Emergency Medicine Pearls 2017

Section Advisory Group on Emergency Care
Section of Clinical Specialists and Scientists
American Society of Health-System Pharmacists
Disclosure

Shane Salimnejad
BTG International Inc: Provided funding for study

All other planners, presenters, and reviewers of this session report no financial relationships relevant to this activity.
Emergency Medicine Pearls

EM Pearls Chair and Moderator
Robert S. Pugliese, Pharm.D., BCPS
Clinical Specialist, Emergency Medicine
Thomas Jefferson University, Philadelphia PA
@theEDpharmacist
Thank You
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Bryan Hayes
Nadia Awad
Aimee Mishler
Chris Edwards
Jill Logan

Brittany R Traylor
David E. Zimmerman
Nicole Acquisto
Denise Pratt
Emily Dyer
Chris Oswald
Engage online!

@ASHP_EMPharm
#EMpearls #ASHP17

Ask a question or start a conversation
Send a message or use hashtag!!!
5 MINUTES EACH!

Hold questions for discussion breaks.
Procainamide Use in the Emergency Department

Michael Thieffault, Pharm.D.
PGY2 Emergency Medicine Pharmacy Resident
Mercy Medical Center
Des Moines, IA

@EDPharmThief
Learning Objectives

• Identify the role of procainamide in atrial fibrillation and ventricular tachycardia cardioversion
Introduction

- Amiodarone is widely used in the emergency department for atrial fibrillation and ventricular tachycardia
- Popularity has pushed drugs like procainamide to the side
- Amiodarone is DEAD
  - Acute atrial fibrillation
  - Stable ventricular tachycardia
- Procainamide is back! Are you ready?
<table>
<thead>
<tr>
<th>Indication</th>
<th>Recommendation</th>
<th>Pitfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>New-onset atrial fibrillation</td>
<td>Class IIa recommendation for pharmacological cardioversion in 2014 AHA/ACC/HRS guideline</td>
<td>1. No different than saline at 1-2 hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Delayed onset cardioversion (8-24 hours)</td>
</tr>
<tr>
<td>Atrial fibrillation with Wolff-Parkinson-White (WPW)</td>
<td>Not recommended for use in 2014 AHA/ACC/HRS guideline</td>
<td>1. Risk of ventricular rate acceleration leading to ventricular fibrillation</td>
</tr>
<tr>
<td>Stable monomorphic ventricular tachycardia</td>
<td>Class IIb recommendation in 2015 AHA guideline</td>
<td>1. Low conversion with rate of 29%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Never shown to be superior</td>
</tr>
</tbody>
</table>
Procainamide Pharmacology

• Pharmacologic category
  – Class Ia antiarrhythmic

• Mechanism of Action
  – Na\(^+\) channel blocker

• Indications
  – Atrial fibrillation
  – Acute treatment of ventricular arrhythmias

• How supplied:
  – 100 mg/mL (10mL) ~ $48/vial
  – 500 mg/mL (2mL) ~ 56/vial
Procainamide Pharmacology

• **Loading Dose:**
  – 20-50 mg/min IV infusion or 100 mg slow IV push every 5 minutes until arrhythmia is suppressed, hypotension occurs, QRS duration increases >50%, or maximum dose of 17 mg/kg is given
  – Max advisable dose is 1 gram for loading
  – 12 mg/kg max LD in renal impairment

• **Maintenance dose:**
  – 1-4 mg/min

• **Warnings / adverse effects**
  – Avoid in patients with QT prolongation and HF
  – Monitor for hypotension

<table>
<thead>
<tr>
<th>Indication</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>New-onset atrial fibrillation</td>
<td>Class Ia recommendation in Canada Cardiovascular Society guideline</td>
</tr>
<tr>
<td>Atrial fibrillation with Wolff-Parkinson-White (WPW)</td>
<td>Class Ic recommendation in 2014 AHA/ACC/HRS guideline</td>
</tr>
<tr>
<td>Stable monomorphic ventricular tachycardia</td>
<td>Class IIa recommendation in 2015 AHA guideline</td>
</tr>
</tbody>
</table>
# Ottawa Aggressive Protocol

<table>
<thead>
<tr>
<th>Study</th>
<th>Intervention</th>
<th>Result</th>
</tr>
</thead>
</table>
| Stiell et al. 2007 (n = 341) | IV Procainamide 1g / 250 mL D5W over 60 min followed by electrical cardioversion if needed | • Conversion rate of 52.2%  
• Median time to conversion of 55 min  
• Adverse events reported in 10% patients (hypotension 8.5%) |
| Stiell et al. 2010 (n = 628) | IV Procainamide 1g / 250 mL D5W over 60 min followed by electrical cardioversion if needed | • Conversion rate of 58.3%  
• Median time to conversion of 54 min  
• Adverse events reported in 7.6% patients (hypotension 6.7%) |
**PROCAMIO**

<table>
<thead>
<tr>
<th>Study</th>
<th>Intervention</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ortiz et al. 2016</td>
<td>IV Procainamide 10 mg/kg vs IV Amiodarone 5 mg/kg both over 20 min</td>
<td>Major cardiac adverse events</td>
</tr>
<tr>
<td>P (n=33) A (n=29)</td>
<td></td>
<td>• Procainamide 3 of 33 (9%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Amiodarone 12 of 29 (41%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Termination of VT within 40 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Procainamide 22 (67%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Amiodarone 11 (38%)</td>
</tr>
</tbody>
</table>

How to Administer

- **Loading dose:**
  - Dilute 1 gram of procainamide in 50, 100 or 250 mL of D5W or NS and infuse over 1 hr.

