



**PEDIATRIC MEDICATION SAFETY QUALITY IMPROVEMENT**  
**PROGRESS REPORT**  
**FEBRUARY 2024**

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## I. BACKGROUND

Prehospital medication dosing errors in pediatric patients are a common occurrence. Published rates of pediatric medication error range from 36 to 49% in the EMS setting, including for critical medications such as midazolam for seizure.<sup>1-4</sup> Dosing errors are the result of multiple causes that include infrequent exposure to pediatric patients and complex calculations for weight-based dosing performed in a stressful environment. In 2020, evidence-based best practices for pediatric medication dosing to reduce the incidence of pediatric medication errors in the prehospital environment were published.<sup>5</sup> These guidelines recommend the following as best practice:

1. **Confirm patient weight at the time care is delivered** (should be done for all pediatric patients). Methods to confirm patient weight include asking the parent, using a length-based tape, or by age.
2. **Use kilograms as the standard of weight used.** Precalculated tools should be used to convert from pounds (lbs) to kilograms (kgs).
3. **Use tools that provide pre-calculated weight-based dosing with reported doses in mL** that can be modified quickly when drug shortages force substitutions.
4. **Increase opportunities for EMS clinicians to practice performing weight-based dosing**, utilizing the tools and equipment that they would actually use in the field.

With the availability of the ImageTrend state data bridge, we were able to examine our own pediatric medication error rate. In 2020 – 2022, only 70% of medications for patients age < 13 yo were dosed correctly. With the assistance of funding from the DOH Bureau of EMS & Trauma Systems/EMS-C, we undertook a regional quality improvement project to reduce pediatric medication error and enhance safety for pediatric patients.

## II. IMPLEMENTATION

Based on the evidence-based guidelines, our plan for improvement was implementation of a volume-based drug dosing tool with associated education. The tool chosen was Handtevy® mobile application as it has been well-established in pediatric medication safety, had been successfully implemented locally by Mercy Flight Central, capable of protocol integration and was backed by published literature<sup>2</sup>. Because of cost limitations, the initial plan was to enable access for all ALS-level clinicians in our region with future plans to expand to BLS clinicians if successful and financially feasible.

Because Handtevy was a volume-based tool, the first step was a regional survey of all 12 participating agencies to determine variability in medication concentration. There was minimal variability found, with the only drug with varying concentrations in our region being ketamine (available as both 50 mg/ml and 100 mg/ml). Information was sent to Handtevy and the application was set up, subsequently reviewed by medical

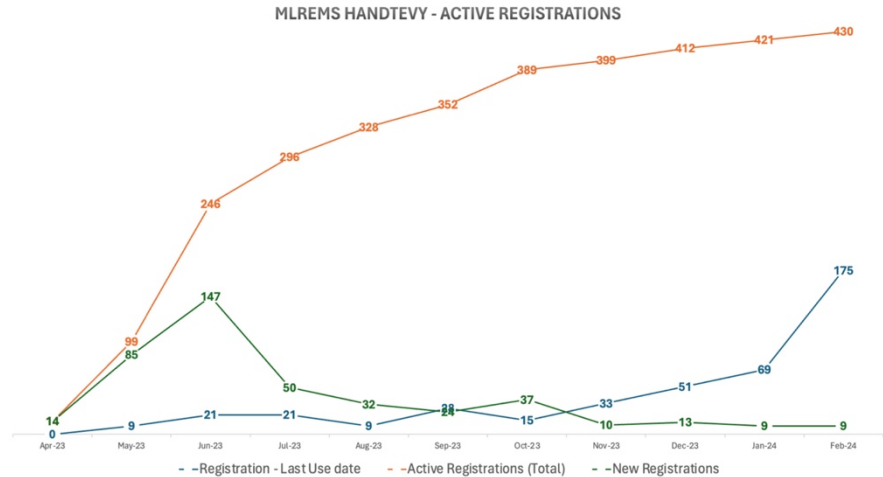
directors in the Division of Prehospital medicine and two EMS clinicians, including the Handtevy administrator.

A small group of EMS clinicians, including ALS-level members of the Regional Patient Safety, were invited to pilot the application prior to Regional release. They were able to identify accessibility issues that were fixed prior to regional release.

To encourage best practice and participation in the pilot, MLREMS REMAC approved a policy entitled “Medication Dosing Safety for Pediatric Patients” (Appendix G, p.34) in October 2022 which was broadly released in conjunction with a regional advisory and notice to leadership regarding the Handtevy implementation and education plan in April 2023.

Given that best practice in pediatric medication dosing requires opportunity for hands on practice of psychomotor skills, it was deemed essential that EMS clinicians receive training that incorporated hands-on use of the application in the context of clinical scenarios. However, it was also recognized that depending on agency resources or architecture, there may be limited time and resources to implement this. There was also limited bandwidth of program agency staff to train all > 300 ALS clinicians at 12 participating agencies in the region. We developed a “train-the-trainer” model which incorporated 5 cases – 3 pediatric (seizure, cardiac arrest, pain management) and 2 adult (ketamine for pain, norepinephrine for shock) – designed to use multiple aspects of the application and encourage use in both pediatric and adult patients. Train the trainer sessions were held in May 2023 and agencies began training their personnel in June 2023. Handtevy Length Based Tapes were distributed during these train the trainer sessions. Introductory material was made available online on the regional learning management system. The initial goal was for training completion by July, but as this was not feasible for a number of agencies, this window extended through the Fall. Agencies variably incorporated the training resources, with training sessions ranging from full integrated scenarios, synchronous mini-sims to choosing one or two cases to briefly practice before release. When there was limited opportunity for psychomotor practice, URM Division of Prehospital Medicine faculty attempted to supplement these educational experiences with simulation sessions but were met with limited attendance. In the post-survey completed by 104 ALS clinicians (Appendix D), 58% completed both asynchronous and hands-on training, 21% completed hands-on only, 18% completed asynchronous (online) training only, and 4% received no training.

By September 2023, there were > 350 active registered users of the MLREMS installation of the Handtevy application, suggesting that nearly all ALS clinicians in the MLREMS region were trained by this time. The majority were trained by July. [FIGURE 1]. We subsequently made remaining licenses available to interested BLS clinicians and first response fire departments.



**FIGURE 1:** Timeline of Active Handtevy Use. Cumulative Active User Registrations are seen in orange. The last time of use is seen in blue. 175 of 430 users used the application within the last week. A very small subset likely last used the application when they were trained and can be seen as last uses in the months of May - Sep.

An e-mail address ([handtevy@mlrems.org](mailto:handtevy@mlrems.org)) which forwards to the e-mails of three individuals with Handtevy Administrator privileges was made available to all EMS clinicians and leaders in the region (introduced as part of the training) to e-mail immediately if they found an error in concentration or had other feedback or requests for the application. This has been used regularly since implementation.

Date	
Oct -Nov 2022	Agency Medication Concentration Survey
Oct 17, 2022	MLREMS Regional Policy outlining “Medication Dosing Safety for Pediatric Patients” approved by REMAC
Nov – Dec 2022	Development of Education Plan
Feb - March 2023	App Review & Refinement for accuracy
April 2, 2023	App Pilot and Feedback by EMS Clinicians (small group)
April 13, 2023	Release of Regional Advisory 23-03 sharing MLREMS Regional Policy for Pediatric Dosing Safety
April 13, 2023	Release of letter to agency leadership to sign up for the train the trainer sessions announcing Educational plan
May 2023	Train the Trainer sessions held for EMS Agency Leadership
May 2023	Asynchronous Introductory training available on LMS & Slides and Cases made available to agency leadership
June 2023	Agencies begin training

Table 1: Timeline of Handtevy Implementation in MLREMS Region

### III. DATA ANALYSIS & SUMMARY OF RESULTS

**MEDICATION ERROR:** Data on medication error is pulled from the ImageTrend state data bridge, and therefore comes with some limitations. First, if the data was not successfully transmitted, it will not be included in the data bridge. Second, only medications for which a clear indication could be discerned based on the primary impression were included as several medications (midazolam, epinephrine) having dosing specific to indication.

