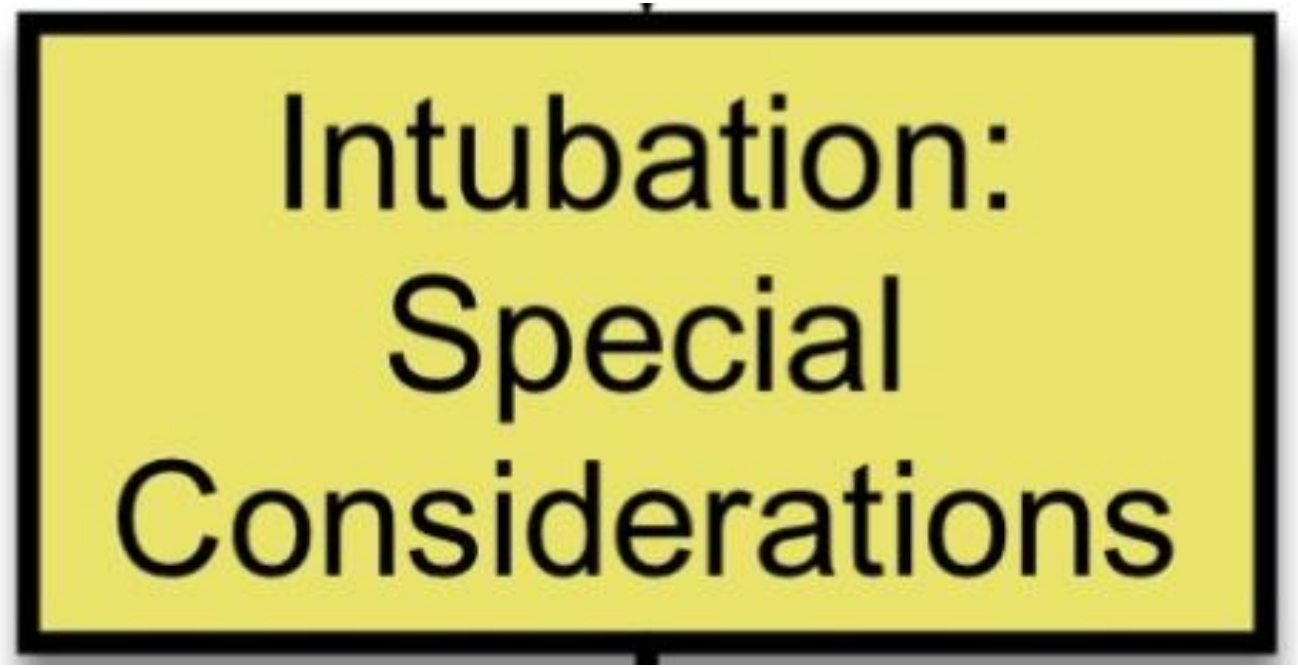
Look
Evaluate mouth opening and airway position
Mallampati score
Obstruction
Neck mobility

