**PICU Pharmacy Pearls for the Medical Residents**

* Therapeutic Drug Monitoring:
  + Antibiotics:
    - See Spectrum of Activity Summary Chart (last page of handout)
    - **Vancomycin**:
      * See “Protocol for Initial Vancomycin Dosing in Pediatric Patients” in the Lexi-Comp Formulary
      * Typical starting dose:

|  |  |  |  |
| --- | --- | --- | --- |
| Goal Trough Concentration (mcg/mL) | Age | Dose | Interval |
| 10 to 15 | < 7 days old and/or for neonates with post menstrual age < 37 weeks | See NeoFax® for dosing | |
| ≥ 7 days to ≤ 2 months | 15 mg/kg | Every 8 hours |
| > 2 months to < 18 years | 12.5 mg/kg  (max 1000 mg/dose) | Every 6 hours |
| ≥ 18 years | 15 mg/kg  (max 1250 mg/dose) | Every 8 hours |
| 15 to 20 | < 7 days old and/or for neonates with post menstrual age < 37 weeks | See NeoFax® for dosing | |
| ≥ 7 days to ≤ 2 months | 12.5 mg/kg | Every 6 hours |
| > 2 months to < 18 years | 15 mg/kg  (max 1000 mg/dose) | Every 6 hours |
| ≥ 18 years | 12.5 mg/kg  (max 1000 mg/dose) | Every 6 hours |

* + - * When to get levels?
        + In a patient with normal renal function, a vancomycin **trough** level should be obtained 0 to 30 minutes **prior** to the **4th dose**
        + If the patient has abnormal renal function, they will probably need a trough level sooner than before the 4th dose. Also, these patients will likely need much more frequent trough levels.
        + Peak levels have not been shown to correlate with toxicity or efficacy so not recommended. If need to obtain: 1 hour after the end of a 1 hour infusion
      * Goal trough levels:

|  |  |  |
| --- | --- | --- |
| Drug | Goal Trough Level (mcg/mL) | Indication |
| Vancomycin | 10 to 15 | All other infections |
| 15 to 20 | Complicated infections such as bacteremia, endocarditis, osteomyelitis, meningitis, and hospital-acquired pneumonia caused by Staphylococcus spp. |

* + - **Aminoglycosides** (gentamicin, tobramycin, amikacin)
      * Tobramycin = aminoglycoside of choice in PICU due to better empiric *Pseudomonas* coverage
      * When to get levels? “around the 3rd dose”
        + **Peak concentration** will be drawn 30 minutes **after** infusion of the **3rd dose**
        + **Trough concentration** will be drawn 30 minutes **prior** to administration the **3rd dose**
      * Goal levels:

|  |  |  |
| --- | --- | --- |
| Drug | Goal Peak Level | Goal Trough Level |
| Gentamicin and tobramycin | 6 to 8 mcg/mL (most infections)  8 to 10 mcg/mL (meningitis, pneumonia) | < 2 mcg/mL |
| Amikacin | 20 to 25 mcg/mL (most infections)  25 to 40 mcg/mL (life threatening infections) | < 8 mcg/mL |

* + Anticonvulsants:
    - Phenytoin/Fosphenytoin: loading dose: 10-20 mg/kg; maintenance: generally 5 mg/kg/**day** (divided BID)
      * When to get levels?
        + Maintenance dose level: trough level 1 hours prior to a dose
        + Post loading dose level: consider obtaining a level 2 hours after administration of the loading dose
      * Goal levels:
        + Total phenytoin level: 10 to 20 mcg/mL

Total phenytoin levels may be affected by hypoalbumemia, uremia, drug interactions, and other various factors

