Most patients receive some form of sedation and analgesia while in the ICU. The specific drugs, route, continuous infusion vs. intermittent dosing, and actual doses used varies depending on patient’s specific disease, degree of illness, and the endpoints to be accomplished with anesthesia. Analgesia is defined as pain control and sedation is to diminish anxiety. Patients in the ICU will often receive a combination of medications to provide both. The most severe of patients will also receive paralytics. Inability to contract any striated muscles is defined as paralysis.

Factors determining the various drugs and doses an individual patient is placed on are as follows:
- Specific illness: ARDS vs. Trauma
- Surgical procedure: CNS tumor resection vs. airway reconstruction
- End organ dysfunction / failure: specifically liver or renal failure
- Solid organ transplant: concerns of graft dysfunction
- Severity of illness: end stage cardiomyopathy vs. lobar pneumonia
- Previous exposure to medications: patients with chronic illness, ex-premature infant

**Continuous infusion vs. Intermittent dosing**
Patients that require prolonged ICU stays are often placed on continuous infusions. By doing so, patients receive consistent pain control and sedation. Many self-extubations and loss of arterial / venous catheters are prevented by maintaining a steady state of sedation. In hemodynamically unstable patients, continuous infusions also prevent an acute decrease in blood pressures that often occurs with bolus doses of medications.

Intermittent dosing should be considered in patients whose mental status must be monitored closely, i.e. neurosurgical and head trauma patients. If such a patient is unarousable on continuous infusion sedation, the etiology of depressed mental status will be difficult to determine. Poor hepatic or renal clearance is a second reason to consider intermittent dosing. Continuous infusions may cause build-up of either the specific drug, its’ metabolite, or both, causing hemodynamic instability and / or depression of mental status.

(Also refer to Table 1)
**Analgesics**: do not provide any sedation (with the exception of Ketamine)
**Morphine**: Opiate
- Intermittent dosing: 0.05mg – 0.2mg/kg every 1-4 hours
- Continuous infusion: 0.02 – 0.3mg/kg/hr
- Onset of action: 5 – 15 minutes
- Duration of action: 2 – 6 hours
• Advantages:
  o Long acting analgesic with pain control lasting 1-4 hours
• Disadvantages:
  o Cases histamine release – worsening any reactive airway disease and may cause profound itching
  o Longer effect with prolonged depressed mental status – frequent neurologic evaluations may be difficult
  o Respiratory depression
  o Hemodynamic instability
  o Build-up of drug / metabolite in hepatic insufficiency or renal failure patients amplifying respiratory depression and hemodynamic instability
• Reversal Agent: Narcan

**Fentanyl**: Opiate
• Intermittent dosing: 1mcg – 3mcg/kg every 0.5-2 hours
• Continuous infusion: 0.5 – 5mcg/kg/hr
• Onset of action: 1 – 5 minutes
• Duration of action: 30 – 90 minutes
• Advantages:
  o Short acting allowing for frequent neurologic assessments in patients with CNS pathology
  o Decreased hemodynamic instability as compared to morphine
• Disadvantages:
  o Rigid chest: chest muscle rigidity which occurs with rapid push of IV fentanyl and can only be treated with paralytics
  o Short acting – pain control provided for shorter period
• Reversal Agent: Narcan

**Dilaudid**: Opiate with excellent pain control
• Intermittent dosing: 15 mcg/kg every 2-6 hours
• Continuous infusion: 1 – 10mcg/kg/hr
• Onset of action: 15 – 30 minutes
• Duration of action: 4 – 5 hours
• Advantages:
  o Excellent pain control for patients with chronic pain
• Disadvantages:
  o Cases histamine release, although considered to be less than morphine – worsening any reactive airway disease
  o Longer effect with prolonged depressed mental status – frequent neurologic evaluations may be difficult
  o Respiratory depression
  o Increases ICP – not to be used in patients with intracranial lesions
• Reversal Agent: Narcan
**Sedatives**: do not provide any pain control

**Versed**
- Intermittent dosing: 0.05mg – 0.2mg/kg every 0.5-2 hours (max dose 4mg)
- Continuous infusion: 0.02 – 0.3mg/kg/hr
- Onset of action: 1 – 2 minutes
- Duration of action: 30 – 80 minutes
- Advantages:
  - Short acting sedative lasting 20-30min with intermittent dosing
- Disadvantages:
  - Hypotension – should be used cautiously in patients with depressed cardiac function
  - Respiratory depression
  - Hepatic clearance; prolonged hemodynamic and neurologic depressive effects in patients with hepatic failure
- Reversal Agent: Flumazenil

**Ativan**
- Intermittent dosing: 0.05mg – 0.2mg/kg every 1-4 hours (max dose 4mg)
- Continuous infusion: not recommended due to build-up of carrier – propylene glycol, but no definitive data of adverse effects, so practices vary according to institution
- Onset of action: 5 – 15 minutes
- Duration of action: 6 – 8 hours
- Advantages:
  - Longer acting sedative
- Disadvantages:
  - Hypotension – should be used cautiously in patients with depressed cardiac function
  - Respiratory depression
  - Hepatic clearance; prolonged hemodynamic, neurologic, and respiratory depressive effects in patients with hepatic failure
- Reversal Agent: Flumazenil