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

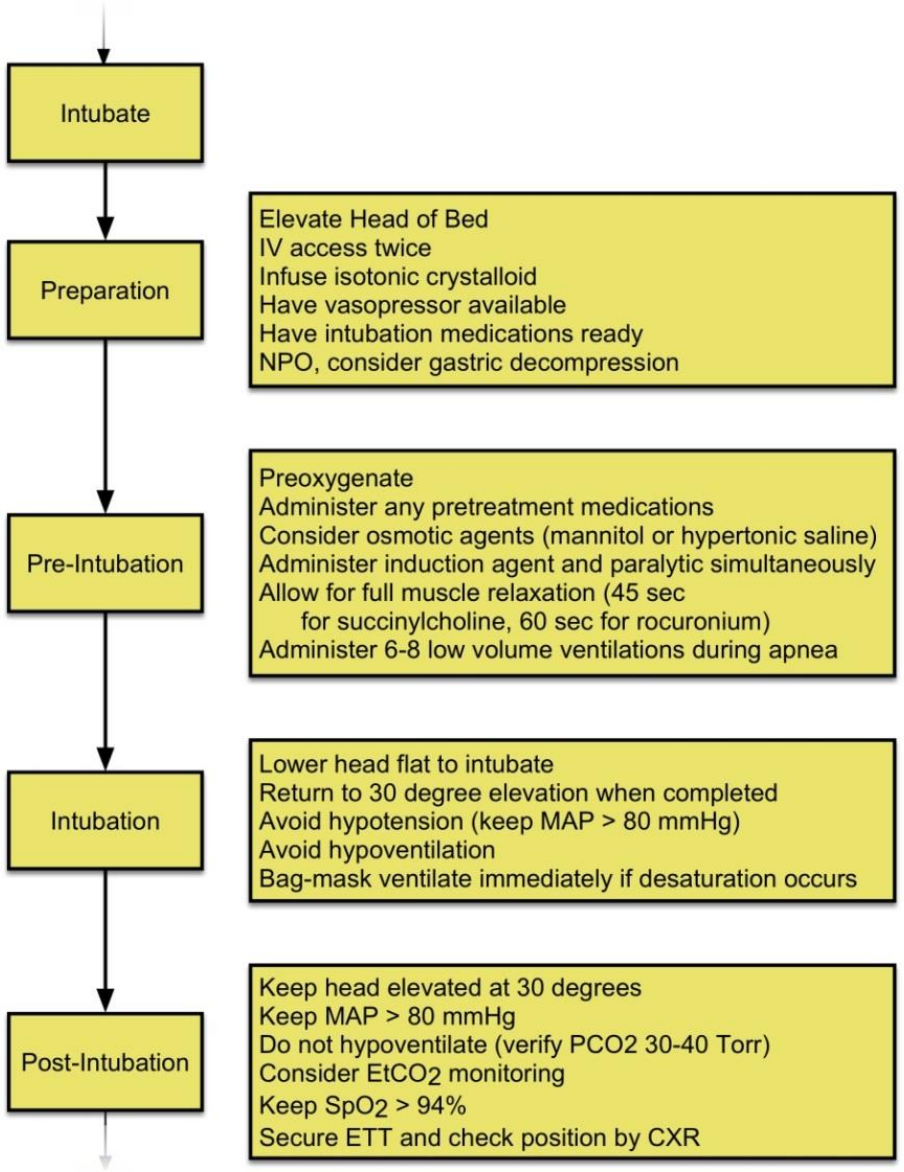
- Cervical Spine Injury
- Intracranial Hypertension
- Brain Ischemia

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

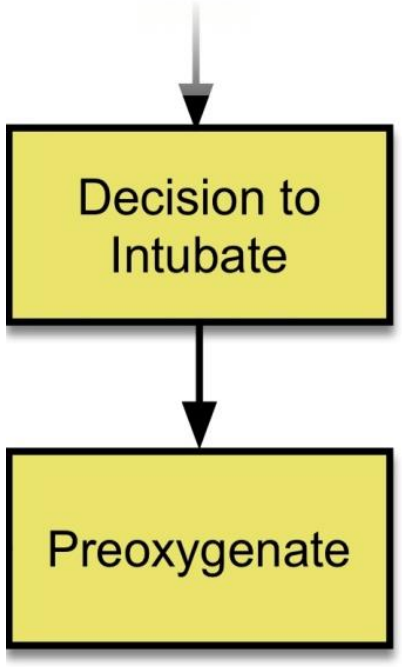
- Maintain CPP
  - ICP < 22 mmHg
  - MAP 80 – 110 mmHg
  - CPP > 60 mmHg
- Avoid rises in ICP
  - Patient positioning
  - Reflex sympathetic response
  - Avoid hypoventilation