- **Stop Infusion if:**
  - Arrhythmia is terminated
  - Hypotension occurs (SBP < 100 mmHg)
  - QRS duration increases >50%
Key Takeaways

• Key Takeaway #1
  – Procainamide is potential option for pharmacological cardioversion of new-onset AF and stable VT in the ED, but, this does not preclude electrical cardioversion

• Key Takeaway #2
  – Loading dose may be given different ways
    IV infusion: 1 gram / 100 mL D5W over 1 hour

• Key Takeaway #3
  – Stop the infusion if the arrhythmia is terminated, hypotension develops or the QRS duration increases >50%
CroFab in Copperhead Envenomation

Shane Salimnejad, Pharm.D.
PGY2 Emergency Medicine
Duke University Hospital
Durham, NC

@SHANESALIMNEJAD
Objective

At the end of this presentation, the audience should be able to evaluate the role of FabAV in mild to moderate copperhead snake envenomation.
21 y.o. female with copperhead snake bite to right foot

Labs WNL

8/10 pain; no progression of swelling
Mild Limb Envenomation

Progression
TREAT

No progression
Antivenin NOT indicated
The Efficacy of Crotalidae Polyvalent Immune Fab (Ovine) Antivenom Versus Placebo Plus Optional Rescue Therapy on Recovery From Copperhead Snake Envenomation: A Randomized, Double-Blind, Placebo-Controlled, Clinical Trial

FabAV vs Placebo

(n=45) (n=29)
Patient Specific Functional Scale

<table>
<thead>
<tr>
<th></th>
<th>FabAV</th>
<th>Placebo</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8.6</td>
<td>7.4</td>
<td>0.04</td>
</tr>
</tbody>
</table>

BOTTOM LINE

New outcome data supports the use of antivenin in mild to moderate copperhead envenomation
Days After Envenomation and Treatment

Opioid Analgesia Use

Subjects on Opioid Analgesics (%)

<table>
<thead>
<tr>
<th>Days</th>
<th>FabAV</th>
<th>Placebo</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>7</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>14</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>17</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>21</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>24</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>28</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
CLINICAL PEARL
Patients treated with antivenin use less opioid throughout their recovery
Key Takeaways

• Key Takeaway #1
  – Current guidelines recommend withholding antivenin from patients with limb envenomation with localized pain and swelling as the only manifestation; provided no progression of symptoms

• Key Takeaway #2
  – There is new outcome data to support the use of antivenin in mild to moderate copperhead envenomation to improve limb function at 14 days

• Key Takeaway #3
  – Patients treated with antivenin use less opioid throughout their recovery
Fixed Dose KCentra

Michelle Maguire, Pharm.D.
PGY2 Emergency Medicine Resident
Massachusetts General Hospital
Boston, MA

@mcmaguire9
Objective

For urgent warfarin reversal, identify potential advantages of fixed dose 4F-PCC compared to traditional dosing regimens
Guyatt, G et al. CHEST 2012; 141(2)(Suppl):7S–47S.
## Package Insert Dosing

<table>
<thead>
<tr>
<th>Pre-treatment INR</th>
<th>2 to &lt;4</th>
<th>4 to 6</th>
<th>&gt;6</th>
</tr>
</thead>
<tbody>
<tr>
<td>4F-PCC IU/kg (ABW)</td>
<td>25</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td>Max Dose</td>
<td>2500</td>
<td>3500</td>
<td>5000</td>
</tr>
</tbody>
</table>

Does one size really fit all?
<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khorsand, Transfus Med 2011</td>
<td>N=67</td>
<td>✓</td>
</tr>
<tr>
<td>Khorsand, Haematologica 2012</td>
<td>N=240</td>
<td>✓</td>
</tr>
<tr>
<td>Varga, Transfusion 2015</td>
<td>N=103</td>
<td>✓</td>
</tr>
<tr>
<td>Abdoellakhan, Neuro Critcare 2017</td>
<td>N=53</td>
<td>X</td>
</tr>
</tbody>
</table>
Acute intracranial hemorrhage
Urgent surgery/ acute major bleed
Key Takeaways

• Current dosing of 4F-PCC can result in a delay of warfarin reversal due to the need for INR and a known patient weight

• Fixed dose 4F-PCC offers a reduced time to therapy and a greater cost saving compared to the traditional dosing regimen
TPA for Frostbite

Brittni Gross, Pharm.D.
PGY2 Emergency Medicine Pharmacy Resident
The Johns Hopkins Hospital
Baltimore, Maryland

@GrossBrittni
Patient Case

MT, 28 yo male, presents to your ED on a cold January day with a CC of discoloration, swelling, and severe pain in his hands. The team learns that he was working outside for the Department of Sanitation this morning, and first noticed that his hands were cold and painful after taking off his work gloves.

There is a concern for severe frostbite in digits 2-5 of both hands. The team would like to treat the patient with IV alteplase, and look to you for help.
WAIT,
SAY WHAAAA...?
Learning Objective

• Given a patient case, develop a therapeutic plan for the treatment of severe frostbite injury using alteplase and an anticoagulation strategy
Pathophysiology

Cold thermal injury

Direct Cellular Injury
- Intracellular and extracellular ice crystal formation
- Cell dehydration and shrinkage
- Electrolyte disturbances
- Denaturation of lipid-protein complexes
- Cell death

Indirect Cellular Injury
- Endothelial Damage
- Intravascular sludging
- Inflammatory mediators and free radicals
- Microvascular thrombosis

Treatment

Initial

• Rapid rewarming

Refractory

• Alteplase
• Surgical amputation of frostbitten digits

Clinical Evidence for Alteplase

Supportive literature limited to five small case series

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomey</td>
<td>2005</td>
<td>n=19</td>
</tr>
<tr>
<td>Bruen</td>
<td>2007</td>
<td>n=6</td>
</tr>
<tr>
<td>Johnson</td>
<td>2011</td>
<td>n=11</td>
</tr>
<tr>
<td>Gonzaga</td>
<td>2016</td>
<td>n=62</td>
</tr>
<tr>
<td>Jones</td>
<td>2017</td>
<td>n=11</td>
</tr>
</tbody>
</table>

### Clinical Outcomes

<table>
<thead>
<tr>
<th>Study</th>
<th>Study</th>
<th>Group</th>
<th>Percent of At-Risk Digits Amputated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twomey</td>
<td>Twomey</td>
<td>Historical Control</td>
<td>7 of 16 patients had amputations*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IA/IV Alteplase</td>
<td>33 of 174 (19%)</td>
</tr>
<tr>
<td>Bruen</td>
<td>Bruen</td>
<td>Historical Control</td>
<td>97 of 234 (41%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IA Alteplase</td>
<td>6 of 59 (10%)</td>
</tr>
<tr>
<td>Johnson</td>
<td>Johnson</td>
<td>IV Alteplase</td>
<td>43 of 73 (59%)</td>
</tr>
<tr>
<td>Gonzaga</td>
<td>Gonzaga</td>
<td>IA Alteplase</td>
<td>148 of 472 (31%)</td>
</tr>
<tr>
<td>Jones</td>
<td>Jones</td>
<td>IV Alteplase</td>
<td>11 of 40 (27.5%)</td>
</tr>
</tbody>
</table>