**Propofol**
- Intermittent dosing: 1mg – 5mg/kg bolus dosing
- Continuous infusion: 20 – 250mcg/kg/min
- Onset of action: 10 – 50 seconds (with bolus dosing)
- Duration of action: 3 – 10 minutes (with bolus dosing)
- Advantages:
• Rapid onset of action makes it an ideal drug for procedural sedation
• Decreases ICP (intra-cranial pressure) and cerebral metabolism – maybe ideal in patient’s with CNS pathology

• Disadvantages:
  o Hypotension – by decreasing both cardiac output and systemic vascular resistance; should be used with extreme caution in patients with depressed cardiac function
  o Depresses respiratory drive
  o Not approved for prolonged infusions in pediatric patients due to concerns of propofol infusion syndrome characterized by metabolic acidosis and cardiac failure

Dexmedetomidine
• Intermittent dosing: none
• Continuous infusion: 0.2 – 1.5mcg/kg/hr
• Advantages:
  o Provides sedation without respiratory depression
  o Pain control lasting 1-4 hours
• Disadvantages:
  o Often associated with bradycardia and secondary hypotension
  o Cleared by liver & kidney; ? buildup with hepatic or kidney failure

Anesthetics
Ketamine:
• Intermittent dosing: 1mg – 2mg/kg IV or 3 – 5 mg/kg IM
• Continuous infusion: 10 – 50mcg/kg/min
• Onset of action: 30 seconds
• Duration of action: 5 – 15 minutes
• Advantages:
  o Provides both sedation and analgesia
  o Rapid onset of action – ideal for procedural sedation
  o Usually causes a rise in blood pressure – ideal for patients with depressed cardiac function
  o Improves reactive airway disease – ideal to sedate asthmatic patients
  o No depression of respiratory drive
• Disadvantages:
  o A relative contra-indication in patient’s with increased intra-cranial pressure due to increase in blood pressures
  o Dissociative anesthetic with visual hallucinations – not well tolerated by patient’s usually with developmental age of 8 years or older; therefore a benzodiazepine must often be concurrently administered
Increases oral and airway secretions; an anti-sialogogue such as glycopyrrolate should be co-administered

**Etomidate**: often used for intubation
- Intermittent dosing: 0.3mg/kg
- Continuous infusion: not recommended
- Onset of action: 10 – 20 seconds
- Duration of action: 4 – 10 minutes
- Advantages:
  - Does not cause hypotension – ideal choice for patients with poor cardiac output
  - Does not increase ICP – ideal for patients with CNS pathology
  - Rapid onset makes it an ideal agent for rapid sequence intubation
- Disadvantages:
  - Causes adrenal suppression, perhaps even with single dosing; multiple doses not recommended
  - Causes histamine release – worsening any reactive airway disease

**Withdrawal**
Patients maintained on sedatives / analgesics for greater than 3-5 days often will experience withdrawal. Symptoms of withdrawal include agitation, fever, tachycardia, hypertension, diaphoresis, emesis, and diarrhea. For patients with prolonged use of sedatives, withdrawal should be anticipated and patients should be transitioned to methadone and ativan around the clock prior to weaning off their continuous infusion medications. Multiple methods of calculate the appropriate dose of methadone and ativan dose exist and should be considered. Methadone in particular may have a profound CNS and respiratory depressive effects in neonates and should be used cautiously. A clonidine patch can often be added as well to mitigate withdrawal symptoms.

**Neuro-Muscular blocking agents**: Provide paralysis, but no sedation or analgesia

ASSURE THE PATIENT CAN BE EASILY BAG-MASK VENTILATED OR HAS AN ENDO-TRACHEAL TUBE IN PLACE PRIOR TO ADMINISTERING PARALYTICS.

**Succinylcholine**: depolarizing muscle relaxant
- Dosing: 2mg/kg
- Continuous infusion: Not recommended
- Onset of action: 30 – 60 seconds
- Duration of action: 6 – 10 minutes
- Advantages:
  - Rapid onset of action – ideal for rapid sequence intubation
  - Short duration of action
Disadvantages
  - Can cause hyperkalemia in burn and crush injury patients
  - Malignant hyperthermia in at prone patients

Rocuronium: non-depolarizing muscle relaxant
  - Dosing: 1-2 mg/kg
  - Continuous infusion: Not recommended
  - Onset of action: 1 – 2 minutes
  - Duration of action: 10 – 30 minutes
  - Advantages:
    - Rapid onset of action – ideal for rapid sequence intubation

Vecuronium: non-depolarizing muscle relaxant
  - Dosing: 0.1-0.2 mg/kg
  - Continuous infusion: 0.05-0.3mg/kg/hr –titrated to effect as based on patient movement and train of 4
  - Onset of action: 2 – 4 minutes
  - Duration of action: 30 – 40 minutes
  - Advantages:
    - Prolonged paralysis
  - Disadvantages:
    - Can cause polyneuropathy when used in patients for prolonged periods particularly in conjunction with steroids or aminoglycosides
    - Hepatic clearance: must be used with caution in patient’s with liver failure

Cisatracurium: non-depolarizing muscle relaxant
  - Dosing: 0.1-0.15 mg/kg
  - Continuous infusion: 1-4 mcg/kg/min –titrated to effect as based on patient movement and train of 4
  - Onset of action: 2 – 3 minutes
  - Duration of action: 30 – 40 minutes
  - Advantages:
    - Minimal hepatic clearance, therefore can be used in hepatic failure patients without concerns for prolonged paralysis
  - Disadvantages:
    - Rare histamine release causing rash / bronchospasm