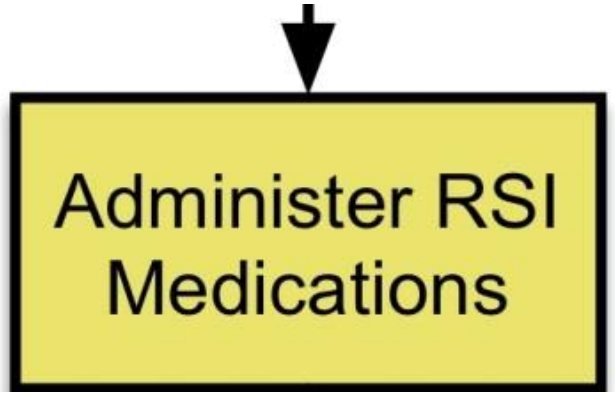
Special Consideration: Brain Ischemia

- 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^{o}
- Preoxygenate
  - HFNC 60-70 L/min, or
  - NPPV FiO_2 100%, or
  - Nonrebreather mask



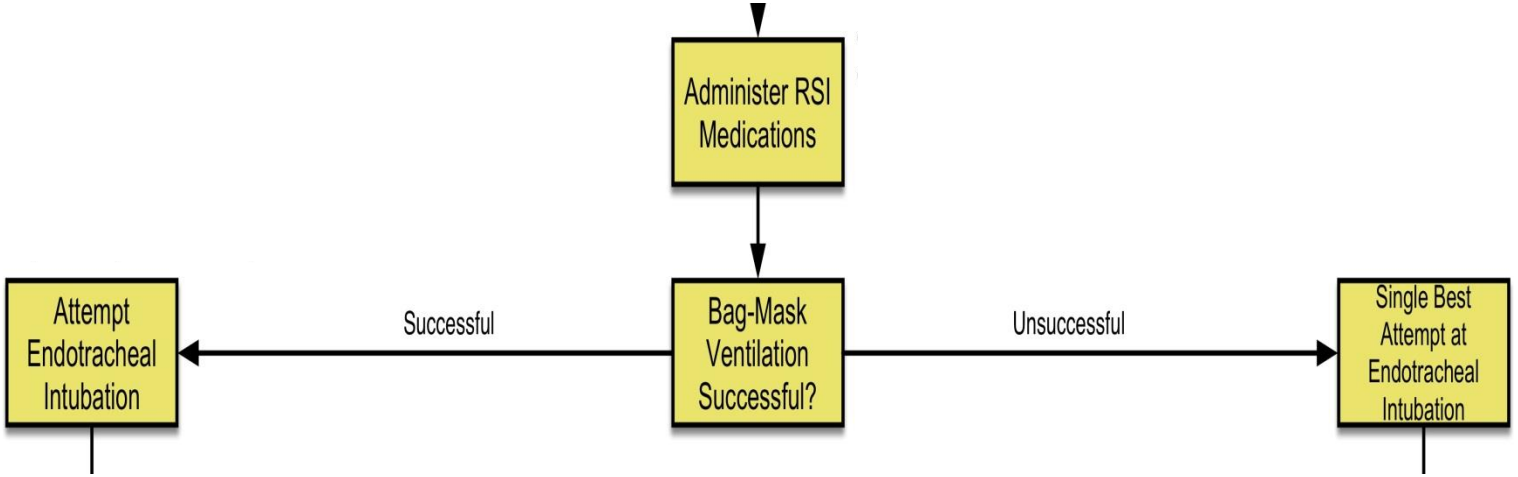
Rapid Sequence Induction

- 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

Drugs	Comments
Etomidate	• Minimal hemodynamic effects (CPP) • *Drug of Choice* with elevated ICP
Propofol	Vasodilator; may require pressor Rx
Thiopental	• Decreases CMRO2 and CBF • Venodilator with risk of hypotension
Ketamine	With concurrent sedation, safe with elevated ICP
Succinylcholine	• Depolarizing NMB (hyperkalemia risk) • Transient (subclinical) effect on ICP