*Number of at-risk digits not defined
# Thrombolytic Dose and Route

<table>
<thead>
<tr>
<th>Route</th>
<th>Bolus Dose</th>
<th>Continuous Dose</th>
<th>Max Duration</th>
<th>Max Dose</th>
<th>Twomey</th>
<th>Bruen</th>
<th>Johnson</th>
<th>Gonzaga</th>
<th>Jones</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td><em>variable, patient specific</em></td>
<td>120 hours</td>
<td>--</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>0.15 mg/kg</td>
<td>0.15 mg/kg/hr</td>
<td>6 hours</td>
<td>100 mg</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
**Post-Alteplase Anticoagulation**

<table>
<thead>
<tr>
<th>Study</th>
<th>Post Alteplase Anticoagulation</th>
<th>Therapeutic Goal</th>
<th>UFH Duration</th>
<th>One-Month Warfarin</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 Twomey</td>
<td>IV heparin beginning immediately after alteplase</td>
<td>PTT 2x Control</td>
<td>3 to 5 days</td>
<td>Yes</td>
</tr>
<tr>
<td>59 Johnson</td>
<td>IV heparin beginning immediately after alteplase</td>
<td>PTT 2x Control</td>
<td>3 to 5 days</td>
<td>No</td>
</tr>
<tr>
<td>28 Jones</td>
<td>IV heparin beginning immediately after alteplase</td>
<td>PTT 2x control</td>
<td>3 to 5 days</td>
<td>Yes*</td>
</tr>
</tbody>
</table>

*If contraindications to warfarin, clopidogrel 300 mg load then 75 mg/day plus aspirin 325 mg/day if P2Y12 assay > 240 P2Y12 reaction units*
### Safety Outcomes

<table>
<thead>
<tr>
<th>Study</th>
<th>Treatment</th>
<th>Adverse Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twomey</td>
<td>IV alteplase</td>
<td>--</td>
</tr>
<tr>
<td>Johnson</td>
<td>IV alteplase</td>
<td>--</td>
</tr>
<tr>
<td>Jones</td>
<td>IV alteplase</td>
<td>bleeding complications while on heparin infusion (2 patients)</td>
</tr>
</tbody>
</table>
Key Takeaways

• Existing literature for the use of alteplase in the treatment of severe frostbite is limited to small, retrospective case series

• Alteplase with ongoing anticoagulation is a promising option for the treatment of severe frostbite

• Preparing an institutional guideline for the use of alteplase to treat severe frostbite may prevent confusion in an emergent situation
Phenobarbital in EtOH Withdrawal

Maryam Zaeem, Pharm.D.
Clinical Pharmacy Specialist, Emergency Medicine
University Hospital | Newark, NJ
Does Your Institution Use Phenobarbital as a First Line Agent for EtOH Withdrawal?
Objective

• Describe the benefits of using phenobarbital (PB) for alcohol withdrawal
Shots, Shots, Shots!

Excitatory (NMDA)
Ca$^{2+}$
Na$^+$

Inhibitory (GABA)
Cl$^-$

Over excitability!!

Adapted from: Goldfrank LR. Goldfrank's Toxicological Emergencies.
Phenobarbital (PB) MOA

Adapted from: Goldfrank LR. Goldfrank's Toxicological Emergencies.
Set It and Forget It

Stage 1: anxiety, insomnia, GI upset (0-8 hours)

Stage 2: increased HR, BP, irritability, sweating, confusion (1-3 days)

Stage 3: hallucinations, fever, seizures, agitation (5-7 days)

ED Phenobarbital Kinetics
Onset: 15-30 minutes
T ½: 79 hours (53 to 118 hours)

Evidence Supporting PB Use

Gold JA, et al.
- PB ↓ need for mech. ventilation in DT

Hendey GW, et al.
- PB efficacy = lorazepam in EtOH withdrawal

Michaelsen IH, et al.
- PB efficacy = diazepam for DT

Gashlin LZ, et al.
- PB safety and efficacy = BZD in EtOH withdrawal
Dosing Strategies

- Sedative naïve
  - PB 10 mg/kg IBW in NS 100 mL over 30 minutes
  - PRN adjunct agents per CIWA
- Sedatives on board
  - PB 130 mg IV Q15-30 min PRN CIWA 10-15
  - PB 260 mg IV Q15-30 min PRN CIWA >15

★ Goal = sleepy but calm patient

Key Takeaways

PB has several advantages over BZD for EtOH withdrawal

Must be patient for effect

Synergism with BZD
Which of the following is the most effective for termination of new-onset atrial fibrillation or flutter?

A. Amiodarone  
B. Propafenone  
C. Electrical cardioversion  
D. Procainamide
When should a procainamide infusion be discontinued?

A. Arrhythmia is terminated
B. SBP < 100 mmHg
C. QRS duration increases > 50%
D. Any of the above
The following snake(s) fall under the subfamily *Crotalinae*:

A. Rattlesnake  
B. Water Moccasin (Cottonmouth)  
C. Copperhead  
D. All the above
Gerardo et al. demonstrated that patients with mild to moderate copperhead envenomation that receive FabAV have improved limb function at 14 days:

A. True

B. False
What is the advantage of fixed dose 4F-PCC?

A. Reduced time to therapy
B. Greater cost savings
C. Reduced rates of thromboembolism
D. All of the above
The ACCP Guideline for Reversal of Antithrombotics in Intracranial Hemorrhage currently recommend traditional dosing based on INR and weight for urgent warfarin reversal.

A. True
B. False
The benefit of alteplase in the treatment of severe frostbite may be related to limiting the negative effect of _________ cellular injury.

A. Direct
B. Indirect
Which of the following doses of IV alteplase would you recommend for the treatment of severe frostbite?

A. Alteplase 0.09 mg/kg bolus then 0.81 mg/kg/hr for 6 hours
B. Alteplase 100 mg administered over 2 hours
C. Alteplase 15 mg bolus then 0.75 mg/kg over 1 hour
D. Alteplase 0.15 mg/kg bolus then 0.15 mg/kg/hr for 6 hours
Which of the Following Is a Potential Benefit to Using PB for EtOH Withdrawal?

A. Short duration of action
B. Quicker peak effect vs. BZD
C. Dual action on NMDA and GABA receptors
D. PB decreases the duration of GABA chloride channel opening
Questions?

