SUBJECT: ICU Analgesia and Sedation Considerations for ECMO Patients **PAGE:** 1 of 4
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PURPOSE:
To provide considerations for the management of analgesia and sedation in ICU patients on ECMO. These recommendations are intended to be used in addition to the agents outlined in the Trauma Services Manual Acute Pain Management Guidelines. This document has been prepared to be a reference for providers.

ANALGESIA:

Continuous Infusions

I. Hydromorphone (preferred agent)
   a. No active metabolites
   b. Less likely to adsorb into ECMO circuit vs fentanyl
   c. Bolus dosing: 0.2-1 mg
   d. Continuous infusion dosing range: 0.5-4 mg/hour

II. Fentanyl (second-line in place of hydromorphone)
   a. No active metabolites
   b. Bolus dosing: 25-100 mcg
   c. Continuous infusion dosing range: 12.5-250 mcg/hour

III. Morphine (third-line in place of fentanyl)
   a. Active metabolite; CAUTION in renal impairment
   b. More likely to cause hypotension (histamine release)
   c. Bolus dosing: 2-5 mg
   d. Continuous infusion dosing range: 2-10 mg/hour

Continuous Infusions Conversions

Fentanyl dose	Hydromorphone dose	Morphine dose
≤ 50 mcg/hour	0.5 mg/hour	2.5 mg/hour
51-75 mcg/hour	**1 mg/hour**	**5 mg/hour**
76-100 mcg/hour	1.5 mg/hour	7.5 mg/hour
≥ 100 mcg/hour	2 mg/hour	10 mg/hour

Enteral (Oral/Per Tube) Agents

I. Oxycodone oral solution or immediate release tablets (preferred agent)
   a. Usual dosing: 5-10 mg q4-6h PRN or scheduled
      i. If patient is on hydromorphone ≥ 1 mg/hour (or equivalent dose of another opioid), consider scheduling to decrease CI analgesia rate
      ii. Preferred dose: 10 mg q4h scheduled

II. Morphine oral solution or immediate release tablets (second-line in place of oxycodone)
   a. Usual dosing: 7.5-10 mg q6h PRN or scheduled
      i. If patient is on hydromorphone ≥ 1 mg/hour (or equivalent dose of another opioid), consider scheduling to decrease CI analgesia rate
      ii. CAUTION in renal impairment

SEDATION:

Continuous Infusions

I. Propofol (preferred agent)
   a. Check baseline triglycerides (TG) and re-check TG q72h
      i. If TG >300 or Propofol dose ≥ 40 mcg/kg/min, check TG q24h
      ii. Change to a different agent if TG ≥ 500
   b. Check baseline CK and re-check CK q72h
      i. Change to a different agent if CK ≥ 5000
   c. Continuous infusion dosing range: 5-50 mcg/kg/min

II. Midazolam (second-line in place of or in addition to propofol)
   a. Active metabolite; CAUTION in renal impairment
   b. Highly lipophilic
   c. Continuous infusion dosing range: 1-20 mg/hour

III. Ketamine (second-line in place of or in addition to propofol and/or midazolam)
   a. Can cause tachyarrhythmias and hypertension
   b. Avoid if poorly controlled cardiovascular disease, significant psychiatric history, or severe hepatic disease (e.g. cirrhosis)
   c. Continuous infusion dosing range**:** 0.5-5 mg/kg/hour

IV. Lorazepam (fourth-line agent in place of midazolam)
   a. Propylene glycol diluent – monitor for toxicity with higher rates and prolonged (>24 hour) use
      i. Check serum osmolality q24h, change to a different agent if osmolar gap ≥ 10
   b. Continuous infusion dosing range: 1-10 mg/hour

V. Dexmedetomidine (as an adjunct to other agents listed above)
   a. Can cause bradycardia and/or hypotension
   b. Should not be used as a sole sedation agent in patients requiring deep levels of sedation and never as sole sedation agent for paralyzed patients
   c. Continuous infusion dosing range: 0.2-1.5 mcg/kg/hour

