Common Dangerous Medication Errors

Session Overview
The Emergency Department is a fast-paced environment in which important treatment decisions are sometimes made with limited time. Medication mistakes, particularly those with high-risk drugs, can increase morbidity and mortality. The goal of this talk is to introduce several high-risk medications and provide practical pearls to help avoid common, potentially serious mistakes.

Objectives
1) List high-risk medication errors in emergency patients
2) Identify strategies to prevent high-risk medication errors

Background

● Medication errors are common. In one academic medical center’s evaluation of medical resuscitations, 1 out of 2 doses was administered in error. 14% were considered at least moderate in severity. 46% were prescribing errors, 28% administration technique, 14% mislabeling, 10% preparation, and 2% improper doses. (Gokham 2012)
● The Institute for Safe Medication Practices (ISMP) defines high-alert medications as “drugs that bear a heightened risk of causing significant patient harm when they are used in error.”
  ○ ISMP maintains a comprehensive, updated list of high-alert medications
● Peth 2003

![Variables associated with medication errors in the emergency department](image)

An easy acronym to remember high-risk medications: PINCH. P - Potassium, I - Insulin, N - Narcotics, C - Chemotherapy, H - Heparin

Potassium
● Treating Hyperkalemia with Insulin
  ○ How insulin works
    ■ Temporarily shifts potassium intracellularly through a complex process of activating Na+-K+ ATPase and by recruitment of intracellular pump components
into the plasma membrane. Insulin binding to specific membrane receptors results in extrusion of Na+ and cellular uptake of K+. (Hundal 1992)

○ The right insulin dose
  ■ 5 unit boluses up to 20 unit/hr infusions have been used (Blumberg 1988). Most common dose is 10 units IV regular insulin bolus (lowers K+ ~ 0.5-1 mEq/L).

○ Preventing hypoglycemia
  ■ Incidence of hypoglycemia
    ● A 10 unit dose of IV regular insulin has an onset of action ~5-10 minutes, peaks at 25-30 minutes, and lasts 2-3 hours. IV dextrose lasts < 1 hour.
    ● Overall incidence of hypoglycemia appears to be ~10%, but could be higher (Allon 1990; Schafers 2012; Apel 2014, Scott 2019)
  ■ Risk factors for developing hypoglycemia (Apel 2014)
    ● No prior diagnosis of diabetes
    ● No use of diabetes medication prior to admission
    ● Lower pretreatment glucose (104 mg/dL vs 162 mg/dL, P = 0.04)
    ● Renal dysfunction (insulin may be partially renally metabolized) (Dickerson 2011)
    ● Higher insulin dose (LaRue 2017)
  ■ Strategies for avoiding hypoglycemia
    ● Here is a suggested strategy for administering enough dextrose to counter the initial insulin bolus of 10 or 20 units. It is loosely based on the Rush University protocol. (Apel 2014)

○ ISMP highlighted this issue in a February 2018 Safety Alert

Insulin

● Insulin has been on the ISMP High Alert list for decades. There are multiple products, each with different kinetic profiles, that can cause confusion.
● Most insulin products are 100 units/mL; some are 200, 300, and 500 units/mL (Kalra 2018)
● In addition, we are now using insulin for non-diabetic treatments, such as calcium channel blocker poisoning. Doses of IV insulin can be up to 10 units/kg/hr. This presents unique challenges in that we potentially need non-standard concentrations of IV insulin infusions to avoid volume overload with the standard 1 unit/mL infusion used for most purposes.
● ISMP published guidelines in 2017 for Optimizing Safe Subcutaneous Insulin Use in Adults

Narcotics

Opioids are a frequent cause of litigation in ED cases, particularly hydromorphone

● Some EDs are becoming ‘opioid free,’ and instead utilizing acetaminophen, NSAIDs, and even ketamine and lidocaine for acute pain control.
● Hydromorphone 1 mg IV = Morphine 7 mg IV
  ○ It seems odd that morphine 10 mg seems like a lot to us, yet hydromorphone 2 mg is prescribed with little concern
  ○ An appropriate starting dose of morphine is 0.1 mg/kg, assuming normal kidney function and age < 65 years
A good strategy is start low, go slow (or consider opioid alternatives)

- **Naloxone**
  - Patients typically receive 2-4 mg in the prehospital setting, a dose often too high for patients chronically taking opioids. This dose can precipitate withdrawal. [The important caveat is that with fentanyl (and fentanyl derivatives) mixed with heroin, a high dose of naloxone (up to 10 mg) may be needed]
  - A more conservative strategy is to start with 0.04 mg and administer 0.04-0.08 mg increments to achieve desired respiratory rate (Kim 2016)
  - Here is a trick-of-the-trade for preparing naloxone to give these smaller doses