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Shane Salimnejad, PharmD @SHANESALIMNEJAD
Michelle Maguire, PharmD @mcmaguire9
Brittni Gross, PharmD @GrossBrittni
Maryam Zaeem, PharmD @rxmrmy27
Tranexamic Acid in Subarachnoid Hemorrhage

Blake Porter, Pharm.D.
Pharmacist Clinician – Emergency Medicine
University of Vermont Medical Center
Burlington, VT

@RxEmergency
Learning Objective

• Discuss the use of tranexamic acid for reduction of rebleeding after an aneurysmal subarachnoid hemorrhage (aSAH)
Aneurysmal Subarachnoid Hemorrhage

- 16,000 – 30,000 new cases each year
- Diagnosis – clinical symptoms, imaging ± lumbar puncture
- Definitive management – clipping or coiling
- What if there is a delay in surgical management?

Rebleeding

Dissolution of clot by fibrinolytic process

Risks – time, neuro status, LOC, size, hypertension

Mortality rate ~60%, worse neurological outcomes

LOC = Loss of consciousness
Tranexamic Acid Mechanism

Adapted from: Santos AT, Rev Bras Anestesiol. 2007 Oct;57(5):549-64.
Tranexamic Acid Mechanism

Adapted from: Santos AT, Rev Bras Anestesiol. 2007 Oct;57(5):549-64.
Tranexamic Acid

• **Dose:** **1000 mg** IV every **6 to 8 hours**
  - Administer early if delay in surgical management is known
• **Duration:** **Up to 72 hours** or until surgical management
  - Class IIa, level of evidence B recommendation in American Heart Association aSAH guidelines
• **Precautions**
  - Cerebral ischemia, hypercoagulable state, thromboembolic disease

# 2013 Cochrane Review

<table>
<thead>
<tr>
<th>Objective</th>
<th>Assess the effects of antifibrinolytic treatment in people with aSAH</th>
</tr>
</thead>
</table>
| Primary outcomes | 1. Poor outcome (death, vegetative state, severe disability)  
2. Death from all causes |
| Studies | 10 randomized trials (9 TXA, 1 aminocaproic acid), 1904 subjects |
| Results | Poor outcome | Death from all causes |
| | RR = 1.02 (95% CI 0.91 – 1.15) | RR = 1 (95% CI 0.85 – 1.18) |

Risk of Rebleeding Decreased

Risk of Rebleeding
RR = 0.65
(95% CI 0.44-0.97)

Risk of Cerebral Ischemia
RR = 1.41
(95% CI 1.04-1.91)

# Ultra-Early Tranexamic Acid After Subarachnoid Hemorrhage (ULTRA)

<table>
<thead>
<tr>
<th>Objective</th>
<th>Does early, short term TXA lead to better functional outcome?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary outcome</td>
<td>Modified Rankin Scale: Good (0-3) vs. Poor (4-6)</td>
</tr>
<tr>
<td>Secondary outcomes</td>
<td>Cause of death/poor outcome, rebleed, thromboembolic events</td>
</tr>
<tr>
<td>Treatment</td>
<td>1 gm IV bolus, then 1 gm IV every 8 hours</td>
</tr>
<tr>
<td>Duration of treatment</td>
<td>24 hours or until surgical management</td>
</tr>
<tr>
<td>Standard care</td>
<td></td>
</tr>
</tbody>
</table>

Key Takeaways

- Rebleeding after aSAH is associated with significant mortality
- Short-term (< 72 hours), early administration of TXA should be considered when there is a delay in surgical management
- Cerebral ischemia is a risk, TXA may still be beneficial in patients at high risk for rebleeding
Hypertonic Saline for Tricyclic Antidepressant Overdose

Kim Friend, Pharm.D.
PGY2 Emergency Medicine Resident
Robert Wood Johnson University Hospital
New Brunswick, NJ

@kb_friend
Learning Objective

• Describe the clinical indications and dosing recommendations of hypertonic saline (HTS) administration for tricyclic antidepressant (TCA) overdose
Case

• 26 yo female found unresponsive with empty bottle of doxepin 50mg tablets

• In the ED she is comatose, hypotensive to 70/40 mmHg with poor respiration; GCS 3

• Received 6 ampules of sodium bicarbonate
FDA

Drug Shortages

https://commons.wikimedia.org/wiki/File:Sodium_Bicarbonate_(1).JPG
TOXICOLOGY/CASE REPORT

Reversal of Severe TCA-induced Cardiotoxicity with IV HTS Solution

Experimental Toxicity: A Randomized, Controlled Comparison of HTS Solution, Sodium Bicarbonate, and Hyperventilation

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Toxicity QRS (ms)</th>
<th>Post Treatment QRS (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTS</td>
<td>158 ± 12</td>
<td>80 ± 14</td>
</tr>
<tr>
<td>NaHCO₃</td>
<td>156 ± 16</td>
<td>105 ± 28</td>
</tr>
</tbody>
</table>

Dosing

200 cc = 100 mEq Na

2 ampules = 100 mEq Na

http://www.drugs-library.com/drugs/sodium-chloride_181705c7.html

https://commons.wikimedia.org/wiki/File:Sodium_Bicarbonate_(1).JPG
Key Takeaways

• Case reports show successful use of HTS for the treatment of TCA overdose

• With NaHCO$_3$ shortages and recalls, HTS is an appropriate alternative for the treatment of TCA overdose
Icatibant for ACE Inhibitor Induced Angioedema

Jessica Corio, Pharm.D.
PGY-2 Emergency Medicine Resident
Boston Medical Center
Boston, MA

#EMpearls
Learning Objective

• Describe the rationale and utility of icatibant in angiotensin converting enzyme (ACE) inhibitor-induced angioedema
Patient Case

- 68 y/o M presents with gradual onset of lip and tongue swelling
- PMH: HTN, T2DM, (+) tobacco
- Allergies: none
- Home medications:
  - Lisinopril 20 mg daily
  - Metformin 1000 mg BID

ACE-Inhibitor Induced Angioedema

Angiotensinogen → Angiotensin I → Angiotensin II → Bradykinin → Metabolites

ACE Inhibitor

↑ Vasodilation
↑ Vascular Permeability
↑ Angioedema

Treatment Approach

• Airway monitoring and supportive care

• Pharmacologic interventions based on case reports and limited trials
  – Epinephrine, antihistamines, steroids
  – Targeting excess bradykinin

