

Extubation Criteria & Delayed Emergence

Extubation Criteria - OR

1. Adequate Oxygenation

- $S_{p}O_2 > 92\%$, $P_{a}O_2 > 60$ mm Hg

2. Adequate Ventilation

- $V_T > 5$ ml/kg, spontaneous $RR > 7$ bpm, $ET_{CO_2} < 50$ mm Hg, $P_{a}CO_2 < 60$ 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

Extubation Criteria - OR

6. Appropriate Acid-Base Status

- $pH > 7.25$

7. Normal Metabolic Status

- Normal electrolytes
- Normovolemic

8. Normothermic

- Temp $> 35.5^\circ$

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)
- $S_{a}O_2 > 90\%$, $P_{a}O_2 > 60$ mm Hg, $P_{a}O_2/F_iO_2 > 150$ on $PEEP < 5-8$ cm H_2O and $F_iO_2 < 0.4-0.5$
- $P_{a}CO_2 < 60$ mm Hg, $pH > 7.25$

Ventilator Criteria (during SBT)

- $RSBI (RR/V_T) < 100$, $NIF > 20$ cm H_2O
- $V_T > 5$ ml/kg, $VC > 10$ ml/kg
- $RR < 30$ 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 breath 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_aO_2 , P_aCO_2 , glucose, and electrolytes
4. Consider neurological insults
 - Perform pertinent neurologic exam
 - Consider further workup (e.g. CT, MRI, EEG)
 - Consider Neuro consult

References

- Feeley TW and Macario A. The postanesthesia care unit. In Miller RD (ed), *Miller's Anesthesia, 6th ed.* Philadelphia: Elsevier Churchill Livingstone, 2005.
- 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)
- Rosenblatt WH. Airway management. In Barash PG, Cullen BF, and Stoelting RK (eds), *Clinical Anesthesia, 5th ed.* Philadelphia: Lippincott Williams & Wilkins, 2006.