# The Michigan Pediatric EMS Error Reduction Study (MI-PEERS) Pediatric Prehospital Drug Dosing Errors

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# Conflict of Interest Disclosure

- I am the recipient of an Emergency Medical Services for Children grant for implementing a prehospital pediatric drug dosing safety system.
- I am an inventor and hold the U.S. patents on 2 drug dosing devices. I receive no royalties and have no royalty arrangements.

# Grant Disclosure


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- *This information or content and conclusions are those of the author and should not be construed as the official position or policy of, nor should any endorsements be inferred by HRSA, HHS or the U.S. Government.*

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# Prior Research

- Prehospital pediatric drug dosing errors occur at a high rate:
  - Kaji, et al 2006 QI study
    - 34% of epinephrine doses correct increased to 65% after QI intervention
  - Hoyle, et al 2012 database study
    - 57% of all drug doses correct
  - Lammers, et al Simulation studies (2009-2014)
    - Midazolam: 24% correct
    - Dextrose: 6% correct
    - Epinephrine (anaphylaxis): 25% correct
    - Epinephrine (cardiac arrest): 31% correct

# MI-MEDIC

## MICHIGAN MEDICATION EMERGENCY DOSING AND INTERVENTION CARDS

Based on State of Michigan EMS Protocols
2017 Revisions

Version 2.0

3-5 kilograms 6-12 pounds | 6-7 kilograms 13-16 pounds | 8-9 kilograms 17-20 pounds | 10-11 kilograms 21-25 pounds | 12-14 kilograms 26-31 pounds | 15-18 kilograms 32-40 pounds | 19-23 kilograms 41-51 pounds | 24-29 kilograms 52-64 pounds | 30-36 kilograms 65-79 pounds | Adult >14 Years

# 8-9 kilograms *(17-20 pounds)* / 7-10 Months (Red)

## CARDIAC RESUSCITATION

**Normal Vitals:** HR: 100-180, RR: 25-35, Systolic BP: 70-110 mmHg, Blood Glucose > 40 mg/dl

| **Resuscitation Medication** - (confirm concentration is as specified) | **Dose** | **Volume** |
|---|---|---|
| Epinephrine 1:10,000 (1 mg/10 mL prefilled syringe) IV/IO Q 3-5 min for arrest/bradycardia[1] | 0.1 mg | **1 mL** |
| Amiodarone (150 mg/3 mL) IV/IO for shock resistant V-Fib | 50 mg | **1 mL** |
| *Lidocaine (100 mg/5 mL) IV/IO for wide-complex tachycardia | 10 mg | **0.5 mL** |
| Atropine (1 mg/10 mL) IV/IO for bradycardia unresponsive to Epinephrine[1] | 0.2 mg | **2 mL** |
| *Adenosine (6 mg/2 mL) IV/IO **1st Dose. Dilute with 4 mL Normal Saline to produce 1 mg/mL. For SVT (HR > 220)** | 1 mg | **1 mL (Diluted)** |
| *Adenosine (6 mg/2 mL) IV/IO **2nd Dose. Dilute with 4 mL Normal Saline to produce 1 mg/mL. For SVT (HR > 220)** | 2 mg | **2 mL (Diluted)** |
| **Electrical Therapy** | **Initial[2]** | **Repeat[2]** |
| Defibrillation (pediatric pads preferred) Adult pads may be used anterior/posterior. | **20 J** | **40 J** |
| *Synchronized Cardioversion[2] for unstable tachycardia | **10 J** | **20 J** |