Icatibant

FDA approved for treatment of acute hereditary angioedema (HAE)

Selective bradykinin β2 receptor antagonist

Self-administered 30 mg subcutaneous injection

Firazyr (icatibant) [prescribing information]. Lexington, MA: Shire Orphan Therapies Inc; August 2011.
### What The Studies Show...

| Bas M, et al. (2015) | Median time to complete resolution of edema significantly shorter with icatibant vs. standard therapy (steroids and antihistamines)  
• 8 hours (IQR 3.0-16.0) vs. 27.1 hours (IQR 20.3-48.0); p=0.002 |
|----------------------|------------------------------------------------------------------|
| Sinert R, et al. (2017) | No difference in time to meeting criteria for discharge (median 4.0 hours, p= 0.63), or time to symptom resolution  
• > 90% of patients received conventional therapies |
Limitations

• Ideal time to administration of icatibant is unknown for the treatment of ACE-inhibitor induced angioedema
• Most patients receive conventional therapies in addition to icatibant
• No literature to support decrease in placement of advanced airway or fewer hospital admissions for airway observation
Key Takeaways

• Key Takeaway #1
  – Lack of data to support use of icatibant in ACE-inhibitor induced angioedema regarding timing of administration, complete resolution of symptoms, and prevention of higher level of care

• Key Takeaway #2
  – Icatibant should not be used routinely for ACE-inhibitor induced angioedema
Putting Them Out When They Are a Little Stout: Etomidate Dosing for RSI in Obese Patients

David E. Zimmerman, Pharm.D., BCPS
Assistant Professor of Pharmacy
Duquesne University School of Pharmacy
EM Clinical Pharmacist at UPMC-Mercy Hospital
Pittsburgh, PA

@DEZ_EM_Pharm
Learning Objective

- Discuss the available evidence and practical considerations to determine which dosing weight is most appropriate for etomidate use in rapid sequence intubation in patients that are obese.
Etomidate Kinetics

- Volume of distribution (Vd): 3-5 L/kg
- Protein binding: ~75% to albumin
- Rapid distribution from the central compartment

“Can someone ask the patient for his ideal or lean body weight?”

http://www.uab.edu/medicine/news
Wait, how do you calculate lean body weight (LBW)??

LBW (female) = \([1.07 \times TBW(\text{kg})] - [0.0148 \times BMI \times TBW \text{ (kg)}]\]

LBW (male) = \([1.1 \times TBW(\text{kg})] - [0.0128 \times BMI \times TBW \text{ (kg)}]\]

http://bigbangtheory.wikia.com
Available Evidence...

- Prospective study in obese patients undergoing laparoscopic surgery

- Received etomidate via syringe pump until goal bispectral index (BIS) was reached

- Calculated dose was compared to control group of non-obese patients

<table>
<thead>
<tr>
<th></th>
<th>Obese (n = 47)</th>
<th>Control (n = 20)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years [SD]</td>
<td>39.4 [10.4]</td>
<td>40 [14.9]</td>
<td>0.20</td>
</tr>
<tr>
<td>Height, cm [SD]</td>
<td>169 [8.5]</td>
<td>165 [8.3]</td>
<td>0.12</td>
</tr>
<tr>
<td>Weight, kg [SD]</td>
<td>130 [16.2]</td>
<td>74.6 [14.1]</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>BMI, kg/m² [SD]</td>
<td>44.3 [5.6]</td>
<td>26.9 [3.1]</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

BIS, bispectral index; SD, Standard deviation

<table>
<thead>
<tr>
<th>Mean (SD)</th>
<th>Obese (n = 47)</th>
<th>Control (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBW predicted dose, mg [SD]</td>
<td>39 [4.9]</td>
<td>22.4 [3.1]</td>
</tr>
<tr>
<td>IBW predicted dose, mg [SD]</td>
<td>18.8 [1.4]</td>
<td>17.9 [1.3]</td>
</tr>
<tr>
<td>LBW predicted dose, mg [SD]</td>
<td>16.5 [2.8]</td>
<td>15.2 [1.9]</td>
</tr>
<tr>
<td>CBW predicted dose, mg [SD]</td>
<td>26.8 [2.5]</td>
<td>19.6 [2.1]</td>
</tr>
</tbody>
</table>

Predicted dose is based on 0.3mg/kg; CBW, corrected body weight; IBW, ideal body weight; LBW, lean body weight; SD, standard deviation; TBW, total body weight

What the heck is BIS???

http://www.covidien.com/pace/clinical-education/246137
http://bme240.eng.uci.edu/
Practical Considerations

• Standard dosing: 0.3 mg/kg

• Vial Size

• Adverse Effects
  – Too much
  – Too little
Key Takeaways

• Key Takeaway #1
  – Etomidate has a large Vd and rapidly distributes from the central compartment

• Key Takeaway #2
  – One small study has shown IBW may be the best dosing weight; however, further evidence is needed to determine what the best dosing weight is for etomidate in obese patients

• Key Takeaway #3
  – Until further evidence is available, consider using TBW to ensure adequate sedation
Use of Sodium Acetate in Toxicologic Emergencies During the Sodium Bicarbonate Shortage

Nick Scaturo, Pharm.D.
PGY2 ED Pharmacy Resident
Tampa General Hospital
Tampa, FL

@nscat20
Learning Objective

• Discuss replacing sodium bicarbonate with sodium acetate for similar indications given shortage situations
Sodium Bicarbonate Shortage

• Several manufacturers have reported shortages of sodium bicarbonate products
  – Amphastar-due to increased demand
  – Pfizer-manufacturing delays

Place in Therapy

- Methanol
- Ethylene glycol
- Salicylates

Systemic Alkalization

- Phenobarbital
- Methotrexate
- Salicylates

Urinary Alkalization

- Tricyclic antidepressants
- Type 1a or 1c antiarrhythmics

Cardiotoxic Drug Ingestion

Sodium Acetate: How does it work?

\[
\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 \rightleftharpoons \text{H}^+ + \text{HCO}_3
\]

Carbon dioxide

Water

Carbonic acid

Hydrogen ion

Bicarbonate ion


Effectiveness

• Sodium acetate can theoretically replace any sodium bicarbonate indications

• No prospective studies evaluate efficacy of sodium acetate for treatment of poisonings
  – Case abstract describes successful treatment of salicylate poisoning using sodium acetate