For calculation of medication dosing errors and other metrics (time to administration) we only used records from patients age 0-13 years and the first dose of the medication given to an individual patient. Medications given prior to arrival of EMS were also excluded.

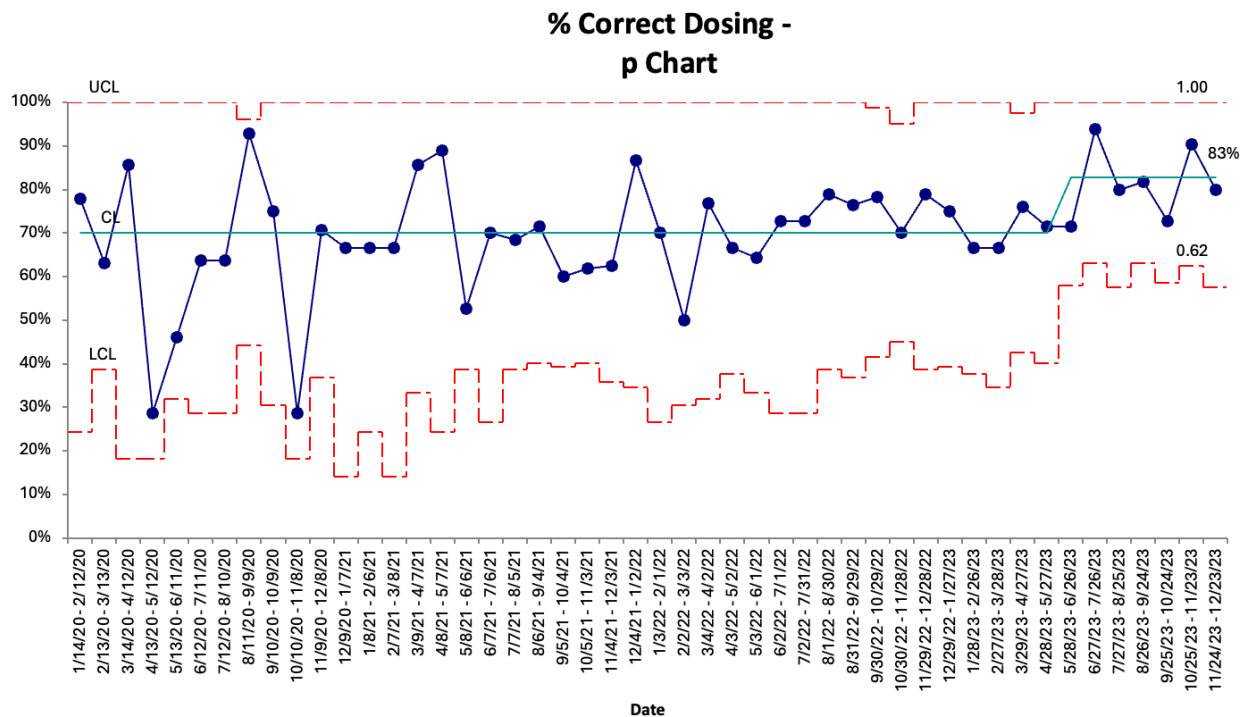
The following medications were included in the analysis and associated definitions of lower and upper limit of correct dosing based on the NYS Collaborative Protocols. A dose was deemed correct if the administered dose was between the upper and lower limit. The total numbers of medication administration by indication and agency are provided in Appendices A and B. The three most administered medications to pediatric patients in our system are dexamethasone, midazolam and fentanyl. The denominator for the calculation is the documented weight in the EMS PCR. Using a sample subset of patients age < 13 yo transported by emsCharts agencies to Strong Memorial hospital who received prehospital medications, we were able to confirm through review of the ED chart that EMS-documented weights are > 90% accurate (Appendix C, p.16).

Medication	Route	Indication	Lower limit definition	Upper limit definition
Midazolam	IM	Agitation	0.8 (0.1 mg/kg) to a max of 5 mg	1.2 (0.1mg/kg) to a max of 5 mg
Midazolam*	IM/IN/IV	Seizure	0.8 (0.1 mg/kg) to a max of 5 mg	1.2 (0.1 mg/kg) to a max of 5 mg
Fentanyl	IM/IN/IV	Pain	1 mcg/kg	1.5 mcg/kg
Epinephrine	IO/IV	Cardiac arrest	0.8 * (0.01 mg/kg) OR 1 mg if patient > 40 kg (per protocols) to a max of 1 mg	1.2 * (0.01 mg/kg) to max of 1 mg
Epinephrine	IM	Allergic reaction or Bronchospasm	< 30 kg, 0.15mg; > 30kg ,0.3 mg or 0.01 mg/kg (whichever is lower)	0.01 mg/kg IM to a max of 0.3 mg
Diphenhydramine	IM/PO/IV	Allergic reaction	0.8 *(1 mg/kg) to a max of 50 mg	1.2 * (1 mg/kg) to a max of 50 mg
Dexamethasone	IM/PO/IV	Allergic reaction, Bronchospasm or Croup	0.8 * (0.6 mg/kg) to a max of 10 mg	1.2 * (0.6 mg/kg) to a max of 10 mg
Morphine	IM	Pain	0.8 * (0.1mg/kg) to a max of 10 mg	1.2 * (0.1 mg/kg) to a max of 10 mg
Morphine	IV	Pain	0.8 * (0.05 mg/kg) to a max of 10 mg	1.2 * (0.05 mg/kg) to a max of 10 mg

\*will change with upcoming NYS protocol increase to 0.2 mg/kg

## OVERALL MEDICATION ERROR RATE

The overall correct medication dosing by quarter is charted below. During Quarters 3 & 4, the majority of ALS clinicians had access to and were trained in Handtevy use. Error rates were lower than in the past (an average of 83% correct dosing since July), but we cannot determine overall if there has been a significant process change until we determine whether the improvement has been sustained over the next several months.

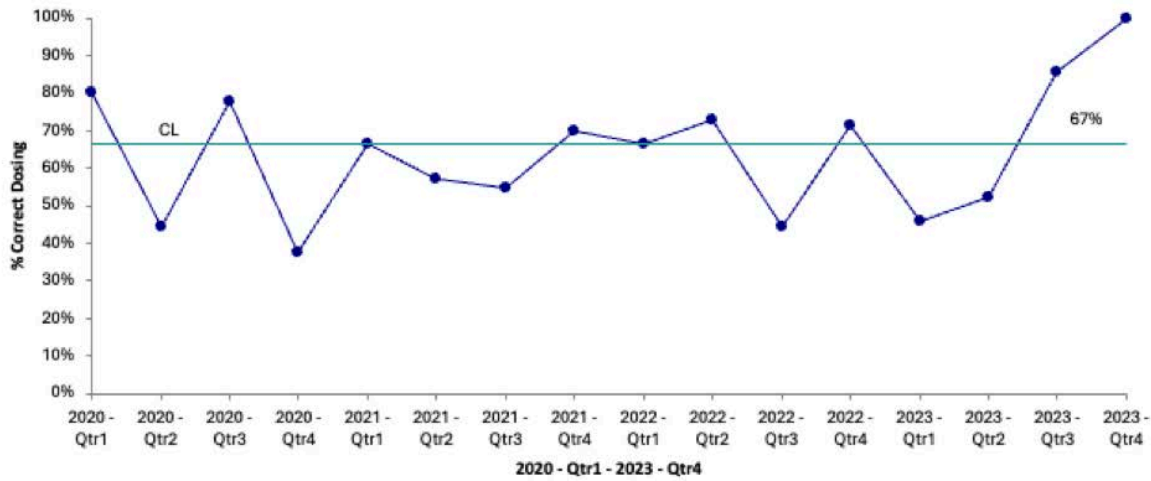


## INDIVIDUAL MEDICATIONS

Evaluating individual medications is much more useful than examining the conglomerate, as not all medications have the same rate of medication error. For example, from 2020 – 2022, midazolam for seizure was dosed correctly on 63% of the time, fentanyl was dosed correctly 51% of the time and dexamethasone was dosed correctly 88% of the time. This is likely because dexamethasone hits a max dose of 10 mg relatively quickly.

