Early Extubation Algorithm

1

- Optimize all non-pharmacologic comfort interventions (cluster care, music therapy, child life, noise control).
- Opioid and sedative infusions started in the OR may be continued until the patient is ready for extubation.

2
Analgesia:
Goal pain score < 4

Start around-the-clock non-opioid analgesics:

- **Acetaminophen**† 15 mg/kg IV/PO Q6 hours x 4 doses – do not exceed 75 mg/kg/day or 4 grams/day
- **Consider ketorolac**†* **(see note below)** 0.5 mg/kg IV Q6 hours (max 30 mg/dose) x 8 doses (max 3 days if < 2 years old; max 5 days if ≥ 2 years old).
    - NOTE: Ketorolac is limited to patients ≥ 3 months of age (CGA>45 weeks) with normal renal function, minimal risk for bleeding, chest tube output < 3 mL/kg/hour, and CT Surgery approval for NSAIDs. NSAIDs are contraindicated in patients post-transplant or post-VAD placement.

†**Route**: Start with IV dosing and transition to enteral acetaminophen or NSAID dosing as soon as able (tolerating enteral medications per current diet order).
***Scheduling**: Alternate administration schedule so that either acetaminophen or ketorolac is given Q3 hours.

Give PRN opioid if patient's pain score ≥ 4 after comfort measures have been provided:

- **Morphine** 0.03 - 0.05 mg/kg/dose IV Q10 minutes until acute pain relieved (max 3 doses). Follow with morphine Q1 hour PRN pain (usual max 2 - 4 mg/dose). **NOTE**: In patients with prior opioid exposure, consider increased dosing of 0.1 - 0.2 mg/kg/dose

OR

- **Fentanyl** 0.5 - 1 mcg/kg/dose IV Q10 minutes until pain relieved (max 3 doses). Follow with fentanyl Q1 hour PRN pain (usual max 50 mcg/dose)

OR

- **Hydromorphone** (for patients over 12 months of age)
    - **Patients weighing < 30 kg**, administer hydromorphone 0.01 - 0.03 mg/kg/dose IV Q10 minutes until pain relieved (max 3 doses). Follow with hydromorphone 0.01 - 0.03 mg/kg/dose Q1 hour PRN pain (usual max 0.3 - 0.5 mg/dose).
    - **For patients weighing ≥ 30 kg,** administer hydromorphone 0.3 - 0.5 **mg/dose** IV Q10 minutes until acute pain relieved (max 3 doses), then follow with hydromorphone 0.3 - 0.5 **mg/dose** Q1 hour PRN

3
Sedation:
Goal SBS -1 to 0

If patient's SBS is > 0 and not responsive to comfort measures and PRN analgesia, start or adjust dexmedetomidine infusion:

- **Dexmedetomidine** 0.2 – 0.5 mcg/kg/hr IV. May be adjusted in increments of 0.1 – 0.3 mcg/kg/hr q30 minutes PRN agitation. Usual max dose 1.5 mcg/kg/hr.
- **Non-standard option: Propofol** infusion starting dose 25-50 mcg/kg/min, max dose 100 mcg/kg/min. May be considered in patients ≥ 12 months old with good ventricular function.

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When patient is ready for extubation, discontinue opioid infusion. Dexmedetomidine infusion may be continued in certain cases based on clinical need.

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AFTER EXTUBATION:

- Continue scheduled non-opioid analgesics as above.
- Continue PRN opioid as above for severe pain.
- Dexmedetomidine infusion may be continued if indicated.
- Consider ondansetron 0.1 mg/kg IV/enteral Q8 hours PRN nausea/vomiting for 48 hours in patients 6 months of age or older. Max 4 mg/dose. Recommend checking QTc on 15 lead ECG prior to administering.

Remain Intubated Algorithm

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- Optimize all non-pharmacologic comfort interventions (cluster care, music therapy, child life, noise control).
- Continue opioid & sedative infusions started in the OR

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Analgesia
Goal pain score < 4

Continue or start an opioid infusion - the following are typical starting doses:

- **Fentanyl** at 0.5 mcg/kg/hour IV (max starting dose 1 mcg/kg/hour)
- The team may choose an alternative opioid
  - **Morphine**, start at 0.03 mg/kg/hour (max starting dose 0.05 mg/kg/hour)
  - **Hydromorphone**, start at 7 mcg/kg/hour (max starting dose 10 mcg/kg/hour)

Administer PRN opioid for pain score ≥ 4

For analgesia, PRN agent/dose may match the continuous infusion agent and dose.

- For neonates, the max starting dose for PRN fentanyl is 0.5 mcg/kg/dose in the post-operative period, monitoring for hypotension.

Start around-the-clock non-opioid analgesics:

- **Acetaminophen**† 15 mg/kg IV/PO Q6 hours x 4 doses – do not exceed 75 mg/kg/day or 4 grams/day
- **Ketorolac**†* **(see notes below)** 0.5 mg/kg IV Q6 hours (max 30 mg/dose) x 8 doses (max 3 days if < 2 years old; max 5 days if ≥ 2 years old).