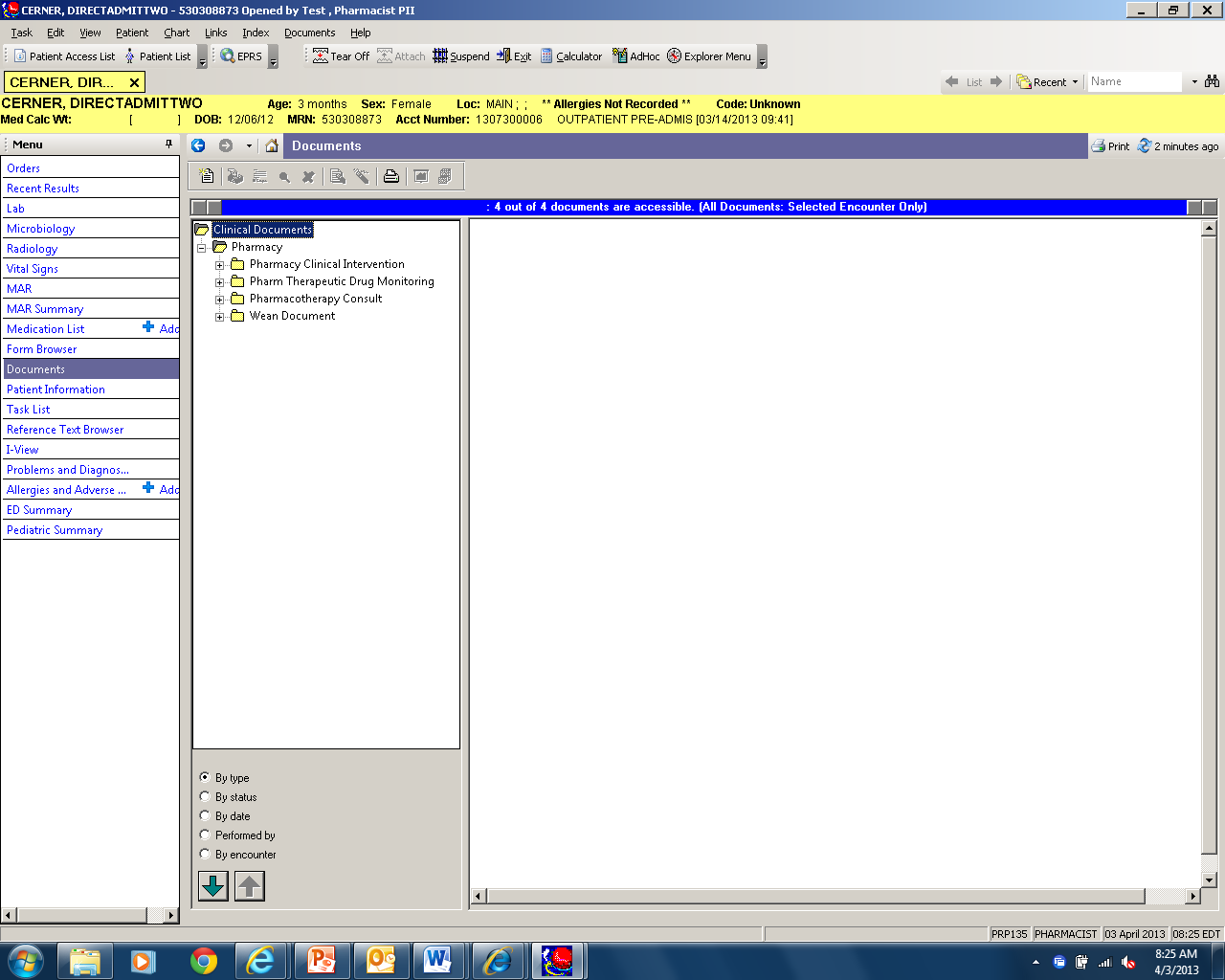
* + - * + Free phenytoin level: 1 to 2 mcg/mL
    - PHENobarbital:
      * When to get levels?
        + Trough level within 1 hour prior to dose (but since long half-life could obtain anytime as long as it’s not right after a dose is given)

Drug have a very long have life so will not be at steady state for weeks

* + - * Goal levels: 15 to 40 mcg/mL
        + Note: with the input of neurology sometimes may aim for levels slightly higher than the general goal level
  + Anticoagulation:
    - Heparin
      * Continuous infusion is monitored via anti-Xa levels via new protocol located on the intranet
    - Enoxaparin:
      * When to get level?
        + Generally levels are not needed if using enoxaparin for prophylaxis (exception: renal impairment and when recommended by Heme)
        + Anti Xa (may be referred to as a LMWH level): should be obtained 3 to 5 hours after a dose is given

If just starting enoxaparin or making a dose titration wait to obtain this level until after to the 2nd dose

* + - * Goal level:
        + Therapeutic: 0.5 – 1 units/mL
        + Prophylaxis (if obtained): 0.1 – 0.3 units/mL
* Pharmacy Notes in Cerner:
  + Types of Notes:
    - **Pharmacotherapy consult note**: a free form note to be used whenever pharmacy is asked to assess a patient for various medication related issues. This note should/will be utilized frequently.
      * example: a note that discusses all dose changes needed for a patient in AKI or on some sort of renal replacement (like PD/IHD/CRRT, etc)
    - **Wean document**: This note will be used for any of the various drug weans a pharmacist would be asked to do (example: methadone, lorazepam, steroids, clonidine, etc.)
    - **Pharmacy therapeutic drug monitoring form**: This form will be used for pharmacists to document monitoring of drugs requiring close therapeutic monitoring (vancomycin, aminoglycosides, phenobarbital, anticoagulants, etc). This note will require the pharmacist to enter a brief clinical history, pertinent lab values, and provide a clinical assessment with recommendations.
    - **Pharmacy Clinical Intervention**: this note is utilized for clinical documentation on rejected orders as well as for chemo/pca double checks.
  + Where to find these notes:



