**Early Extubation Algorithm**

**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 and Hydromorphone are first line agents for patients who are extubated:

* **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). Potential for rigid chest syndrome – use with caution in extubated patients.

**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,** administerhydromorphone 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 pain

**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.

**4**

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

**5**

**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.

**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.

***RESTORE-Cardiac***

**Nurse-Implemented Goal-Directed Comfort Algorithm**

**(Page 1 of 3 – Short term)**

**Remain Intubated Algorithm**

**6**

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

**7**

**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.

**8**

**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: CICU attending approval required for use in neonates. Use dexmedetomidine cautiously in neonates (max 0.5 mcg/kg/hour). Watch for bradycardia.

**9**

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

**10**

**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**

**16**

**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).

**15**

**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 for < 5 days**

* Around the time of extubation, discuss with attending physician and multidisciplinary team the specific plan for decreasing and/or stopping pain and sedation infusions as clinically indicated.
* PRNs opioids can be continued as needed for comfort and/or safety peri-extubation.

**12**

**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.

**11**

**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.**
* **For patients on the High Risk Bundle – discuss readiness to be placed on CICU Comfort Algorithm.**

**13**

**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.

† For patients receiving a neuromuscular blockade agent (NBA) infusion, use Pediatric NBA

* Opioids include Fentanyl, Morphine, and Hydromorphone
* Sedative includes Dexmedetomidine and Midazolam

**19**

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

**18**

**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.

**17**

* 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.**