NOTE: Ketorolac is limited to patients ≥ 3 months of age (CGA>45 weeks) with normal renal function, minimal risk for bleeding, chest tube output < 3 mL/kg/hour, and CT Surgery approval for NSAIDs. NSAIDs are contraindicated in patients post-transplant or post-VAD placement.
†Route: Start with IV dosing and transition to enteral Acetaminophen or NSAID dosing as soon as able (tolerating enteral medications per current diet order).
***Scheduling**: Alternate administration schedule so that either acetaminophen or ketorolac is given Q3 hours.

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Sedation
Goal SBS as ordered

If patient's SBS is above goal and unresponsive to comfort measures and PRN analgesia, start or titrate dexmedetomidine infusion:

- **Dexmedetomidine** 0.2 – 0.5 mcg/kg/hr IV. May be adjusted in increments of 0.1 – 0.3 mcg/kg/hr q30 minutes PRN agitation. Usual max dose 1.5 mcg/kg/hr.

Note: Use dexmedetomidine cautiously in neonates (max 0.5 mcg/kg/hour): watch for bradycardia.

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Titrate opioid and sedative infusion(s) per the Nurse-Implemented Goal-Directed Algorithm (page 3)

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Algorithm Dosing Guidelines

Max dose opioid infusions:

- Fentanyl: 3 mcg/kg/hour
- Morphine: 0.25 mg/kg/hour
- Hydromorphone: 40 mcg/kg/hour
- Wean for bradycardia and hemodynamic instability

Max dose of sedation infusion:

- Dexmedetomidine: 1.5 mcg/kg/hour **[Neonatal (< 1 month of age) max 0.5 mcg/kg/hour]**
- Wean for bradycardia and hemodynamic instability

If patient is unresponsive to maximum dose of dexmedetomidine, the multidisciplinary team may consider initiation of a midazolam infusion (note risk for hemodynamic compromise):

- Midazolam (starting dose): 0.03 mg/kg/hour to 0.1 mg/kg/hour

Nurse-Implemented Goal-Directed Sedation Algorithm

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Titration Phase
Goal: Maintain SBS goal with minimum effective dose.

- Optimize all non-pharmacologic comfort interventions (cluster care, music therapy, child life, noise control).
- **Discuss patient's SBS† goal every day during rounds.**

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Patient's SBS more positive than prescribed:
- Exclude reversible causes & provide comfort measures. If SBS remains above goal, administer PRN opioid dose.
- If ≥ 3 nonprocedural PRN doses given in ≤ 8 hours, bedside RN may increase opioid or sedative infusion by 10% of current dose.

Patient's SBS at goal:
- Bedside RN may continue opioid and sedation infusions at current doses.

Patient's SBS more negative than prescribed:
- If < 3 nonprocedural PRN doses given in ≤ 8 hours, bedside RN may decrease opioid or sedative infusion by 10% of current dose.

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Weaning Phase
Following extubation, the goal is to discontinue infusions and minimize iatrogenic withdrawal based on patients individual goal WAT-1 score. The current dose of infusions at time of weaning phase will be the dose from which the dose weans will be made.

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Patient on analgesic and sedative infusions for < 5 days
- Discontinue infusions with extubation as ordered.
- Timing for turning off infusions to be discussed by multidisciplinary team.
- PRNs opioids can be continued as needed for comfort and/or safety peri-extubation.

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Patient on analgesic and sedative infusions between 5 and 10 days
- Identify baseline WAT-1 score before first wean.
- For most patients WAT-1 ≥ 3 is consistent with iatrogenic withdrawal.
  - Goal WAT-1 to be determined by multidisciplinary team and based on patient's baseline WAT-1.
- Wean opioid by 10% of starting dose (dose at wean hour zero), then wean by that same amount Q12 hours (goal off in 5-6 days).

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Patient on analgesic and sedative infusions > 10 days
- Identify baseline WAT-1 score before first wean.
- For most patients WAT-1 ≥ 3 is consistent with iatrogenic withdrawal.
  - Goal WAT-1 to be determined by multidisciplinary team and based on patient's baseline WAT-1.
- Wean opioid by 10% of starting dose (dose at wean hour zero), then wean by that same amount Q24 hours (goal off in ~ 10 days).

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- After opioid is discontinued, wean sedative by 10% of starting dose, then wean by that same amount Q24 hours (goal off in 10 days).
- **Interval between sedation weans can be adjusted based on patient tolerance as determined by multidisciplinary team.**

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Patient's WAT-1 > goal
- Consider PRN rescue dose and hold one wean step.
- Consider slowing the wean or starting intermittently dosed enteral medications (e.g., methadone, morphine or clonidine as appropriate) to facilitate weans.

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- Consider transitioning from infusions to intermittent dosing (IV or enteral) whenever clinically feasible.

† For patients receiving a neuromuscular blockade agent (NBA) infusion, use Pediatric NBA
- Opioids include Fentanyl, Morphine, and Hydromorphone
- Sedative includes Dexmedetomidine and Midazolam