**Electrolyte Replacement:**

* + Sodium:
    - IV: 3% saline (513 mEq/L)
      * Typical Starting Dose: 5 mL/kg bolus follow by 1 mL/kg/hr continuous infusion (adjusted per serum sodium levels and/or ICP goals)
      * Once stable: Can do math to determine mEq/day that patient is getting from drip and switch to PO
    - PO: NaCl
      * General starting dose for replacement: 2 to 4 mEq/kg/day
      * Available formulations:
        + Sodium chloride 1 gram **tablets** = 17 mEq
        + Sodium Chloride **oral solution** = 1 mEq/mL
        + **Table salt** = ~ 100 mEq per teaspoon
        + **Morton’s lite salt** = 50 mEq per teaspoon (no longer able to use at Children's National Medical Center)
  + Potassium:
    - Potassium chloride - KCl (IV/PO):
      * Dose: 0.25 to 1 mEq/kg (max dose: 40 mEq)
      * Notes: no oral potassium to be given 1 hour before or after bolus dose
  + Calcium:
    - Calcium GLUConate (IV): preferred for patients without central access
      * Dose: 100 mg/kg (max dose: 2000 mg)
      * Notes: 100 mg = 10 mg elemental Ca2+
    - Calcium chloride (IV): for CV patients, cardiac arrest and symptomatic hypocalcemia
      * Dose: 10 to 20 mg/kg (max dose: 1000 mg)
      * Notes: 100 mg = 27 mg elemental Ca2+
  + Magnesium:
    - Magnesium sulfate:
      * Dose: 25 to 50 mg/kg (max dose: 2000 mg)
  + Phosphate:
    - Potassium phosphate KPhos (IV): preferred for IV boluses
      * Dose: 0.15 – 0.5 mmol/kg (max dose: 30 mmol)
      * Note: 4.4 mEq K = 3 mmol PO4
    - Sodium phosphate NaPhos (IV): preferred for TPN
      * Dose: 0.15 – 0.5 mmol/kg (max dose: 30 mmol)
      * Note: 4 mEq Na+ = 3 mmol PO4

**Pain and Sedation:**

* + **PICU Sedation Protocol:**
    - Order in Cerner via “Critical Care Sedation Orders Plan”
    - Acute Phase: this is the phase of sedation during the patients’ acute illness. During this phase you want the patient to be sedated so that they aren’t contributing to the care you are providing.
      * Goal MMAAS: -1 to -2
      * Typical starting regimen:
        + Morphine continuous infusion 0.05 mg/kg/hr (maximum starting dose: 4 mg/hr)
        + Midazolam continuous infusion 0.05 mg/kg/hr (maximum starting dose: 2 mg/hr)
      * Titration:
        + Nurse to titrate up by 10 to 20% if ≥ 3 non-pre care boluses needed in ≤ 8 hours
    - Plateau “Titration” Phase: patient is getting better during this phase and your goal is to decrease sedation so that they are able to contribute to their care (e.g. trigger breaths on own and use accessory muscles)
      * Goal MMAAS: 0 to -1 (needs communication order!)
      * Titration:
        + Nurse is to wean drips by set decrements (typically starting with the opioid) **every 8 hours alternating. Dexmedetomidine does NOT wean in this phase.**
    - Wean to Extubate Phase: patient is still getting better and is getting ready for extubation but you want to prevent withdrawal from benzos/opioids
      * Goal MMAAS: +1 to 0
      * Titration:
        + Nurse is to wean drips by set decrements (starting with the opioid) **every 8 hours weaning opioid to OFF and then starting with benzodiazepine**
  + Role of dexmedetomidine:
    - **Sedation agent of choice for patients < 6 month old (instead of midazolam)**
    - Generally reserved for patients patients that are not being sedated with high doses of midazolam (> 0.3 mg/kg/hr), or for patients in whom you want to sedate without effecting respiratory drive (e.g. short term intubation)
    - Typical starting dose: 0.5 – 1 mcg/kg/hr (max: 2.5 **mcg**/kg/hr)
    - Note: bolus dose of dexmedetomidine is ALWAYS equal to 0.5-1 mcg/kg (do not match to hourly rate!)
    - Withdrawal can occur if on drip for > 3 -5 days
      * Weaning by 0.1 mcg/kg/hr every 8 hours once in Wean to Extubate Phase
  + Withdrawal: (WAT-1 > 3)
    - From opioids = methadone use protocol or work with pharmacy to determine equivalent dose
    - From benzodiazepines = LORazepam use protocol or work with pharmacy to determine equivalent dose
    - From dexmedetomidine = cloNIDine 5 to 10 **mcg**/kg/day divided q 6-8 hours (enteral) or via patch
      * Note: clonidine can also be used to assist with weaning from opioids/benzos
    - Pharmacy will put in a wean note for patients. Our typical wean is a very slow wean of ~10% of the original dose every other day. We will typically start by weaning methadone on day 1 followed by weaning LORazepam on day 2.

**Current Drug Shortages Affecting the PICU:**

* Further information can be found on Lexicomp Formulary by searching “drug shortages”
* Fosphenytoin
  + Use criteria during drug shortage:
    - Any patient < 5 years old
  + Alternatives:
    - IV phenytoin
* Vecuronium:
  + Alternatives:
    - For continuous infusions: rocuronium 0.4 to 1 mg/kg/hr
    - For boluses: rocuronium 0.6 to 1 mg/kg PRN movement
* Meropenem!!!
  + Reserved for patients with ONLY carbapenem susceptibilities
  + Doripenem better stock!
* Cefotaxime
  + IV:
    - Patients > 1 month of age: cefTRIAXone
    - Patients < 1 month of age: cefTAZidime or cefepime
  + Oral:
    - Cefdinir