Emergency Neurological Life Support Airway, Ventilation and Sedation Protocol Version 5.0

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Last updated: May 2022

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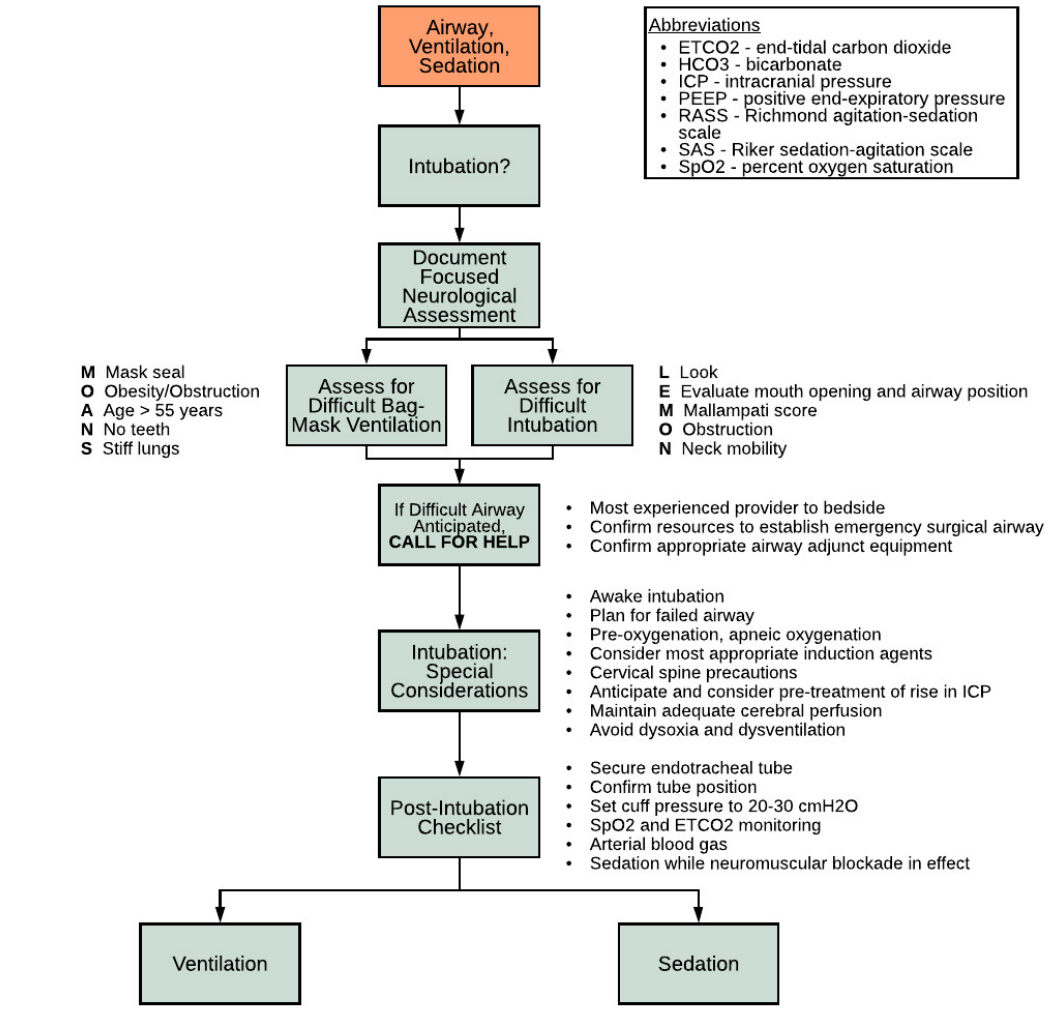
EMERGENCY NEUROLOGICAL LIFE SUPPORT

Airway, Ventilation and Sedation Algorithm



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Checklist

☐ Assess the need for intubation or noninvasive positive pressure ventilation
☐ Perform and document a focused neurological assessment prior to intubation
☐ Perform adequate airway assessment, complete pre-intubation checklist, and intubate patient
☐ Verify the endotracheal tube position
☐ Determine ventilation and oxygenation targets, and verify with ABG/SpO2/ETCO2
☐ Assess the need for analgesia and/or sedation in mechanically ventilated patients

Communication

☐ Mental status and neurological examination immediately pre-intubation
☐ Intracerebral hemorrhage (ICH) score, if appropriate
☐ Vitals, hemodynamics, and gas exchange pre- and post-intubation
☐ Relevant drugs used around intubation
☐ Technique of intubation, confirmation of tube position
☐ Ease of bag mask ventilation, intubation, and tube passage
☐ Cormack-Lehane grade, if appropriate
☐ Ventilator settings, ventilation, and ETCO2 targets
☐ Analgesia and sedation strategy
☐ Pending investigations