Potential Adverse Effects

- Myocardial Depression
- Hypotension
- Hypoxemia

## Dosing Recommendations

<table>
<thead>
<tr>
<th></th>
<th>Indications and Goals</th>
<th>Sodium Bicarbonate</th>
<th>Sodium Acetate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bolus</strong></td>
<td>• Initial treatment of QRS widening, severe cardiac dysthymias, salicylism</td>
<td>• 1-2mEq/kg infused over 1 min</td>
<td>• 1mEq/kg infused over 15-20 min</td>
</tr>
<tr>
<td></td>
<td>• Goal serum pH 7.5-7.55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Dosing Recommendations

<table>
<thead>
<tr>
<th>Maintenance Infusion</th>
<th>Indications and Goals</th>
<th>Sodium Bicarbonate</th>
<th>Sodium Acetate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Maintaining alkaline serum pH of 7.5-7.55</td>
<td>• 150mEq diluted to 1L with D5W; infuse at 2x maintenance</td>
<td>• 150mEq diluted to 1L with D5W; infuse at 2x maintenance</td>
</tr>
</tbody>
</table>

Sodium Bicarbonate Advantages

• Sodium bicarbonate preferred due to quicker administration
  – Severe metabolic acidosis (pH<7.2)
    • Dialysis can be utilized in these situations
  – Cardiotoxic drug ingestion (sodium channel blockade) with cardiovascular collapse
    • Can consider 3% NaCl
Key Takeaways

• Key Takeaway #1
  – Sodium acetate appears to be a safe alternative to sodium bicarbonate for toxicologic emergencies

• Key Takeaway #2
  – Sodium acetate requires a longer infusion time for the initial bolus, but is dosed on an equimolar basis

• Key Takeaway #3
  – Sodium bicarbonate may need to be reserved for uses that require immediate activity
5 Minute Q&A #2

@ASHP_EMPharm
#EMpearls
#ASHP17
What is the mortality rate after rebleeding from an aSAH?

A. 10 – 30%
B. 30 – 50%
C. 50 – 70%
D. 70 – 90%
If there is a delay in surgery, how quickly should TXA be given?

A. Within an hour
B. Within three hours
C. Within 72 hours
D. As soon as possible
HTS works to overcome Na+ channel blockade to reverse cardiac effects in TCA overdose.

A. True
B. False
200 cc of 3% HTS provides a similar Na+ content to that of 2 ampules of NaHCO₃⁻
Elevated levels of bradykinin due to ACE inhibitor therapy may induce which of the following?

A. Vasodilation
B. Increased vascular permeability
C. Angioedema
D. All of the above
Recent literature for icatibant in ACE inhibitor induced angioedema demonstrate a rapid improvement in symptom resolution, resulting in earlier discharges from the hospital.

A. True
B. False
What would be the biggest concern of giving too low of a dose of etomidate?

A. Hypotension
B. Under sedation
C. Adrenal suppression
D. Myoclonus
An 80kg patient requires etomidate for RSI, what dose would you recommend for this patient?

A. 16 mg  
B. 24 mg  
C. 80 mg  
D. What was the dosing again for etomidate?
How can you treat a phenobarbital overdose if sodium bicarbonate is completely out of stock at your hospital?

A. Fomepizole
B. Sodium acetate
C. Aggressive fluid resuscitation
D. N-Acetylcysteine (NAC)
How quickly can sodium acetate be given?

A. Push over 1-2 minutes
B. Infused over 1 hour
C. Infused over 15-20 minutes
D. Infused over 6 hours
Questions?

Blake Porter, PharmD @RxEmergency
Kim Friend, PharmD @kb_friend
Jessica Corio, PharmD
David E. Zimmerman, PharmD, BCPS @DEZ_EM_Pham
Nick Scaturo, PharmD @nscat20
Esmolol in Refractory Ventricular Fibrillation

Emily Kilber, Pharm.D., BCPS
Emergency Medicine Clinical Pharmacist
Maricopa Integrated Health System
Phoenix, AZ

@enkilber
Learning Objective

• Describe the concept of utilizing short acting beta-blockade in refractory ventricular fibrillation
Case

• 50 yo M
• Witnessed OHCA
• Unknown PMH

• Pre-hospital:
  – Ventricular fibrillation x 15 minutes
  – Defibrillation x 3
  – Epinephrine 1mg x 2
  – Amiodarone 300mg x 1
Case

- Arrives to your ED and the monitor shows the following:
Introduction

Epinephrine =

α stimulation

β stimulation

Beta Blockade

• Need selective and short acting agent to stop electrical storm:
  • Esmolol
  • Beta 1 selective
  • Half-life ~ 9 minutes
### Evidence

<table>
<thead>
<tr>
<th></th>
<th><strong>Driver et al.</strong></th>
<th><strong>Lee et al.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design</strong></td>
<td>Retrospective observational</td>
<td>Retrospective pre-post</td>
</tr>
<tr>
<td><strong>Sample size</strong></td>
<td>n = 25</td>
<td>n = 41</td>
</tr>
<tr>
<td><strong>Intervention</strong></td>
<td>Esmolol (n = 6) vs no esmolol (n = 19)</td>
<td>Esmolol (n = 16) vs no esmolol (n = 25)</td>
</tr>
<tr>
<td><strong>Outcomes measured</strong></td>
<td>Sustained ROSC</td>
<td>Sustained ROSC</td>
</tr>
<tr>
<td></td>
<td>Survival to hospital discharge</td>
<td>Survival at 30 days</td>
</tr>
<tr>
<td></td>
<td>Good neurologic outcome</td>
<td>Good neurologic outcome</td>
</tr>
</tbody>
</table>

## Evidence

<table>
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<tr>
<th></th>
<th><strong>Driver et al.</strong></th>
<th><strong>Lee et al.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Results</strong></td>
<td>Sustained ROSC:</td>
<td>Sustained ROSC:</td>
</tr>
<tr>
<td></td>
<td>• 4 of 6 (66.7%) vs 6 of 19 (31.6%)</td>
<td>• 9 of 16 (56.3%) vs 4 of 25 (16%), (p = 0.007)</td>
</tr>
<tr>
<td></td>
<td>Survival to hospital discharge:</td>
<td>Survival at 30 days:</td>
</tr>
<tr>
<td></td>
<td>• 3 of 6 (50%) vs 3 of 19 (15.8%)</td>
<td>• 3 of 16 (18.8%) vs 2 of 25 (8%), (p = 0.36)</td>
</tr>
<tr>
<td></td>
<td>Good neurologic outcome:</td>
<td>Good neurologic outcome:</td>
</tr>
<tr>
<td></td>
<td>• 3 of 6 (50%) vs 2 of 19 (10.5%)</td>
<td>• 3 of 16 (18.8%) vs 2 of 25 (8%), (p = 0.36)</td>
</tr>
</tbody>
</table>