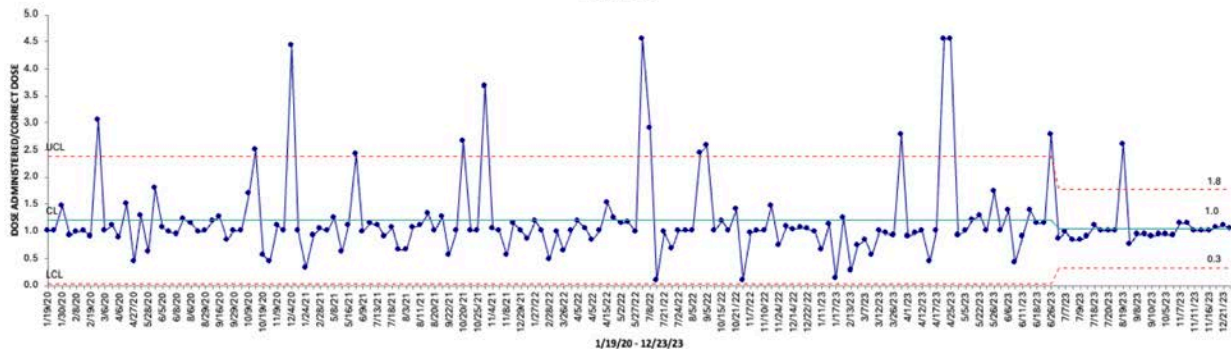
- i. **MIDAZOLAM FOR SEIZURE** – The impact on Midazolam dosing for seizure was impressive. There was an increase in correct dosing for midazolam dosing, with 0 errors made in the last quarter of 2023:

### Midazolam For Seizure % Correct Dosing



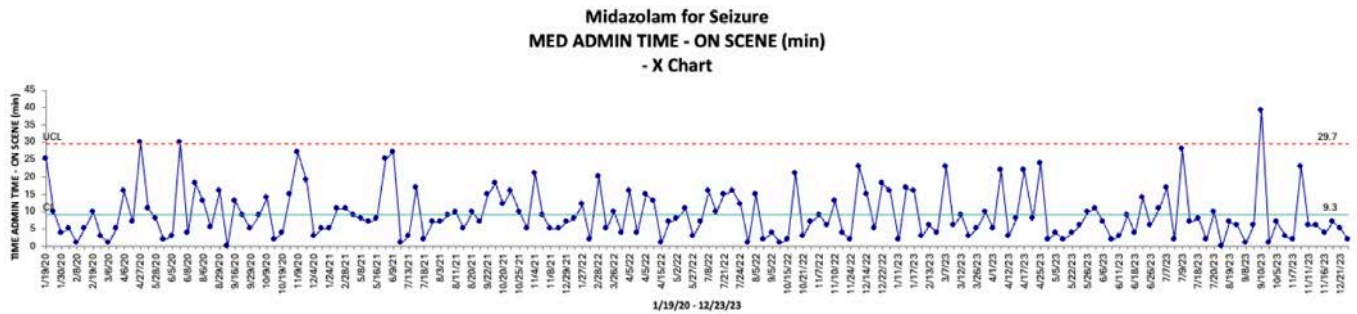
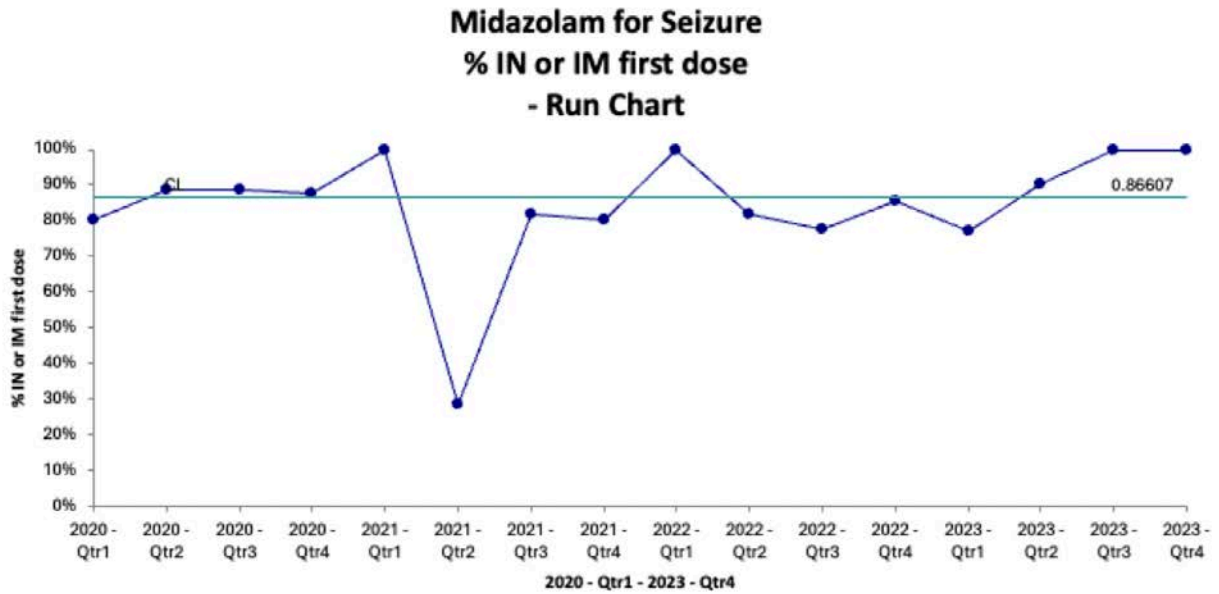
While there are not enough data points on the above chart to determine whether there has been sustained process change, when we look at individual administrations of midazolam and examining the ratio of administered dose/correct dose (goal = 1), we can see that there has been a significant decrease in variability and points are tightly centered around an average of 1 (chart below). There has been a single instance of significant midazolam dosing error based on protocol, and by chart review, the paramedic who administered the medication/cared for the patient is not a registered Handtevy user and there was no documented use of LBT:

### MIDAZOLAM FOR SEIZURE CORRECT DOSE ADMINISTERED/CORRECT DOSE - X Chart

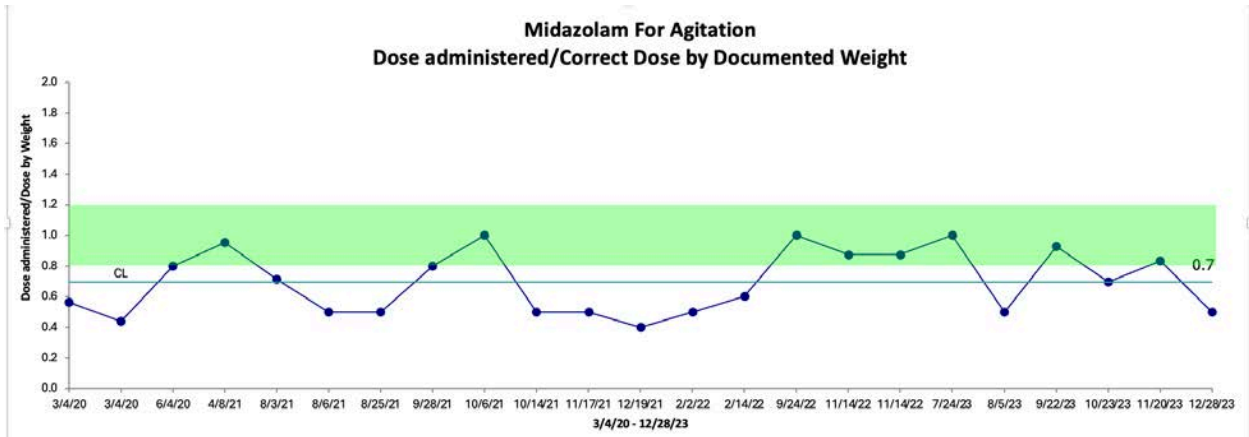




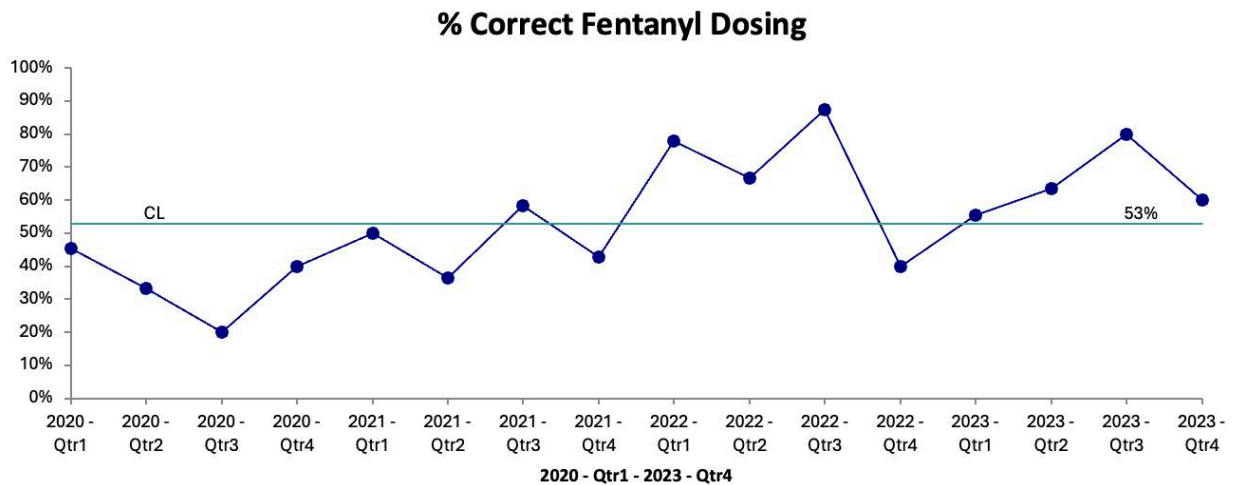
We also examined route of administration and time to midazolam administration (defined as medication administration time – on scene time interval). We found a trend (unclear if process change yet as too early) towards guideline-recommended IN/IM for first dose, but no significant decrease in time to administration:

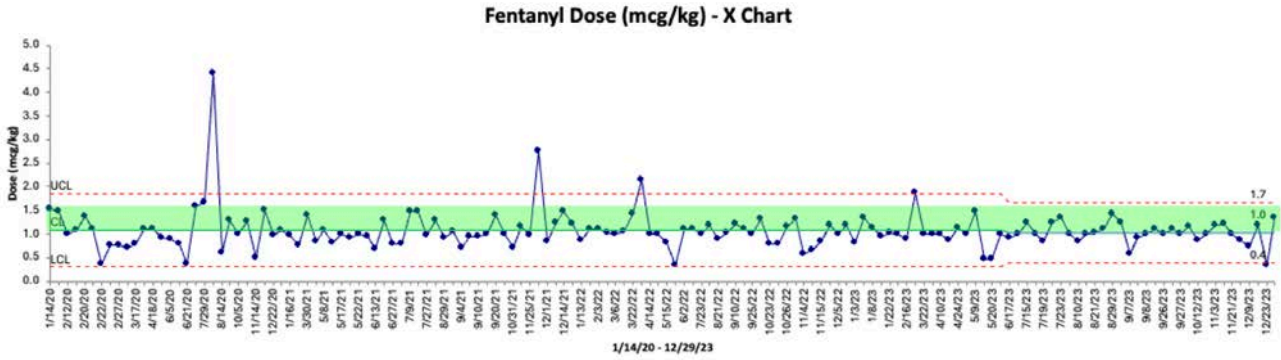


- ii. **Midazolam for Agitation:** There was no apparent trend in correct dosing of IM midazolam for agitation, though overall administrations are low. Of note, there have been no overdoses and the most common “error” is underdosing which is of unclear clinical significant as the documented response is often “improved” despite a lower dose.



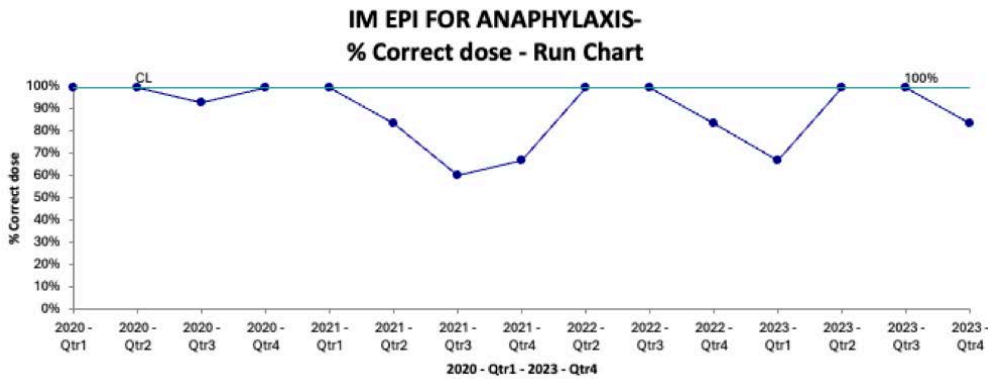
- iii. **Fentanyl for Pain:** Interestingly (and positively given undertreatment of pain in pediatric patients), we have had a trend of increasing instance of fentanyl administration over the last few years. Variability in fentanyl dosing decreased (see X-chart below) following Handtevy implementation, but underdosing continues to predominate. There was no incidence of fentanyl overdosing since Handtevy implementation, but this was rare previously (though occurred with > 2 fold documented errors).