**Equipment**

OPA: **50 mm** NPA: **14 F** BVM: **Infant** Laryngoscope: **1 (straight)**

ET Tube: **3 (cuffed)** ET Depth: **11 cm** *No ETI unless unable to ventilate*

**Fluid Bolus**

Normal Saline **170 mL IV/IO - May repeat x 1 PRN**

***Contact Medical Control Prior to Administering**

[1]**CPR if HR < 60 after $O_2$**

[2]**May adjust to closest available energy setting**

# Michigan Pediatric EMS Error Reduction Study (MI-PEERS)

- 3 year EMSC-funded study with 8 intervention and 8 control EMS agencies in Michigan
- Instituting a “safety bundle” to reduce drug dosing errors.
  - 911 asks caller for weight of patient and communicates that to EMS crew
  - Weight hierarchy
  - New EMS pediatric measuring tape for weight only.
  - Checklists
  - Twice monthly on-line mini pediatric training
  - Enforce use of MI-MEDIC cards
  - Every pediatric case gets a quality improvement exam
  - Sharing of pediatric data among agencies

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# MI-PEERS

- Patient safety training specific to pediatrics
- Anonymous error reporting system
  - Anonymous data gets shared with all agencies

- Evaluation of effectiveness:
  - Simulation: allows us to actually see what happens
    - Many errors occur, aren't realized and aren't documented
  - MIEMSIS data: lets us track every pediatric patient

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# Methods

- **Pre-intervention** evaluation of drug-dosing accuracy
- Crews were required to administer drugs as they normally would using their regular drug bag.
- Four scenarios
  - Infant seizing (hypoglycemic)
    - Midazolam and Dextrose
  - 5 year old with anaphylactic shock
    - Epinephrine, solumedrol, diphenhydramine, albuterol
  - 18 month old with a partial thickness burn
    - Fentanyl
  - Infant cardiac arrest
    - Epinephrine
- These scenarios were completed by EMS crews in prior research before implementation of MI-MEDIC.[4,5]
- Dose error defined as ≥ 20% difference from the correct dose.

[4] Lammers, et al Prehospital Emergency Care 2014; 18:295-304
[5] Lammers, et al Prehospital Emergency Care 2009; 13:345-356

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# Results (Pre-MI-PEERS Intervention)

- 142 simulations completed
  - Seizure - 36
  - Anaphylactic shock - 36
  - Burn - 35
  - Cardiac Arrest - 35

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# Results

- 65 participants
  - 44 male, 21 female
- Crew configuration
  - 21 EMT-P/EMT-P teams
  - 12 EMT-P/EMT-B teams
  - 3 EMT-P/EMT-I teams
- Average years of experience
  - < 1: 11 (16.92%)
  - 1-4: 19 (29.23%)
  - 5-10: 24 (36.92%)
  - >10: 11 (16.92%)

- Initial results in Prehospital Emergency Care (on line)
  - Doi.org/10.1080/10903127.2019.1619002

# Errors Found in Simulation

| Drug/ Route | # Correct / total | % Correct (95% CI) |
|---|---|---|
| Midazolam IM | 21/32 | 65.6% (46.8%, 81.4%) |
| Midazolam IV | 7/18 | 38.9% (17.3%, 64.3%) |
| Dextrose | 20/28 | 71.4% (51.3%, 86.9%) |
| Epinephrine (1mg/1ml) IM | 22/30 | 73.3% (54.1%, 87.7%) |
| Diphenhydramine | 24/30 | 82.8% (64.2%, 94.2%) |
| Methylprednisolone | 10/13 | 76.9% (46.2%, 95.0%) |
| Fentanyl IN | 2/4 | 50.0% (6.8%, 93.2%) |
| Fentanyl IV | 37/57 | 64.9% (51.1%, 77.1%) |
| Morphine IV | 4/6 | 66.7% (22.3%, 95.7%) |
| Epinephrine (1mg/10ml or 1:10,000) IV | 51/70 | 72.9% (60.9%, 82.8%) |
| All drugs | 198/288 | 68.8% (63.5%,74.2%) |