Sample communication:
"Mr. Smith, 52-year-old gentleman with intracerebral hemorrhage required urgent intubation."
"His GCS was 6 prior to intubation—he would not open his eyes to pain, was mute, and would only withdraw to pain on the right; he appeared to be left hemiplegic. His right pupil was 5 mm and sluggish, and left pupil was 3 mm and briskly reactive. Following intubation, his pupils are 3 mm and reactive bilaterally."
"His vitals prior to intubation were BP 220/110, HR 66/m, SpO2 97% on 2 L/m nasal cannula. Following intubation, his BP is 130/60, HR 55/m, SpO2 99% on FiO2 100% and ETCO2 is 32."
"We treated with him with lidocaine, fentanyl, and 30 cc of 23.4% NaCl prior to intubation. We used etomidate and rocuronium for rapid sequence intubation (RSI)."
"We intubated him with direct laryngoscopy using a Mac 4 blade. Tube position was confirmed with a CO2 detector and auscultation."
"Bag mask ventilation was easy, although I did use an oral airway. I had a Grade 2a view without cricoid pressure, and tube passage was easy."
"We have him on assist control, volume control, with a tidal volume of 6 cc/kg, respiratory rate of 24/m, PEEP 5, and FiO2 100%. Our goal ETCO2 is 30–35, and goal SpO2 is > 94%."
"We started a propofol infusion, titrated to deep sedation because of the herniation syndrome."
"He will be transported to CT now, and the neurosurgeons will likely take him straight to the operating room. We did not have time to get a chest X-ray, but he has equal breath sounds and is ventilating and oxygenating well."

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"His wife is with him and has been counseled about his condition"

Airway, Ventilation, Sedation

Neurocritically ill patients often have evolving processes that threaten the airway and adequate ventilation; as such, airway and respiratory management are of utmost importance. Airway management, intubation, ventilation, and sedative choices directly affect brain physiology and perfusion. Emergency Neurologic Life Support (ENLS) topics discussed here include acute airway management, indications for intubation with special attention to hemodynamics and preservation of cerebral blood flow, initiation of mechanical ventilation, and the use of sedative agents based on the patient's neurological status in the setting of acute neurologic injury.

Intubation - does the patient need to be intubated?

There are four commonly accepted indications to intubate a patient:

1. **Failure to oxygenate**
   This finding may be determined by visual inspection such as evidence of respiratory distress or cyanosis, vital signs data such as low oxygen saturation on pulse oximetry, or laboratory data such as arterial blood gas analysis.
2. **Failure to ventilate**
   Ventilation is assessed by visual inspection including observation of respiratory effort exerted, capnometry through nasal cannula or transcutaneous monitoring [1], and/or arterial blood gas analysis.
3. **Failure to protect the airway**
   Airway protection is the result of numerous variables including bulbar function, airway anatomy, quantity and quality of secretions, strength of cough reflex, and ability to swallow after suctioning.[2, 3] The presence of a gag reflex is an inadequate method of assessing airway protection.[4]
4. **Anticipated neurological or cardiopulmonary decline requiring transport or immediate treatment**
   Anticipation of the trajectory of the patient's condition can allow for appropriate preparation for the procedure as opposed to rushed or emergent intubations.

Document focused neurological assessment

Before sedatives/paralytics administered

Whenever possible, urgent management of the airway should coincide with a focused neurological exam that may be conducted in 2 minutes or less. Document the neurological exam in the record. This is an important baseline for subsequent care and is essential prior to sedation or chemical paralysis.

Exam should include:

- Level of arousal, interaction, and orientation, as well simple cortical functions such as vision, attention, and speech comprehension and fluency
- Cranial nerve function
- Motor function of each individual extremity
- Tone and reflexes
- Sensory level in patients with suspected spinal cord injury
- Involuntary movements such as tremor or seizure
- Cervical tenderness or gross spinal abnormality

Airway assessment

Assess for difficult bag-mask ventilation and intubation.

A difficult airway may be broadly defined as an endotracheal intubation attempt in which a provider who is appropriately trained in airway management experiences difficulty with bag-mask ventilation, tracheal intubations or both.