Enteral (Oral/Per Tube)/IM Agents

I. Diazepam tablet (preferred agent)
   a. Usual dosing: 2-10 mg q6h PRN or scheduled
      i. If patient is on midazolam infusion ≥ 4 mg/hour, consider scheduling to decrease CI rate
      ii. Preferred starting dose: 10 mg q6h scheduled

II. Atypical antipsychotics (in addition to diazepam)
   a. Monitoring
      i. Check QTc at baseline and with every dose increase
      ii. Discontinue if QTc > 500 ms OR if > 100 ms increase from previous (recent) EKG

   b. Quetiapine tablet (preferred atypical antipsychotic agent)
      i. Usual dosing: 12.5-100 mg q8-12h scheduled
         1. If patient is on midazolam ≥ 4 mg/hour, consider scheduling to decrease CI rate
         2. Preferred starting dose: 50 mg q12h scheduled

c. Olanzapine tablet/ODT (second-line in place of quetiapine)
    i. Use if history of long QTc or if receiving ≥ 3 QTc prolonging agents
    ii. Less QTc prolonging than other atypical antipsychotic agents
    iii. Usual dosing: 2.5 – 10 mg q12-24h scheduled (max: 20 mg/day)
        1. If patient is on midazolam ≥ 4 mg/hour, consider scheduling to decrease CI rate
        2. Preferred starting dose: 5 mg QHS

III. Phenobarbital IM injection, IVPB (third-line for refractory agitation; in addition to diazepam and quetiapine/olanzapine)
a. Check liver function at baseline and with each dose increase
b. Discontinue if liver function labs > 3x ULN
c. Usual dosing: 130 – 260 mg IM/IVPB x 1 dose; can be repeated q30min PRN
    i. Max total daily dose: **400 mg**

IV. Phenobarbital tablets (third-line for refractory agitation; in addition to diazepam and quetiapine/olanzapine)
a. Check liver function at baseline and with each dose increase
b. Discontinue if liver function labs > 3x ULN
c. Usual dosing (taper):
    i. 97.2 mg q4h scheduled x 5 doses
    ii. 64.8 mg q4h scheduled x 4 doses
    iii. 64.8 mg q8h scheduled x 3 doses

NEUROMUSCULAR BLOCKING (PARALYTIC) AGENTS

- If paralytics are used, the patient must be sedated to a Riker of 1 **prior to** initiation of the paralytic
- Paralytics are titrated per unit policy (e.g. ventilator synchrony, train-of-four, ICP, etc.)
- For all agents, use IDEAL body weight in obese patients

I. Cisatracurium (preferred agent)
a. Bolus dose: 0.2 mg/kg IVP (rounded to nearest 10 mg)
b. Continuous infusion dosing range: 0.5-10 mcg/kg/min

II. Vecuronium (second-line agent)
a. Elimination prolonged in severe hepatic and/or renal impairment
b. Bolus dose: 0.2 mg/kg IVP (rounded to nearest 10 mg)
c. Continuous infusion dosing range: 0.8-2 mcg/kg/min

III. Rocuronium (third-line agent)
a. Bolus dose: 1 mg/kg IVP (rounded to nearest 50 mg; max bolus dose: 100 mg)
b. Continuous infusion dosing range: 5-16 mcg/kg/min

RIKER SEDATION-AGITATION SCALE

Score	Term	Description
7	Dangerous agitation	Pulling at ETT, trying to remove catheters, climbing over bed rail, etc.
6	Very agitated	Does not calm despite frequent verbal reminding of limits, requires physical restraints, biting ETT
5	Agitated	Anxious or mildly agitated, trying to sit up, calms down to verbal instructions
4	Calm and cooperative	Calm, awakens easily, follows commands
3	Sedated	Difficult to arouse, awakens to verbal stimuli or gentle shaking but drifts off, follows simple commands
2	Very sedated	Arouses to physical stimuli but does not communicate or follow commands, may move spontaneously
1	Unarousable	Minimal or no response to noxious stimuli, does not communicate or follow commands