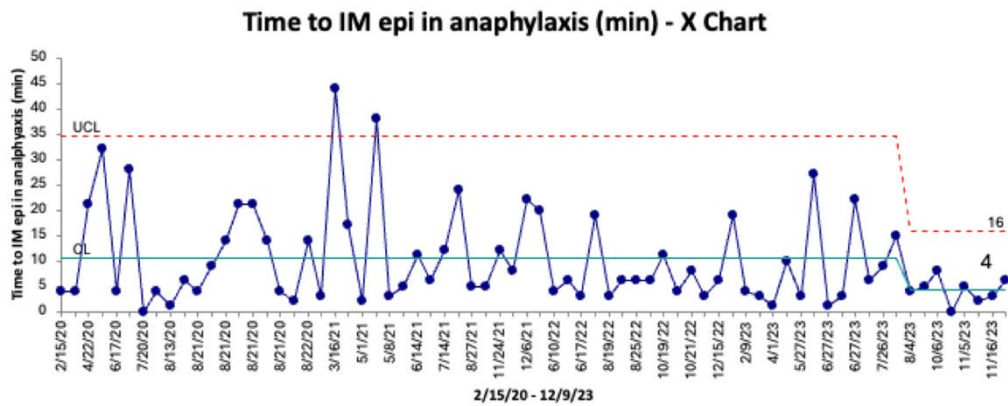


iv. **IM epinephrine for anaphylaxis/allergy:**

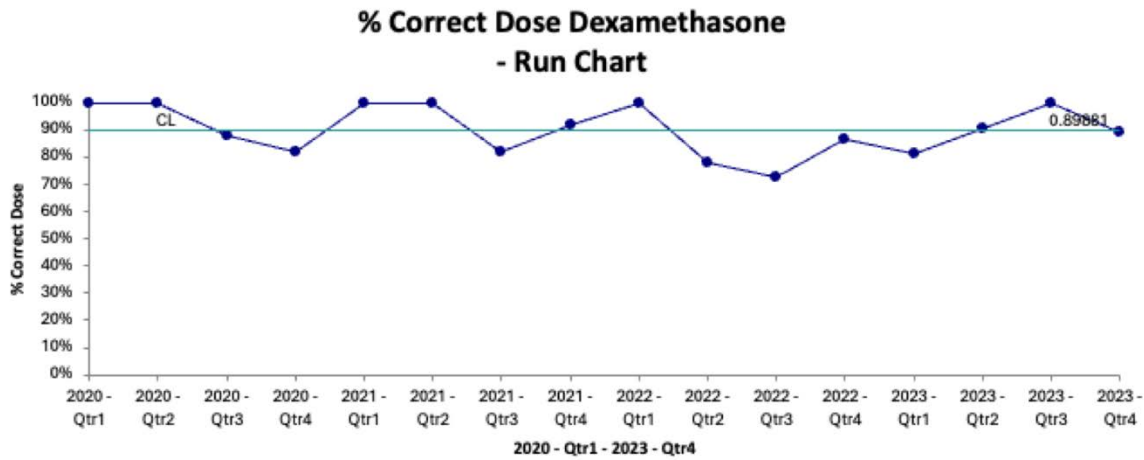
Overall, correct dosing for IM epi for anaphylaxis is common, though the most common error is underdosing by giving 0.15mg IM to a pediatric patient who weighs > 30 kg. In all of these cases, the documented patient response was “improved”.



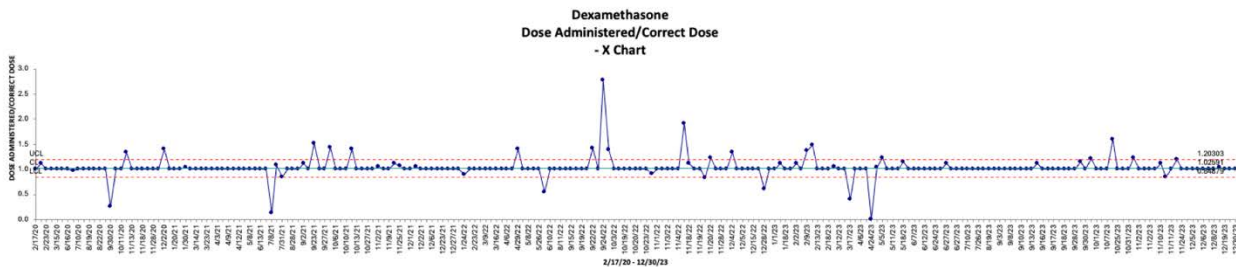
Interestingly, there has been a significant decrease in time to IM epinephrine administration, though it is unclear whether this is related to our QI initiative or other regional efforts regarding early anaphylaxis treatment:



- v. **Dexamethasone dosing** : There has been no appreciable change in correct dexamethasone dosing, which was high to begin with:



Unlike other medications, overdosing was more common than underdosing for dexamethasone:



**a. EMS CLINICIAN– SURVEY RESULTS**

MLREMS ALS clinicians were surveyed prior to Handtevy implementation and 6 months after predicted Saturation. The survey was released in April 2023 and also accessible through the introduction to Handtevy video available through the Regional LMS. 123 surveys were completed between 4/13/24 – 7/28/23 and included in the pre-analysis. Post survey responses were gathered by distribution via EMS agency leadership to distribute and through direct e-mail to Handtevy users. There were 108 post-surveys completed between 2/1/24-2/23/24. The complete pre-post survey results are catalogued in Appendix D.

96% (104) of post-survey respondents had access to the Handtevy application. There was increase in % survey respondents reporting that they used an app for drug calculations (44% Pre vs. 83% Post). 92% of those who use an app for drug

calculations use Handtevy. 60% reported estimating patient weight using the Handtevy app. There was no significant difference in % respondents reporting “always” using Length Based Tape for critically ill children (52% Pre vs. 54% Post). The most common method of estimating patient weight remained asking the parents (93% Pre vs. 85% Post). There was variable reported usage of the Handtevy app in frequency of use for protocol reference, drug calculation or assistance in running a cardiac arrest. The most commonly reported use of the app was as a protocol and dosing reference for adult patients.

Demographics of survey responses in terms of years of certification and pediatric call volume did not change pre/post. Overall, there was a non-significant trend towards increased comfort in caring for and administering medications to pediatric patients of all ages. There was no noticeable trend toward increased comfort with particular medication classes (benzodiazepines for seizure or pain management) or caring for critically ill children. As expected, EMS clinicians are more uncomfortable caring for pediatric patients the younger they are, in particular children < 1 year of age and those that are critically ill.

Free-text Feedback regarding barriers to safe pediatric medication dosing was collected pre-and post- application implementation and are available in Appendices E and F. Overall, the majority of feedback was very positive regarding the Handtevy application. The most commonly cited barriers remain frequency of clinical encounters and training opportunities for critical pediatric patients and staffing concerns. There is also a subgroup of EMS clinicians who have yet to gain trust in a phone application or cognitive aids in general, but these seem to be the minority. The most common feedback regarding the Handtevy application is limited availability of adult weight options.

#### **IV. FUTURE DIRECTIONS AND CHANGE IDEAS**

##### **1. Increase App Utilization through expansion of Adult Weight Options and Drip Rates:**

- a. Based on survey responses, expansion of adult weight options would make this more useful – and we suggest that increased app utilization because of increased frequency of adult encounters will likely increase the probability that it will be used for a pediatric patient. Handtevy now offers dosing ranges from 40kg – 100kg in 10 kg intervals and we have submitted for this upgrade. We will also be changing notation on fixed drips (Magnesium, Amiodarone, Hydroxocobalamin) to include recommended drip sets/rates.
- b. We will also be incorporating checklists into the app with the hope that this will help the app get integrated into workflows and help build a culture of safety.

- c. Direct upload into charting software: Work to enable direct import of medications recorded with Handtevy application into ImageTrend and emsCharts.
2. **Work with agencies to increase pediatric training opportunities:** Our goal will be to expand hands-on, deliberate practice focused pediatric training opportunities in the region that will incorporate LBT and Handtevy app usage. We will need to engage with EMS clinicians to develop ways improve attendance.
3. **Sustainability:**
  - a. **DOH Funding runs out in June 2024:** Develop a sustainable funding plan through shared agency-financing of the application for continued MLREMS regional installation.
  - b. **Incorporate into agency on-boarding/credentialing:** Assist agencies in incorporating Handtevy into their on-boarding/credentialing process so that each new ALS clinician coming in has access and opportunity for psychomotor training. All MCC paramedic students currently get access and training as part of their paramedic school education.