## Evidence

<table>
<thead>
<tr>
<th></th>
<th><strong>Driver et al.</strong></th>
<th><strong>Lee et al.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, median (yr)</strong></td>
<td>54.5 vs 56</td>
<td>58 vs 52</td>
</tr>
<tr>
<td>(no esmolol survivors: 22 and 28)</td>
<td></td>
<td>• Sustained ROSC: 50 vs 55</td>
</tr>
<tr>
<td><strong>Witnessed arrest (%)</strong></td>
<td>83.3 vs 84.2</td>
<td>87.5 vs 68</td>
</tr>
<tr>
<td><strong>CPR duration, median (min)</strong></td>
<td>63 vs 57</td>
<td>55 vs 67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sustained ROSC: 92.3 vs 67.9</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>STEMI (%): 60 vs 14.3</td>
<td></td>
</tr>
</tbody>
</table>

Considerations

• Who?
  – Continued shockable rhythm despite conventional care
  – Inhalant abuse—“sudden sniffing death”

• Dose?
  – Retrospective studies used 500mcg/kg loading dose then 0-100mcg/kg/min infusion

• Administration?
  – 10mg/ml infusion: 3.5 ml bolus*
  – 20mg/ml infusion: 1.75 ml bolus*

*for 70 kg patient
Key Takeaways

• Key Takeaway #1
  – Beta stimulation from both endogenous and exogenous catecholamines worsen electrical storm making ROSC difficult to obtain

• Key Takeaway #2
  – Although the evidence is limited, the use of short acting beta blockers in the setting of refractory VF may increase survival in select patients
Vitamin C for Methemoglobinemia

Shannon Sullivan, Pharm.D.
PGY2 Emergency Medicine Resident
Banner-University Medical Center
Tucson, Arizona
Learning Objectives

• Describe treatment options for methemoglobinemia.

• Explain the role of high dose vitamin C in the management of methemoglobinemia.
Standard of Care

- **Methylene Blue**
  - Accelerates degradation
  - Glucose-6-phosphate dehydrogenase (G6P-D) deficiency
  - Risk of serotonin syndrome
  - Significant toxicity as dose increases

Glucose-6-phosphate $\rightarrow$ G6PD $\rightarrow$ NADP$^+$ $\rightarrow$ NADPH $\rightarrow$ 6-phosphogluconate $\rightarrow$ Leukomethylene blue $\rightarrow$ Methylene blue $\rightarrow$ metHb $\rightarrow$ Hb

Reading et al. *Am J Hemat.* 2017;92:474
Role of Vitamin C

- Proposed mechanism of action:
  - Acts via antioxidant properties, reducing agent
  - In vitro studies show reduction of nitrite induced methemoglobin with high dose vitamin C

Role of Vitamin C

- Case studies show efficacy of high dose vitamin C as an alternative to methylene blue
  - Nitrite induced methemoglobinemia in pediatric patients
    - 5 pediatric patients (Age: 1 - 42 months)
    - 1-2 g Vitamin C in divided dose for 1 day
    - Mean reduction in methemoglobin 12%

Role of Vitamin C

- Case Study: Dapsone induced methemoglobemia
  - Administered 10 g IV vitamin C every 6 hours over 54 hours period-
  - methemoglobin levels reduced to <10% (80 g total)

# Vitamin C v. Methylene Blue

<table>
<thead>
<tr>
<th>Vitamin C</th>
<th>Methylene Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple IV doses required for methemoglobin reduction</td>
<td>Usually single dose over 5 minutes (can be repeated)</td>
</tr>
<tr>
<td>May take &gt; 24 hours for significant methemoglobin reduction</td>
<td>Contraindicated with G6P-D deficiency</td>
</tr>
<tr>
<td>Caution with renal insufficiency-oxalate nephropathy</td>
<td>Caution with other serotonergic agents</td>
</tr>
</tbody>
</table>
Key Takeaways

• Key Takeaway #1
  – Vitamin C may be an effective alternative to methylene blue for methemoglobinemia when: methylene blue is unavailable, G6P-D deficiency is present, or patient is on other serotonergic agents.

• Key Takeaway #2
  – Exact dose of Vitamin C is not well elucidated but IV doses of 5-10 g every 6 hours have been previously published.

• Key Takeaway #3
  – Compared to methylene blue, vitamin C requires several IV doses over at least 24 hours and should be used with caution in patients with renal impairment.
When the Beat Drops: Practical Tips for Codes

Aimee Mishler, Pharm.D., BCPS
Emergency Medicine Pharmacist
Maricopa Medical Center
Phoenix, AZ

@EM_Pharm
Objective

• By the end of this presentation the audience should be able to implement strategies to optimize time and effort during cardiac resuscitation.
When the EPI runs dry

= 18 min

+ another 36 min

@EM_Pharm
When the EPI runs dry

1. 

2. 

3. =12mg/120mL

= 108 mL

Add 12mg/12mL

@EM_Pharm
When the EPI runs dry
When the EPI runs dry

• Things to consider...
  – Location of nearest 30mg/30mL epinephrine and 100mL NS
  – Nearest location of extra epinephrine pre-filled syringes
  – Time constraint for preparation, money on wasted medication

• Prefilled syringe ~$4 vs 30ml vial ~$100 + NS 100ml $2
It’s all about the math

\[
\frac{1 \text{ mg}}{180 \text{ sec}} \times \frac{1,000 \text{ mcg}}{1 \text{ mg}} \times \frac{60 \text{ sec}}{1 \text{ min}} = 333 \text{ mcg/min}
\]
It’s all about the math

• The CHEER trial
  – N=26
  – Epinephrine at 50mcg/min
It’s all about the math

Things to consider...
- 1mg bolus EVERY 3min vs. 1mg OVER 3min
- Limited/no evidence
- 1mg epinephrine q3 min may be too much
- Quality chest compressions
- Peripheral vs. central access
- Smart pump soft/hard stops and hospital policy
- We got ROSC, now what
- Time constraint for preparation, money on wasted medication

