Extubation Criteria & Delayed Emergence

**Extubation Criteria - OR**

1. Adequate Oxygenation
   - \( S_O_2 > 92\% , P_O_2 > 60 \text{ mm Hg} \)

2. Adequate Ventilation
   - \( V_T > 5 \text{ ml/kg, spontaneous RR} > 7 \text{ bpm, } ET_{CO_2} < 50 \text{ mm Hg, } P_{aCO_2} < 60 \text{ mm Hg} \)

3. Hemodynamically Stable

4. Full Reversal of Muscle Relaxation
   - Sustained tetany, TOF ratio > 0.9
   - Sustained 5-second head lift or hand grasp

5. Neurologically Intact
   - Follows verbal commands
   - Intact cough/gag reflex

6. Appropriate Acid-Base Status
   - \( pH > 7.25 \)

7. Normal Metabolic Status
   - Normal electrolytes
   - Normovolemic

8. Normothermic
   - Temp > 35.5°

9. Other Considerations
   - Aspiration risk
   - Airway edema
   - Awake vs. Deep (i.e. NOT in Stage II)

**Extubation Criteria - ICU**

**Subjective Criteria**
- Underlying disease process improving.

**Objective Criteria**
- Adequate mentation (GCS > 13, minimal sedation)
- Hemodynamically stable, on minimal pressors (e.g. dopamine < 5 mcg/kg/min)
- \( S_O_2 > 90\% , P_O_2 > 60 \text{ mm Hg, } P_aO_2/FIO_2 > 150 \text{ on } PEEP < 5-8 \text{ cm H}_2O \text{ and } FIO_2 < 0.4-0.5 \)
- \( P_{aCO_2} < 60 \text{ mm Hg, } pH > 7.25 \)

**Ventilator Criteria (during SBT)**
- \( RSBI (RR/V_T) < 100, NIF > 20 \text{ cm H}_2O \)
- \( V_T > 5 \text{ ml/kg, VC} > 10 \text{ ml/kg} \)
- \( RR < 30 \text{ bpm} \)
Potential Difficult Extubation

- History of difficult intubation
- OSA
- Maxillofacial trauma
- Generalized edema
- Paradoxical vocal cord motion (preexisting)
- Post-procedural complications:
  - Thyroid surgery (~4% risk of RLN injury, late hypocalcemia)
  - Diagnostic laryngoscopy +/- biopsy (laryngospasm, edema)
  - Uvulopalatoplasty (edema)
  - Carotid endarterectomy (hematoma, nerve palsies)
  - ENT surgeries (hematoma, jaw wires)
  - Cervical decompression (edema)

Approach to Difficult Extubation

- If intubation was technically difficult (e.g. multiple DLs, FOI), consider maintaining a “pathway” to the trachea (e.g. bougie, FOB, Airway Exchange Catheter).
- If airway edema is suspected due to fluids or traumatic intubation, consider performing a “Cuff-Leak Test”
  - Deflate cuff, occlude ETT, observe whether patient can breathe around the tube.
  - A failed leak test does NOT always lead to failed extubation, but may warrant further patient observation; likewise, passing a leak test does NOT guarantee successful extubation.

Stages of Anesthesia

Historical terminology to describe depth of anesthesia upon gas induction. Today, more important for emergence.

Stage 1
- Sedated, intact lid reflex, follows commands

Stage 2
- Excited/disinhibited, unconscious, unable to follow commands or exhibit purposeful movement
- Irregular breathing & breath-holding, dilated & disconjugate pupils, conjunctival injection
- Increased incidence of laryngospasm, arrhythmias, and vomiting.

Stage 3
- Surgical anesthesia

Stage 4
- Medullary depression, cardiovascular/respiratory collapse

Delayed Emergence

Definition
- Failure to regain consciousness as expected within 20-30 minutes of the end of a surgical procedure.

Causes
1. Residual drug effects
   - Absolute or relative overdose
   - Potentiation of agents by prior intoxication (e.g. EtOH, illicit drugs) or medications (e.g. clonidine, antihistamines)
   - Organ dysfunction (e.g. renal, liver) interfering with metabolism/excretion.
2. Hypercapnia and/or Hypoxemia
3. Hypothermia (<33˚C)
4. Hypo-/Hyperglycemia
Delayed Emergence

**Causes**

5. Metabolic Disturbances
   - Acid-base, hyponatremia, hypo-/hypercalcemia, hypomagnesemia
6. Organ Dysfunction
   - Renal failure, liver failure (e.g. hepatic encephalopathy)
7. Neurologic Insults
   - Seizure/post-ictal state
   - Increased ICP
8. Perioperative Stroke
   - Risk factors: AFib, hypercoagulable state, intracardiac shunt
   - Incidence: 0.1-0.4% in low-risk procedures; 2.5-5% in high-risk procedures

Diagnosis and Treatment

Ensure adequate oxygenation, ventilation, and hemodynamic stability first, then proceed with:

1. Administer “reversal agents”
   - Naloxone 0.40 mg – 2 mg IV Q 2-3 minutes.
   - If no response after 10 mg, reconsider narcotic overdose as cause of delayed emergency
   - Flumazenil 0.2 mg IV bolus Q 45-60 seconds over 15 seconds
   - May repeat doses. Maximum of 1 mg IV bolus. No more than 3 mg total in one hour.
   - Physostigmine 1-2 mg IV (for central cholinergic syndrome)
   - Neostigmine – maximum of 5 mg IV. Give with glycopyrrolate.
2. Ensure patient is normothermic
   - Use Bair Hugger
3. Check ABG for $P_{a}O_2$, $P_{a}CO_2$, glucose, and electrolytes
4. Consider neurological insults
   - Perform pertinent neurologic exam
   - Consider further workup (e.g. CT, MRI, EEG)
   - Consider Neuro consult

References

- MacIntyre NR et al. 2001. Evidence-based guidelines for weaning and discontinuing ventilatory support: a collective task force facilitated by the ACCP, AARC, and the ACCCM. *Chest, 120*: 375S-95S.
- Rashad Net University (www.rashaduniversity.com/delem.html)