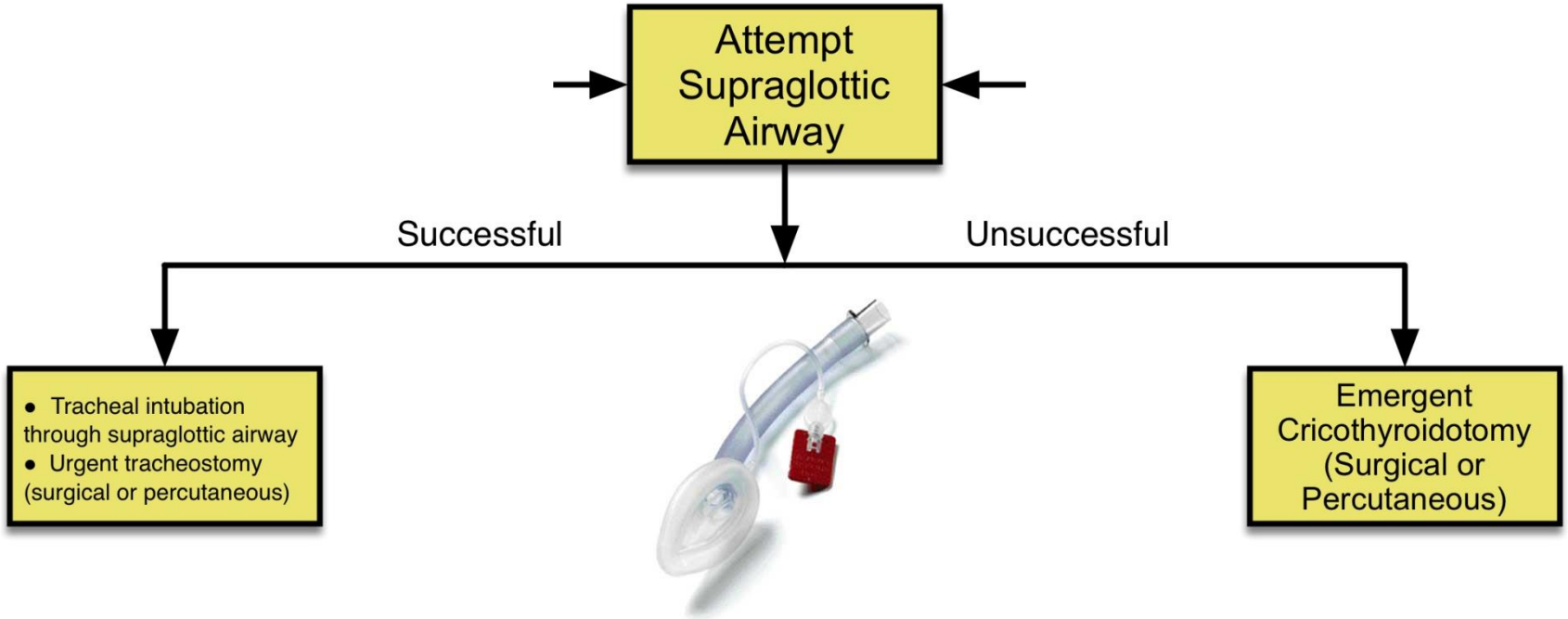
Intubation

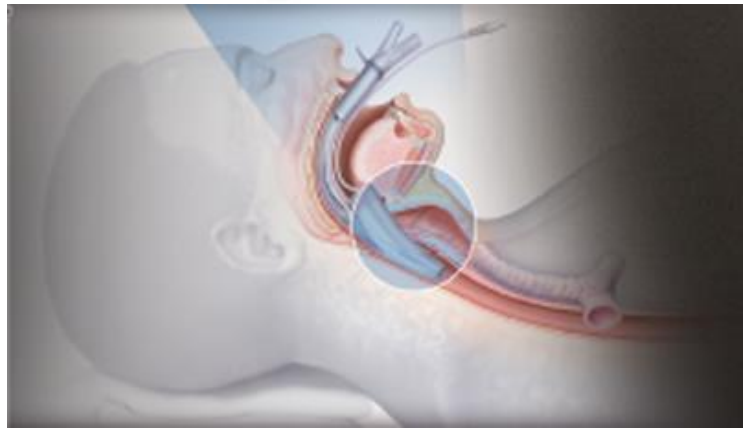


- Continue apneic oxygenation
  - NC at 15 L/min
  - HFNC at 60-70 L/min
- 2-3 attempts if SpO_2 > 95%
- BMV between attempts
- Change operator and/or technique between attempts