## V. REFERENCES

1. Shah, M. I. *et al.* Multicenter Evaluation of Prehospital Seizure Management in Children. *Prehospital Emergency Care* **25**, 475–486 (2021).
2. Rappaport, L. D., Markowitz, G., Hulac, S. & Roosevelt, G. Medication Errors in Pediatric Patients after Implementation of a Field Guide with Volume-Based Dosing. *Prehospital Emergency Care* **27**, 213–220 (2023).
3. Hoyle, J. D., Davis, A. T., Putman, K. K., Trytko, J. A. & Fales, W. D. Medication Dosing Errors in Pediatric Patients Treated by Emergency Medical Services. *Prehospital Emergency Care* **16**, 59–66 (2012).
4. Hoyle, J. D. *et al.* Dosing Errors Made by Paramedics During Pediatric Patient Simulations After Implementation of a State-Wide Pediatric Drug Dosing Reference. *Prehospital Emergency Care* **24**, 204–213 (2020).
5. Cicero, M. X. *et al.* Medication Dosing Safety for Pediatric Patients: Recognizing Gaps, Safety Threats, and Best Practices in the Emergency Medical Services Setting. A Position Statement and Resource Document from NAEMSP. *Prehospital Emergency Care* **25**, 294–306 (2021).

APPENDIX A: Total number of First Dose Administrations by Medication and Indication for Patients Age 0-13 years within Monroe-Livingston Region transported between January 2020 – December 2023 (as pulled via the ImageTrend State Data Repository).

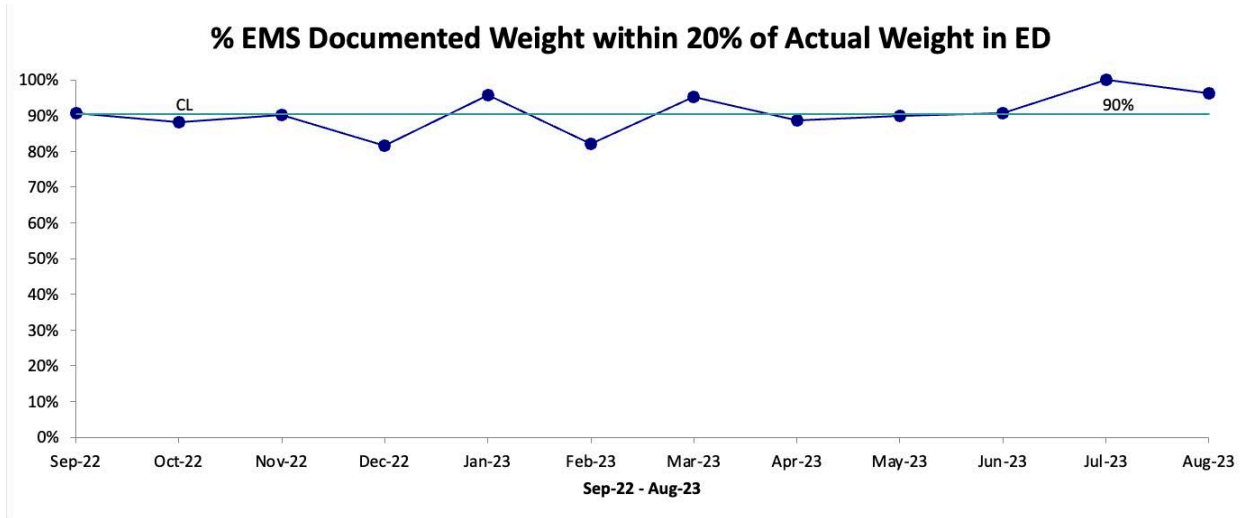
Medication	Indication								Grand Total
	AGITATION	ALLERGY	ANAPHYLAXIS/ALLERGIC REACTION	BRONCHOSPASM	CARDIAC ARREST	PAIN	RESPIRATORY	SEIZURE	
DEXAMETHASONE		49					176		225
MIDAZOLAM	23							166	189
FENTANYL						144			144
DIPHENHYDRAMINE		116							116
EPINEPHRINE 1 mg/ml			70	24					94
EPINEPHRINE 1 mg/ 10 ml					19				19
MORPHINE						18			18
<b>Grand Total</b>	<b>23</b>	<b>165</b>	<b>70</b>	<b>24</b>	<b>19</b>	<b>162</b>	<b>176</b>	<b>166</b>	<b>805</b>

APPENDIX B: Total number of First Dose Administrations by Medication and Indication for Patients Age 0-13 years within Monroe-Livingston Region transported between January 2020 – December 2023 by EMS Agency.

	DEXAMETHASONE	DIPHENHYDRAMINE	EPINEPHRINE 1 mg/ 10 ml	EPINEPHRINE 1 mg/ml	FENTANYL	MIDAZOLAM	MORPHINE	Grand Total
National Ambulance & Oxygen Service, Inc. (AMRRural/Metro ,Village of East Rochester Ambulance) (1244)	122	35	7	42	30	68	7	311
Monroe Medi-Trans, Inc. (Monroe Ambulance) (2745)	44	21	4	19	22	38	4	152
CHS Mobile Integrated Healthcare, Inc. (Henrietta; Chili; Scottsville; Caledonia) (2725)	10	10	1	11	22	21		75
Gates Volunteer Ambulance Service, Inc. (2738)	6	4	1	2	12	13		38
Penfield Vol. Emergency Ambulance Service, Inc. (2729)	10	5		2	8	13		38
Livingston County EMS (0729)	6	3	1		14	8	5	37
Northeast Quadrant ALS, Inc. (2783)	10	10	3	3	4	2		32
Brighton Volunteer Ambulance, Inc. (2750)	4	8		1	10	7		30
Irondequoit Ambulance, Inc. (2749)	4	7	1	1	5	3	2	23
Perinton Volunteer Ambulance Corps, Inc. (2730)	1	2		4	8	6		21
Pittsford Volunteer Ambulance Service, Inc. (2731)	1	6		4	3	5		19
Honeoye Falls Ambulance, Village of (2727)	4	2		1	5	1		13
Barnard Fire District (6204)	3	3	1	2		2		11
Livonia Ambulance District #1, Town of (0806)					1	2		3
North Greece Fire District (1084)					1			1
Ridge Road Fire District (0873)					1			1
<b>Grand Total</b>	<b>225</b>	<b>116</b>	<b>19</b>	<b>94</b>	<b>144</b>	<b>189</b>	<b>18</b>	<b>805</b>

APPENDIX C: Accuracy of EMS Weight Documentation.