# Overdoses

| Drug/Route | Number of overdoses | Magnitude of overdose (median and range) | 95% Confidence Interval of median |
|---|---|---|---|
| Midazolam IM | 2 | 2.25 (0.50) | (2.00, 2.50) |
| Midazolam IV | 8 | 3.75 (3.50) | (2.00, 5.00) |
| Dextrose | 3 | 7.69 (6.15) | (1.54, 7.69) |
| Epinephrine (1mg/1ml) IM | 4 | 6.67(2.00) | (4.67, 6.67) |
| Fentanyl IN | 1 | 1.25* | * |
| Fentanyl IV | 16 | 5.00 (10.75) | (2.40, 8.00) |
| Morphine IV | 2 | 6.10(8.20) | (2.00, 10.20) |
| Epinephrine (1mg/10ml or 1:10,00) IV | 13 | 3.6 (18.60) | (1.60, 10.00) |

# Underdoses

| Drug/ Route | Number of under doses | Magnitude of under dose (median and range) | 95% Confidence Interval of median |
|---|---|---|---|
| Midazolam IM | 9 | 0.50 (0.70) | (0.10, 0.60) |
| Midazolam IV | 3 | 0.75 (0.15) | (0.60, 0.75) |
| Dextrose | 5 | 0.73 (0.49) | (0.28, 0.77) |
| Epinephrine (1mg/1ml) IM | 4 | 0.67 (0) | (0.67, 0.67) |
| Diphenhydramine | 2 | 0.55 (0.10) | (0.50, 0.60) |
| Methylprednisolone | 1 | 0.43 (0) | * |
| Fentanyl IN | 1 | 0.25 (0) | * |
| Fentanyl IV | 4 | 0.60 (0.70) | (0.00, 0.70) |
| Morphine IV | 0 | N/A | N/A |
| Epinephrine (1mg/10ml or 1:10,00) IV | 6 | 0.07 (0.70) | (0.01, 0.70) |

# Errors When Drugs Were Diluted

| Drug/ Route | Dilution errors # / (% of total doses) | Overdoses / Under doses #/# |
|---|---|---|
| Midazolam IM | 3 (11.1%) | 0/3 |
| Midazolam IV | 6 (41.7%) | 3/3 |
| Dextrose | 6 (27.3%) | 2/3 |
| Epinephrine (1mg/1ml) IM | 0 | 0/0 |
| Diphenhydramine | 4 (6.9%) | 2/2 |
| Fentanyl IN | 1 (33. 3%) | 0/1 |
| Fentanyl IV | 9 (6.8%) | 7/0 |
| Morphine IV | 1 (16.7%) | 0/0 |
| Epinephrine (1mg/10ml or 1:10,00) IV | 1 (1.5%) | 0/1 |

# Dose Errors Pre and Post MI-MEDIC Pediatric Drug Reference Implementation

| Drug (Indication) | Percent of correct doses (95% Confidence Interval) pre PDR | Percent of correct doses (95% Confidence Interval) post PDR |
|---|---|---|
| Midazolam (Seizure) | 24.0%*# | 65.6% (46.8%, 81.4%)^ |
| Dextrose (Seizure) | 6% (2.5%, 8.8%) | 71.4% (51.3%, 86.9%) |
| Epinephrine 1 mg/ml IM (Anaphylaxis) | 25.0% (9.7%, 30.3%) | 73.3 % (54.1%, 87.7%) |
| Epinephrine 1mg/10 ml IV (Cardiac Arrest) | 31.0% * | 72.9% (60.9%, 82.8%) |

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# Systems and Errors

- "Medical mistakes are merely human mistakes committed within a human system inadequately designed to catch and neutralize those mistakes"

- "Every system is perfectly designed to get the results it gets." Paul Baltaden

- ***The current system (and culture) of EMS are perfectly designed to achieve an error rate of 32% for all pediatric drug doses.***
  - The system and culture need to be changed to decrease these errors

# MI-PEERS Intervention Results?

- Stay Tuned
- Will begin our simulations to test the effect of the intervention this Fall.
- Caution:  you never know how a “good idea” is going to work until it is tested.
  - Law of unintended consequences
    - May actually do harm or cause an error somewhere else in the system