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

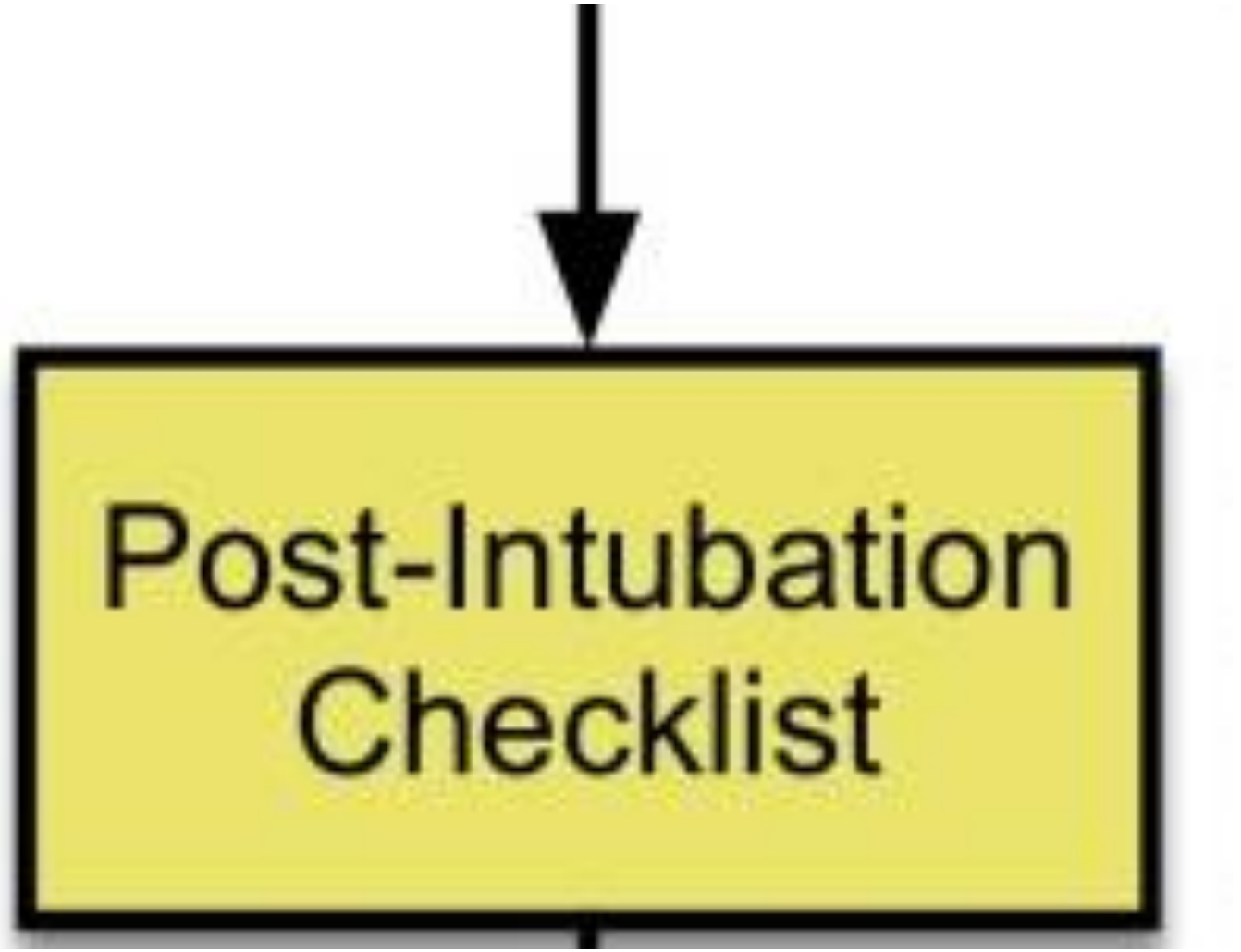
Unsuccessful Intubation





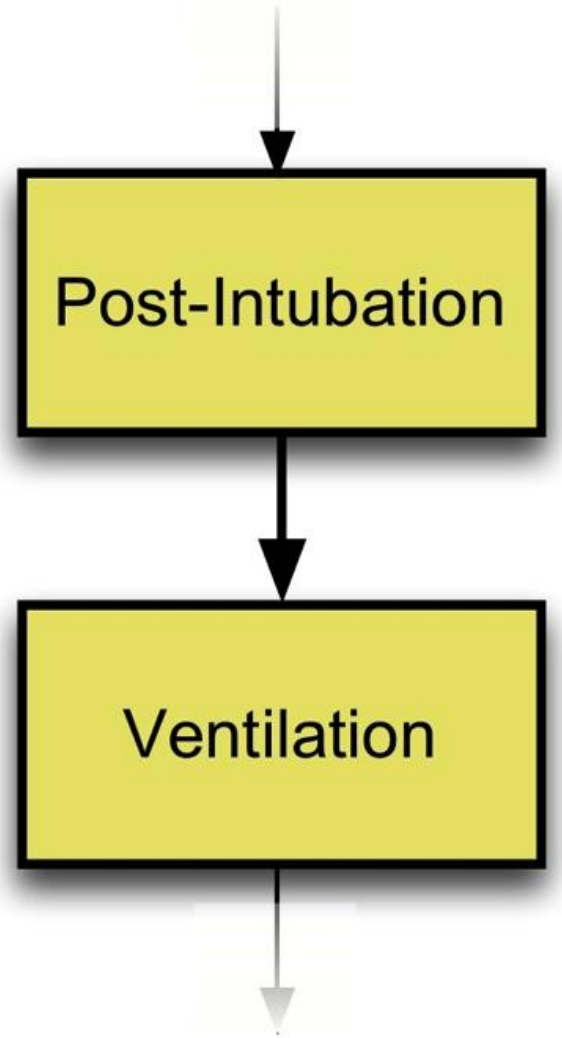
Post-Intubation