Records of pediatric patients Age 0-13 years of age transported by emsCharts agency to Strong Memorial Hospital were reviewed for comparison of EMS documented weight vs. Actual weight in ED encounter





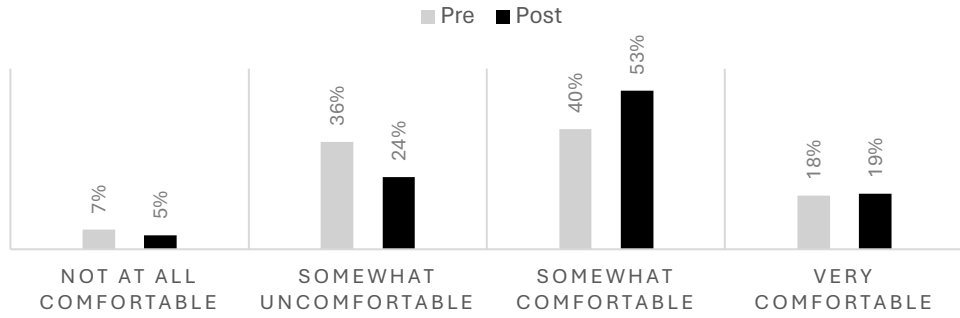
APPENDIX D: EMS Clinician Survey Responses (Pre and Post)

Demographics																
<p>Years of Certification as a paramedic...</p>	<p>A grouped bar chart comparing 'Pre' (grey) and 'Post' (black) survey responses for years of certification. The x-axis categories are 1-3 YEARS, 3-5 YEARS, 5-10 YEARS, and &gt;10 YEARS. The y-axis represents percentage.</p> <table border="1"> <thead> <tr> <th>Years of Certification</th> <th>Pre (%)</th> <th>Post (%)</th> </tr> </thead> <tbody> <tr> <td>1-3 YEARS</td> <td>24%</td> <td>19%</td> </tr> <tr> <td>3-5 YEARS</td> <td>14%</td> <td>17%</td> </tr> <tr> <td>5-10 YEARS</td> <td>16%</td> <td>10%</td> </tr> <tr> <td>&gt;10 YEARS</td> <td>46%</td> <td>54%</td> </tr> </tbody> </table>	Years of Certification	Pre (%)	Post (%)	1-3 YEARS	24%	19%	3-5 YEARS	14%	17%	5-10 YEARS	16%	10%	>10 YEARS	46%	54%
Years of Certification	Pre (%)	Post (%)														
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>10 YEARS	46%	54%														
<p>On average in the last year, I cared for a pediatric patient (age &lt; 18)</p>	<p>A grouped bar chart comparing 'Pre' (grey) and 'Post' (black) survey responses for the frequency of caring for pediatric patients. The x-axis categories are LESS THAN ONCE PER MONTH, MONTHLY, WEEKLY, and DAILY. The y-axis represents percentage.</p> <table border="1"> <thead> <tr> <th>Frequency</th> <th>Pre (%)</th> <th>Post (%)</th> </tr> </thead> <tbody> <tr> <td>LESS THAN ONCE PER MONTH</td> <td>33%</td> <td>39%</td> </tr> <tr> <td>MONTHLY</td> <td>46%</td> <td>44%</td> </tr> <tr> <td>WEEKLY</td> <td>20%</td> <td>18%</td> </tr> <tr> <td>DAILY</td> <td>1%</td> <td>0%</td> </tr> </tbody> </table>	Frequency	Pre (%)	Post (%)	LESS THAN ONCE PER MONTH	33%	39%	MONTHLY	46%	44%	WEEKLY	20%	18%	DAILY	1%	0%
Frequency	Pre (%)	Post (%)														
LESS THAN ONCE PER MONTH	33%	39%														
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WEEKLY	20%	18%														
DAILY	1%	0%														
<p>On average in the last year, I have administered weight-based medications to a pediatric patient (age &lt; 18)</p>	<p>A grouped bar chart comparing 'Pre' (grey) and 'Post' (black) survey responses for the frequency of administering weight-based medications to pediatric patients. The x-axis categories are LESS THAN EVERY 3 MONTHS, EVERY 3 MONTHS, ONCE A MONTH, and WEEKLY. The y-axis represents percentage.</p> <table border="1"> <thead> <tr> <th>Frequency</th> <th>Pre (%)</th> <th>Post (%)</th> </tr> </thead> <tbody> <tr> <td>LESS THAN EVERY 3 MONTHS</td> <td>75%</td> <td>70%</td> </tr> <tr> <td>EVERY 3 MONTHS</td> <td>15%</td> <td>19%</td> </tr> <tr> <td>ONCE A MONTH</td> <td>11%</td> <td>10%</td> </tr> <tr> <td>WEEKLY</td> <td>0%</td> <td>0%</td> </tr> </tbody> </table>	Frequency	Pre (%)	Post (%)	LESS THAN EVERY 3 MONTHS	75%	70%	EVERY 3 MONTHS	15%	19%	ONCE A MONTH	11%	10%	WEEKLY	0%	0%
Frequency	Pre (%)	Post (%)														
LESS THAN EVERY 3 MONTHS	75%	70%														
EVERY 3 MONTHS	15%	19%														
ONCE A MONTH	11%	10%														
WEEKLY	0%	0%														