The "MOANS" mnemonic helps predicts ease of bag-mask ventilation:

M = Mask seal; may be compromised by abnormal facies, facial hair
O = Obesity / Obstruction (e.g. 3rd trimester pregnancy, neck swelling, angioedema, hematomas, cancer)
A = Age > 55 years
N = No teeth
S = Stiff lungs

The "LEMON" mnemonic helps to predict difficult tracheal intubations:

L = Look for abnormal external facial features and body habitus
E = Evaluate the mouth opening and airway position using the 3-3-2 rule
- 3 fingers in open mouth between incisors
- 3 fingers between chin (mentum) and hyoid
- 2 fingers between hyoid and superior thyroid notch

M = Mallampati score
- Grade I- Soft palate, entire uvula, faucial pillars visible
- Grade II- Soft palate, entire uvula visible
- Grade III- Soft palate, base of uvula visible
- Grade IV- Only hard palate visible

O = Obstruction/obesity
N = Neck mobility

The “MACOCHA” mnemonic successfully predicts difficult tracheal intubation:

M = Mallampati Score III or IV (5 points) (Figure 2)
A = Apnea Syndrome (obstructive) (2 points)
C = Cervical spine limitation (1 point)
O = Opening mouth < 3cm (1 point)
C = Coma (1 point)
H = Hypoxia (<80%) (1 point)
A = Anesthesiologist non-trained (1 point)
Score > 3 suggests a difficult airway

Pre-intubation checklist

PATIENT

1. **RELIABLE IV/ IO ACCESS**
2. **OPTIMAL POSITION**
   - Head of bed- consider 30-45º elevation
   - Bed height
   - Access to airway
   - Sniffing/ neutral
3. **PRE-OXYGENATION**
   - Heated high flow nasal cannula 60-70 L/mt
   - Noninvasive positive Pressure ventilation
   - Reservoir-bag mask
   - Bag-valve mask
4. **APNEIC OXYGENATION IN PLACE**
   - Heated high flow nasal cannula 60-70 L/mt
   - Nasal cannula 15L/mt
5. **OPTIMIZE PATIENT STATE**
   - Pre-treat with fentanyl and lidocaine
   - Raised intracranial pressure- 23.4% NaCL or mannitol
   - Hypotension/ hypovolemia- fluid bolus or vasopressors infusing
   - Left/ right ventricular failure- vasopressor available/ infusing

EQUIPMENT

1. **MONITORING**
   - SpO2 with volume turned up
   - Quantitative waveform capnography (ETCO2)
   - Electrocardiogram
   Blood pressure- cuff to cycle every 2 minutes or arterial line. Cuff not on side of SpO2 probe.
2. **EQUIPMENT**
   - Laryngoscope handle and blades, test bulb
   - Video laryngoscope, blade and rigid stylet
   - Endotracheal tube x2 with stylet- selected size and smaller option
   - Bougie
   - Oral/ nasal airway
   - Suction
   - CO2 detector
   - Supraglottic airway
   - Kit for invasive airway
3. **MEDICATIONS**
   - Sedative
   - Neuromuscular blocking agent
   - Vasopressor
   - Sedation/ analgesia following intubation