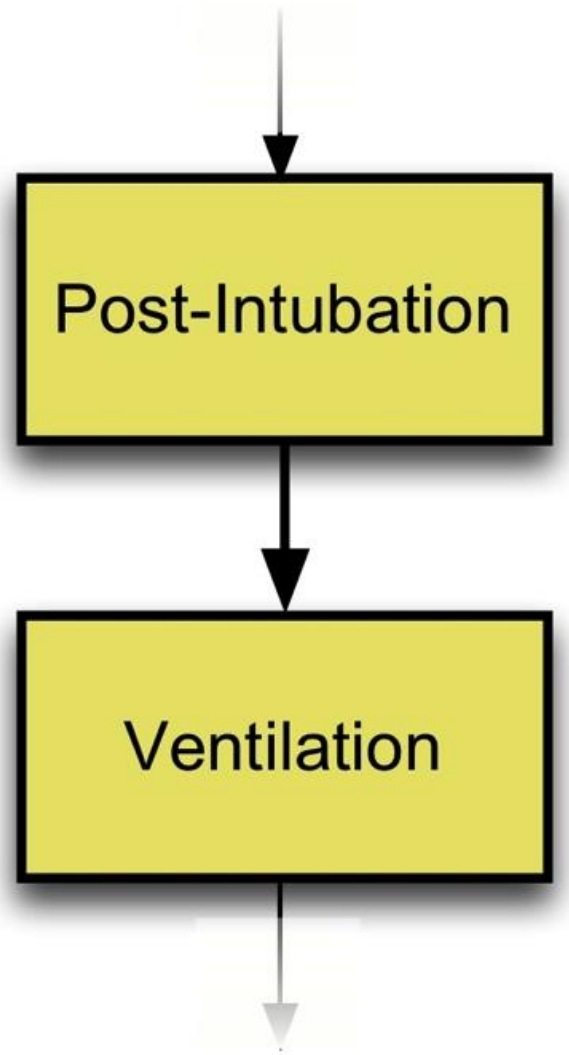
- Secure the ETT
- Confirm tube position
- Set cuff pressure 20-30 cmH_20
- SpO_2 and $ETCO_2$ monitoring
- Arterial blood gas
- Sedation while NMB in effect