@EM_Pharm
Stayin’ Alive

@EM_Pharm

Ghari S. ALiEM. 2016.
Key Takeaways

• Key Takeaway #1
  – Pre-charge the defibrillator before the rhythm check to decrease hands-off time

• Key Takeaway #2
  – Add 12mg of epinephrine 1mg/ml to 100ml NS to get 1mg/10ml and 12 extra doses

• Key Takeaway #3
  – An epinephrine drip at 333mcg/min ~1mg every 3min

@EM_Pharm
Ketamine for Analgesia

Emily Wiener, Pharm.D.
Emergency Medicine Clinical Pharmacist
University of Baltimore Washington Medical Center
Glen Burnie, MD

@pharmdEMily
Learning Objective

- Describe the evidence for use of ketamine for treatment of acute pain in the emergency department (ED) setting

Definitions

• **NSAIDs** - Non-steroidal anti-inflammatory drugs
• **NMDA** – N-methyl-d-aspartate
• **IVPB** – IV piggy back
• **IVP** – IV push
• **Numeric Rating Scale (NRS)** – Patient reported pain on a scale from 0 to 10
**Downsides to current options**

- **Opioids**
  - Current opioid epidemic
  - Chronic users with hyperalgesia
- **NSAIDs**
  - Contraindications with multiple common disease states
- **Acetaminophen**
  - IV product often restricted
Ketamine 101

- NMDA receptor antagonist
- Widely used for conscious sedation and RSI induction
- Effects highly dependent on dose
- Extensively studied for analgesia peri-operatively
- Possible psychiatric and hemodynamic adverse effects
The Ketamine Continuum

- Analgesic dose: 0.1-0.3 mg/kg
- Recreational Dose: 0.2-0.5 mg/kg
- Partially dissociated dose: 0.4-0.8 mg/kg (aka “The K-hole”)
- Dissociative dose: >0.7 mg/kg

http://emupdates.com/2013/12/25/the-ketamine-brain-continuum/
# Adjunctive Ketamine in the ED

<table>
<thead>
<tr>
<th>Study</th>
<th># of Patients/Group</th>
<th>Dose of Ketamine</th>
<th>Comparator</th>
<th>Key Findings</th>
<th>Adverse Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaudoin 2014</td>
<td>20</td>
<td>0.15 mg/kg or 0.3 mg/kg</td>
<td>Placebo</td>
<td>0.3 mg/kg sustained analgesia</td>
<td>Dizziness, dysphoria, disorientation, nausea</td>
</tr>
<tr>
<td>Sin 2017</td>
<td>30</td>
<td>0.3 mg/kg IVPB</td>
<td>Placebo</td>
<td>Quicker analgesia</td>
<td>No difference</td>
</tr>
</tbody>
</table>

## Ketamine Monotherapy in the ED

<table>
<thead>
<tr>
<th>Study</th>
<th># of Patients/Group</th>
<th>Dose of Ketamine</th>
<th>Comparator</th>
<th>Key Findings</th>
<th>Adverse Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motov 2015</td>
<td>45</td>
<td>0.3 mg/kg IV Push</td>
<td>Morphine 0.1 mg/kg</td>
<td>Similar analgesia</td>
<td>Increased dizziness, disorientation, mood changes, and nausea</td>
</tr>
<tr>
<td>Motov 2017</td>
<td>24</td>
<td>0.3 mg/kg IVPB</td>
<td>0.3 mg/kg IV push</td>
<td></td>
<td>Lower rates of sedation and feelings of unreality in IVPB group</td>
</tr>
</tbody>
</table>

**Key Takeaways**

<table>
<thead>
<tr>
<th>Key Takeaway #1</th>
<th>Ketamine 0.3 mg/kg IV quickly and effectively reduces acute pain in the ED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Takeaway #2</td>
<td>Ketamine may be a good alternative or adjunct to opioids in acute pain</td>
</tr>
<tr>
<td>Key Takeaway #3</td>
<td>An IV drip may reduce the trip</td>
</tr>
</tbody>
</table>
5 Minute Q&A #3

@ASHP_EMPharm
#EMpearls
#ASHP17
Which of the following leads to worsening of electrical storm and refractory ventricular fibrillation?

A. Endogenous catecholamines
B. Chest compressions
C. Exogenous catecholamines
D. Both A and C
E. Both B and C
Esmolol should be used in all cases of cardiac arrest when other treatments fail.

A. True
B. False
In which of the following patients should Vitamin C be considered as an alternative treatment option to methylene blue for methemoglobinemia?

A. Patient with G6P-D deficiency.
B. Patient taking sertraline.
C. Patient with renal dysfunction.
D. Both A and B
High dose vitamin C has been associated with oxalate nephropathy.

A. True
B. False
You can make 1mg/10mL epinephrine by adding 12mg/12mL of epinephrine to 100mL bag of NS.

A. True
B. False
Running an epinephrine drip at 333mcg/min is ~1mg every 3 minutes.

A. True
B. False
What is/are commonly reported side effect(s) of ketamine?

A. Dysphoria
B. Nausea
C. Dizziness
D. All of the above
Ketamine quickly and effectively reduces acute pain.

A. True
B. False
Questions?

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Shannon Sullivan, PharmD  @SSullivanpharma
Aimee Mishler, PharmD, BCPS  @EM_Pharm
Emily Wiener, PharmD  @pharmdEMily
Thank You!
Emergency Medicine

Latest Discussion Posts

RE: Etomidate in RSI kits
By: Ryan Cossmann, yesterday
We have vec/roc/suc/etomidate/ld50/SWFI/atropine in our RSI kits. All of the non refrigerated items state... store at 20-25° C (See USP Controlled Room Temperature)*. Based upon this messaging...we are refrigerating the entire contents based upon the ...

RE: Pharmacist Code Response
By: Frank Peiloumay, 24 days ago

Latest Shared Files

Opioid Reduction Attachments
By: Teresa Bowman 7 months ago

Summary of Discussion at Midyear 2016 EM Networking ...
By: Kathleen Hildago 8 months ago
Emergency Care

The Emergency Care Resource Center contains a compilation of resources that pharmacists of all experience levels may find helpful for developing their practice, expanding their knowledge base, and keeping up-to-date on new developments within the specialty.

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