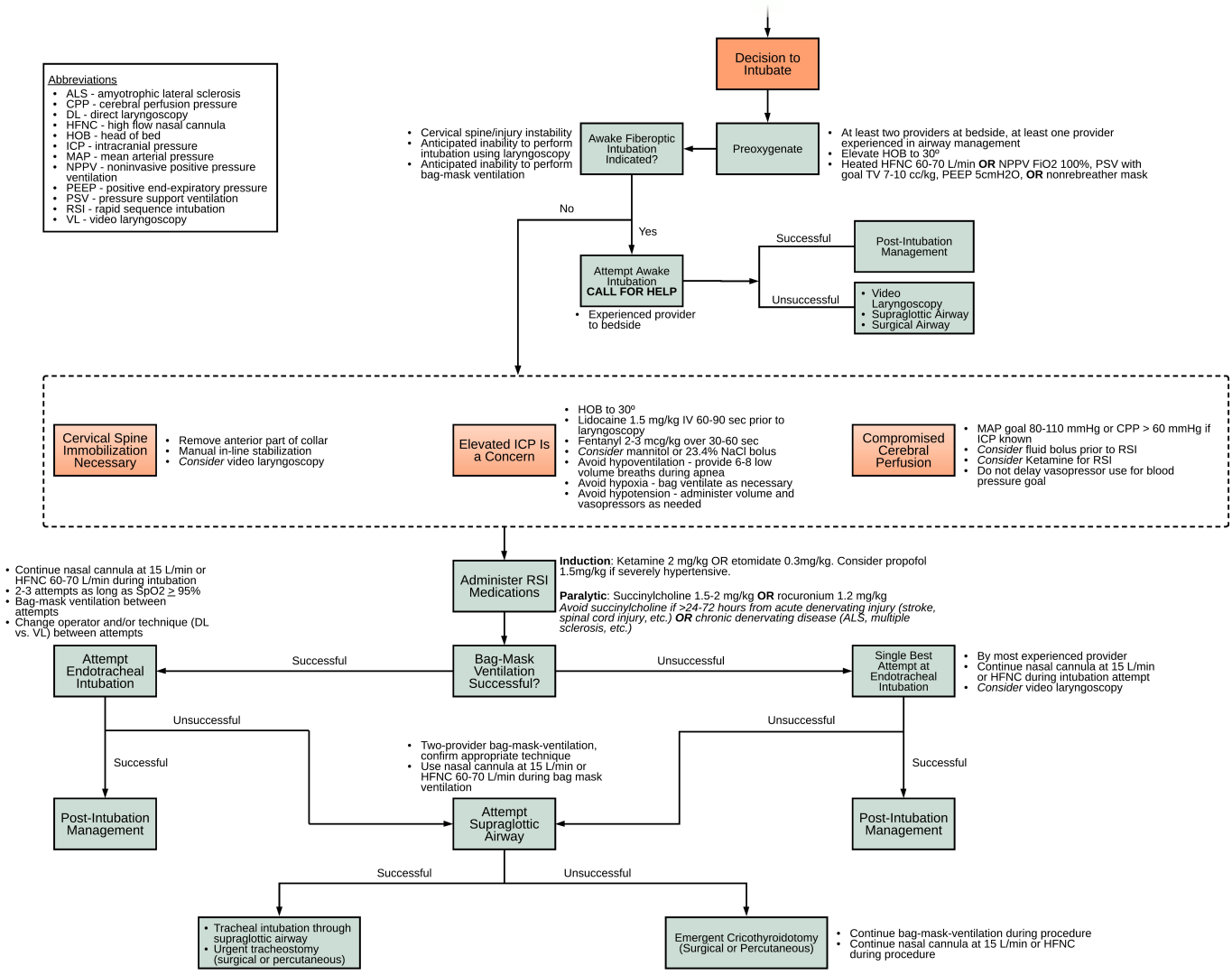
TEAM

1. **ASSIGN ROLES**
   - First intubator
   - Backup intubator
   - Bag-mask ventilation
   - Manual in-line stabilization
   - Drugs
   - Monitoring
   - Documentation
   - Invasive airway
2. **Who will be called for backup?**

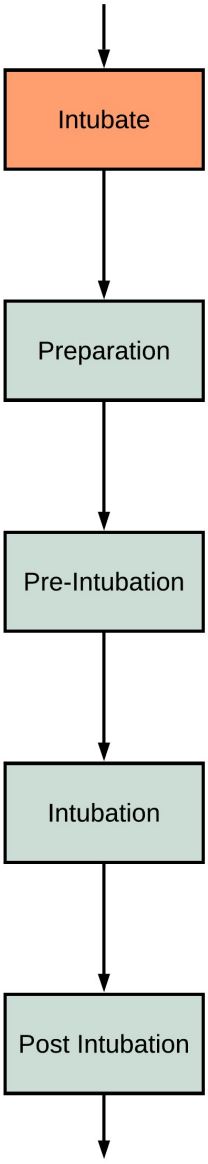
PLAN FOR DIFFICULTY

1. **CANNOT INTUBATE CAN VENTILATE**
   - 2-3 attempts by experienced operator with apneic oxygenation as long as SpO2≥95%
   - Supraglottic airway
   - Invasive airway
2. **CANNOT INTUBATE CANNOT VENTILATE**
   - Supraglottic airway
   - Emergent Cricothyroidotomy

Algorithm for endotracheal intubation



Intubation Sequence for Elevated ICP



- Elevate head of bed
- Intravenous access at two sites
- Infuse isotonic crystalloid
- Have vasopressor available
- Have intubation medications ready
- NPO, consider gastric decompression

- Preoxygenate
- Administer any pretreatment medications
- Consider osmotic agents (mannitol or hypertonic saline)
- Administer induction agent and paralytic simultaneously
- Allow for full muscle relaxation (45 sec for succinylcholine, 60 sec for rocuronium)
- Administer 6-8 low volume ventilations during apnea

- Lower head flat to intubate
- Return to 30 degree elevation when completed
- Avoid hypotension (keep MAP > 80mmHg)
- Avoid hypoventilation
- Bag-mask ventilate immediately if desaturation occurs

- Keep head elevated at 30 degrees
- Keep MAP > 80mmHg
- Do not hypoventilate (verify $PaCO_2$ between 35-45 mmHg or 4.7-6.0 kPa)
- Consider $EtCO_2$ monitoring
- Keep SpO_2 > 94%
- Secure ETT and check position by CXR