Mechanical Ventilation: Outline

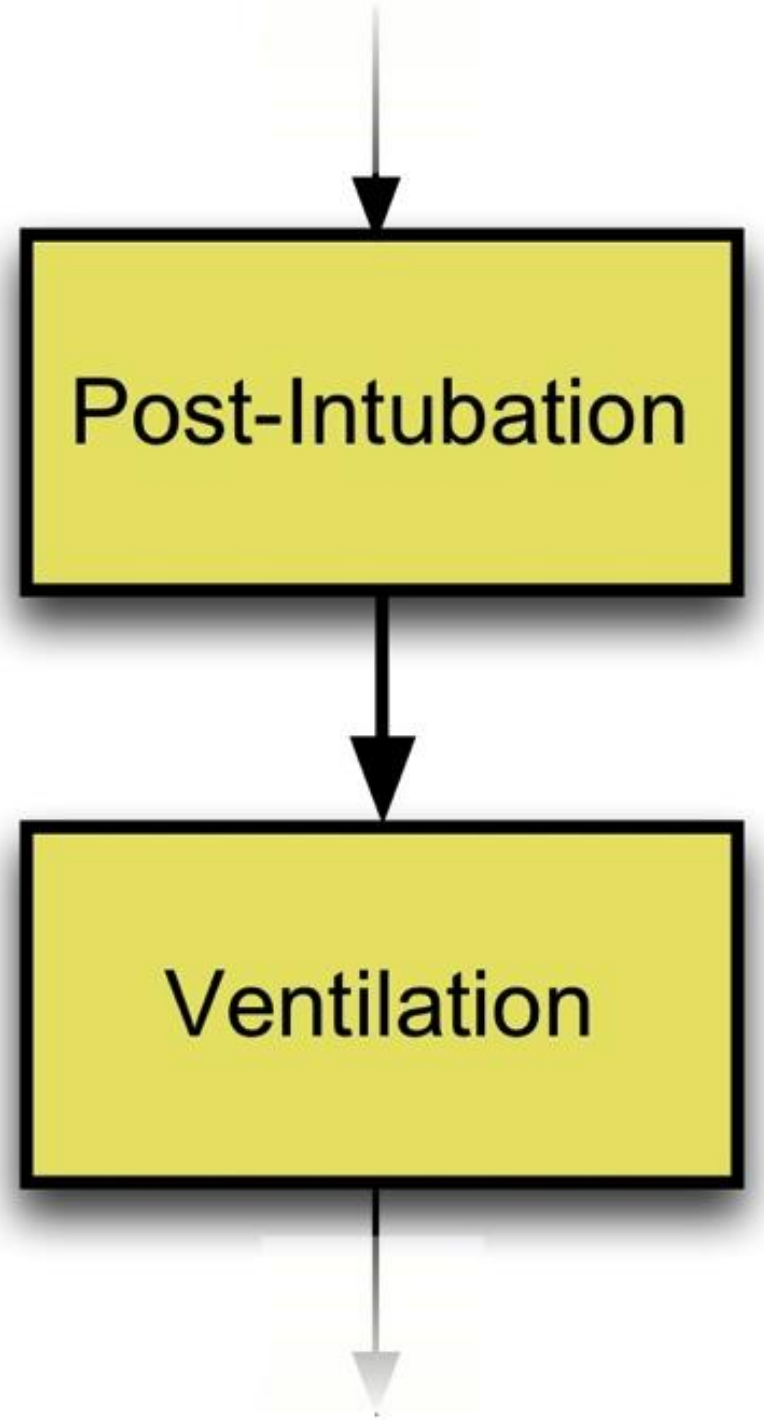
- Target SpO_2 > 94%
- Target pre-morbid pCO_2
- Target pH 7.3-7.4
- Hyperventilate ONLY for herniation
- Prevent lung injury
- Normalize work of breathing
- Address ventilator-patient dyssynchrony