**Heparin**

- Heparin is fraught with errors (Grissinger 2010). Factors that may increase risk of error:
  - Indication (ACS, VTE/PE, etc)
  - Bolus vs. no-bolus vs. infusion
  - Dosing (weight-based vs. non-weight-based)
    - Dosing in obesity (actual vs adjusted)
  - Monitoring frequency
  - Prophylaxis vs. treatment
  - Utilization with other anticoagulants, antiplatelets, or blood-altering drugs (eg, tPA)
  - Multiple concentrations and vial/bag sizes
- Avoiding errors: EMR order sets, nurse-driven adjustments, double checks, barcode scanning, infusion pumps

**IV Hydralazine**

- Potent vasodilator. Onset of action: ~20 minutes, peak effects last 60 minutes, duration of action is unpredictable and can persist for up to 8 hours. (Powers 1998)

- Dangerous adverse effects
  - Stimulation of sympathetic nervous system, leading to exacerbation of oxygen consumption in a myocardium as well as an increase in heart rate.
  - Associated with increasing ICP. (Rhoney 2006; Skinhoj 1983)
  - Latent period of 5-15 minutes followed by progressive and often precipitous BP drop. (Schroeder HA. J Clin Invest 1951;30:672-3.) (Shepherd 1980)
  - Severe hypotension and complications associated with birth. (Obstet Gynecol 2011; Magee 2003)
  - Profound hypotension in critically ill. (Kane-Gill 2014)

- Inappropriate use (Campbell 2011)
  - Only 2% of all patients had documented evidence of hypertensive crisis.
  - Over 80% of all doses were associated with a reduction in systolic BP < 25%.
  - Of the 16 patients who experienced an adverse effect, most were related to hypotension, with six experiencing a decrease in systolic BP > 65 mmHg.

- Bottom line: start low, go slow (or consider alternative agents)
- Further reading from EM PharmD blog

PharmERToxGuy.com
Epinephrine

Epinephrine is one of the most problematic medications in the ED with regard to errors

- The ratio concentration labeling only increases the confusion. And, there are so many sizes/concentrations that may be available in EDs and code carts.
  - Cardiac arrest concentration: **1:10,000 = 1 gm/10,000 mL = 1,000 mg/10,000 mL = 0.1 mg/mL**
  - Pretty-much-everything-else concentration: **1:1,000 = 1 gm/1,000 mL = 1,000 mg/1,000 mL = 1 mg/mL**
  - Fortunately, the epinephrine ratio labeling are going away starting in May 2016 (at least in the U.S.)! ([EMPharmD: No More Epinephrine Ratios](https://www.empharmd.com/no-more-epinephrine-ratios); [ISMP Canada: Changes in Expression of Strengths](https://www.ismp.ca/changes-in-expression-of-strengths))

- Here are a few ways to reduce errors:
  - Limit the number of epinephrine sizes/concentrations in your ED
  - Consider stocking epinephrine auto injectors for anaphylaxis/asthma ([EMPharmD: Epinephrine IM for Anaphylaxis](https://www.empharmd.com/epinephrine-im-for-anaphylaxis); [EMPharmD: Epinephrine Auto-Injectors for In Hospital Use](https://www.empharmd.com/epinephrine-auto-injectors-for-in-hospital-use))

Alteplase (tPA)

tPA, although actually easy to mix ([tPA Mixing Tutorial](http://www.empharmd.com/t-pa-mixing-tutorial)), is prepared in high-pressure situations and can lead to dosing errors

- Make sure to have dosing sheets available on paper and in EMRs

Second Antibiotic Dose in Sepsis

- Most studies evaluating early antibiotic administration in sepsis patients focus on timing of the first dose. But, what about the second dose? We get it wrong, a lot. [PharmERToxGuy.com](https://www.pharmertoxguy.com) highlights this issue and offers some potential solutions.

Syringe labeling in the ED

- The two critical pieces of information that must be on every syringe are: drug name and concentration ([Kothari 2013](http://www.ajem.org/article/S0883-8960(13)00241-0/abstract))
- Further reading from [Academic Life in EM](https://www.academiclifeinem.com)

Medication Error-Prevention Strategies ([Weant 2014](https://www.pharmertoxguy.com/medication-error-prevention-strategies))

- Medication-error analysis
- Computerized provider-order entry systems
- Automated dispensing cabinets
- Bar-coding systems
- Medication reconciliation
- Standardizing medication-use processes
- Education
- Emergency-medicine clinical pharmacists ([ACMT 2018; ACEP 2015](https://www.acmt.org/))