Post-Intubation Checklist

- ☐ Secure endotracheal tube
- ☐ Confirm tube position, order chest x-ray
- ☐ Set cuff pressure to 20-30 cmH2O
- ☐ Pulse oximetry and quantitative waveform capnography
- ☐ Arterial blood gas measurement
- ☐ Consider analgo-sedation for patient comfort
- ☐ Deep sedation while neuromuscular blockade in effect
- ☐ Counsel next of kin on change in patient status

Goals of mechanical ventilation

Mechanical ventilation must be carefully titrated to maintain physiologic homeostasis as $PaCO_2$ is a potent acute mediator of cerebral vascular tone and cerebral blood flow. Hyperventilation to a low $PaCO_2$ and high pH may cause decreased cerebral blood flow, worsening brain ischemia. Hypoventilation to a high $PaCO_2$ and low pH may cause cerebral vasodilation and worsen intracranial hypertension. Hypoxia is an important cause of secondary brain injury, while hyperoxia may also be harmful.

Immediately following intubation, respiratory and hemodynamic homeostasis should be restored. The goals of mechanical ventilation are:

- Normalization of oxygenation utilizing the lowest FiO2 that will maintain oxygen saturation of hemoglobin > 94%
- Normalization of ventilation to achieve a systemic pH of 7.35–7.45, and PaCO2 to 35–45 mmHg (4.7 – 6.0 kPa) or ETCO2 that corresponds to PaCO2 target
- Therapeutic hyperventilation ONLY in the setting of acute cerebral herniation
- Normalization of the work of breathing
- Prevention of ventilator induced lung injury, using tidal volumes of 6-8cc/kg ideal body weight and positive end-expiratory pressure (PEEP) ≥ 5
- Management of ventilator-patient dyssynchrony

Ideal Body Weight:
Men - 50 kg + 2.3 kg for every inch > 60 inches height (or every 2.54 cm above 152 cm)
Women - 45.5 kg + 2.3 kg for every inch > 60 inches height (or every 2.54 cm above 152 cm)

Oxygenation Goal: P_aO_2 > 110 mmHg, or SpO_2 >94%, or disease specific goal.

Analgo-Sedation

The goal of analgesia and sedation in the critically ill patient with neurological illness is to use the lowest dose of sedative/ analgesic that maintains comfort and ventilator-patient synchrony, while avoiding over-sedation and preserving the ability to clinically assess the patient's neurological status.

Occasionally, severe intracranial hypertension, status epilepticus, or the need for neuromuscular blockade may necessitate a state of deep, continuous sedation.

- Titrate to light sedation using a validated sedation scoring system- Richmond Agitation-Sedation Scale (RASS) 0 to -2 or Riker Sedation Agitation Scale (SAS) 3 to 4).
- Consider starting with analgo-sedation, using a short acting opioid infusion.
- Consider intermittent sedation.
- Dexmedetomidine or Propofol are preferred when continuous sedation is necessary.
- Deep sedation is necessary when neuromuscular blocking agents are used, in the presence of intracranial hypertension refractory to light sedation, and the management of seizures refractory to other antiseizure therapy.
- Perform daily sedation interruption unless contraindications exist (e.g. high ICP, status epilepticus).
- Employ non-pharmacological strategies: attention to day/night sleep cycles, limit noise, play music as appropriate, reassuring presence of family and friends.

Commonly used sedative and analgesic agents in the neurocritical care unit

Fentanyl: Fentanyl is an opioid agonist exhibiting analgesic effects with a rapid onset and a short duration of action. It is an agent which can be used for analgosedation, or in combination with a sedative.

Propofol: The lipid formulation of propofol allows for rapid penetration of the blood brain barrier, resulting in rapid onset and cessation of action. It has potent and immediate depressant effects on cerebral electrical and metabolic activity and does not require renal or hepatic metabolism for elimination. Disadvantages include robust vasodilating and hypotensive effects, considerable IV lipid load, and the potential for the rare, but frequently fatal, propofol infusion syndrome.

Benzodiazepines: Midazolam has a rapid onset of action and short duration of effect with bolus administration, making it an ideal agent for procedural sedation. Bolus-dose midazolam is a good choice for intermittent agitation in a NCCU population. Conversely, midazolam infusions have been associated with prolonged mechanical ventilation.

Dexmedetomidine: Dexmedetomidine is a centrally acting alpha-2 agonist Desirable properties include rapid onset and termination of activity, mild to moderate sedation without significant respiratory depressant action, analgesic effects, and less delirium than the benzodiazepines. Undesirable properties include a high incidence of bradycardia and hypotension.