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

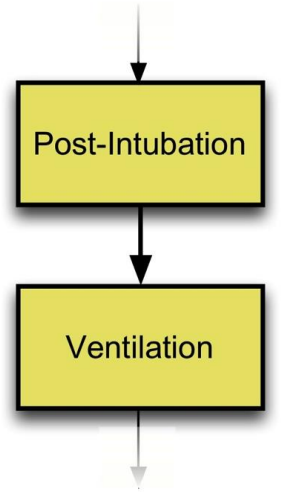
- **Hyperoxia** (PaO_2 > 300 mmHg): poor outcomes
  - inflammation
  - direct epithelial toxicity
  - absorption atelectasis
- **Hypoxia**
  - major cause of secondary brain injury
- **Goals**
  - Provide FiO_2 at 0.5 and titrate to the lowest FiO_2 (FiO2 < 0.5 if possible) to keep SpO_2 > 94%

Ventilation

Table 2 Chronic respiratory acidosis: estimated pre-morbid pCO_2 based on admission HCO_3 level

Admission bicarbonate	45	42	39	36	33	30	27	24
Predicted "usual" pCO2	92.5	85	77.5	70	62.5	55	47.5	40

- 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 PCO_2) as target
- Neuromonitoring may be needed to assess brain perfusion



Special Considerations: Therapeutic Hyperventilation

- Decreases ICP by decreasing CBF, but may increase brain ischemia
- Maximal cerebral vasoconstriction at pCO_2 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

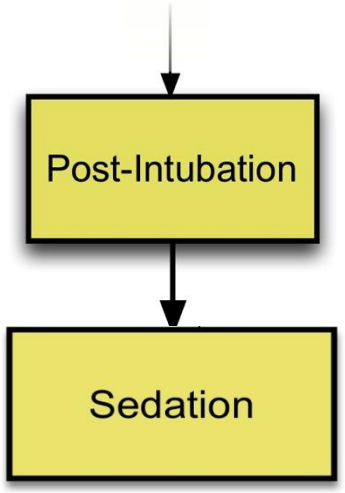
Suppression is NOT recommended unless hyperventilation is shown to be causing brain ischemia

Special Considerations: ARDS

- ARDS patients treated with lung protective ventilation
  - V_T 4-6cc/kg
  - $P_{PLAT} \leq 30$ cm H_2O
  - Optimal PEEP
  - $F_IO_2 < 0.6$
  - 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

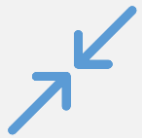
- Obliterates the neurological examination, makes monitoring difficult, prolongs ventilation and hospitalization, causes delirium, and renders prognostication inaccurate.

- Decreases $CMRO_2$, ICP, and systemic metabolic stress, protects against ischemia, provides comfort and amnesia, and facilitates procedures

Sedative & Analgesia Agents

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

Sedation Targets



Minimize sedation

Treat pain and anxiety as separate entities

Titrate sedation to effect

Validated Scales

Short acting sedatives preferred with daily awakening, if clinically appropriate

Sedation Targets

Richmond Agitation and Sedation Scale

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

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

Handoff Checklist

- ☐ Mental status (GCS, FOUR) & neuro exam prior to intubation
- ☐ Vitals pre and post intubation, drugs used
- ☐ Ease of intubation & ETT position confirmation
- ☐ Ventilation targets and $ETCO_2$ when appropriate
- ☐ Analgesia and sedation strategy

Thanks!

Questions?