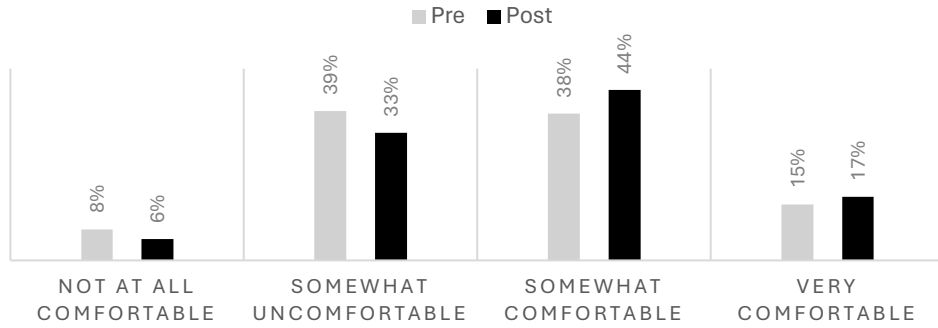
## EMS Clinician Comfort

### Patients < 1 Year

Overall Comfort

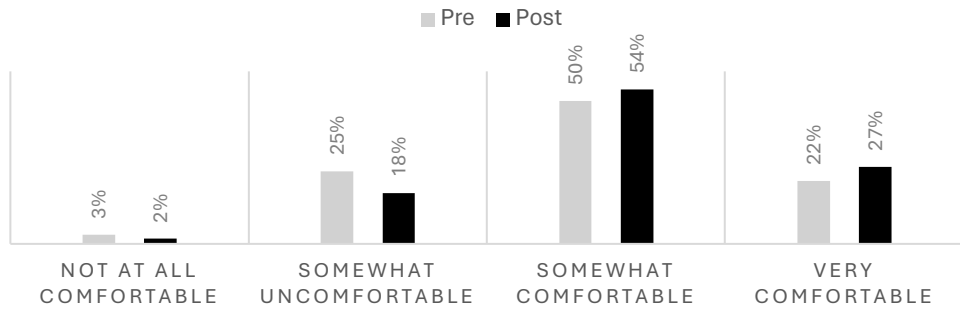


Medication Administration

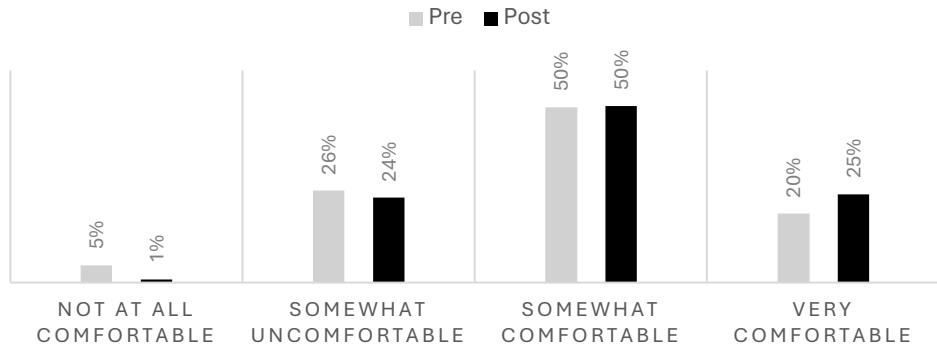


### Patients 1-3 years

Overall Comfort

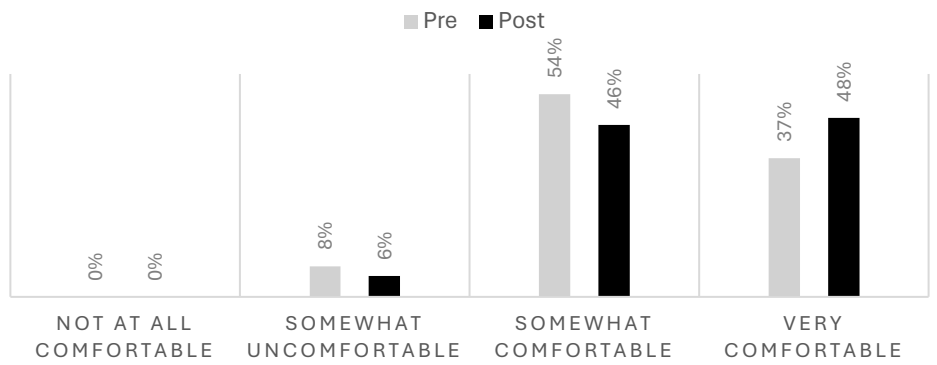


Medication Administration

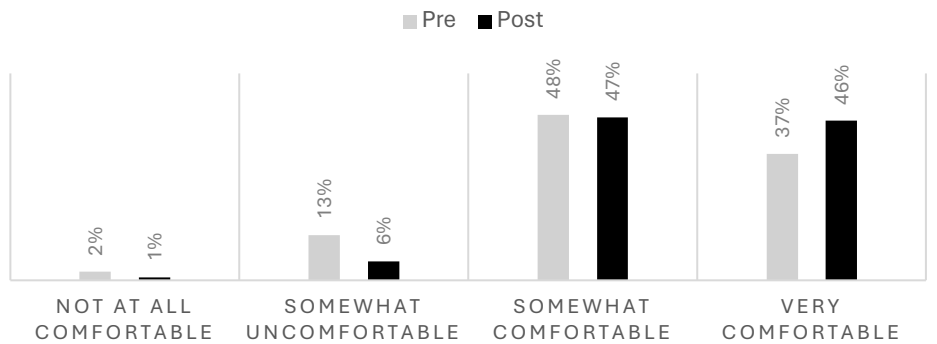


Patients 4-10 years

Overall Comfort

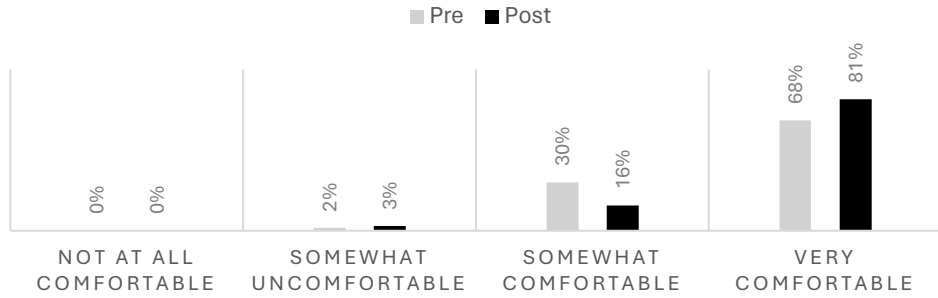


Medication Administration

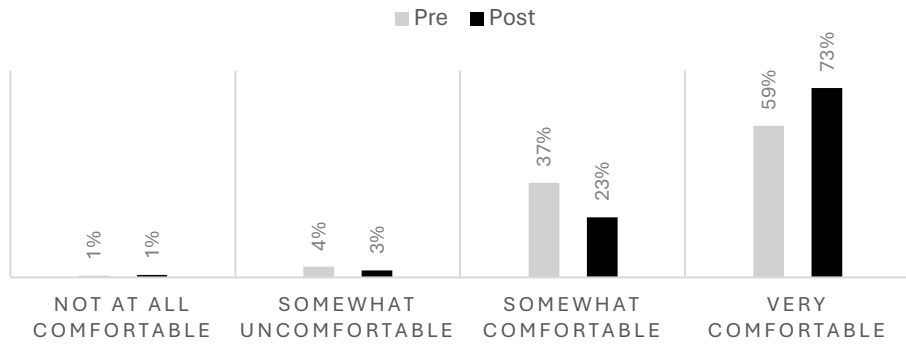


**Pediatric Patients > 11 years**

**Overall Comfort**

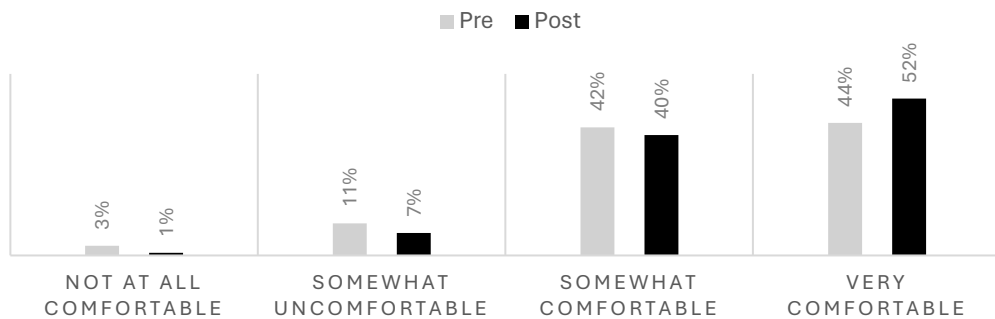


**Medication Administration**

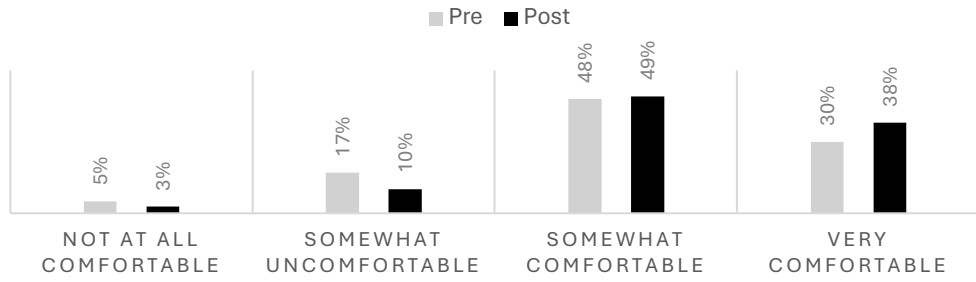


**Medication Classes/Indications**

**Benzodiazepines for pediatric seizure?**

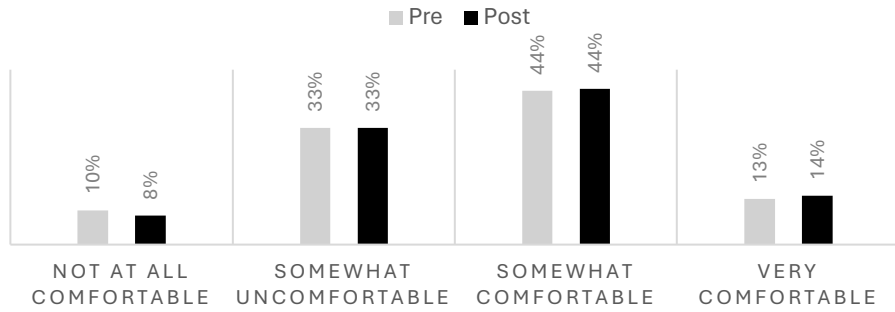


Pediatric pain protocol to give children analgesics?



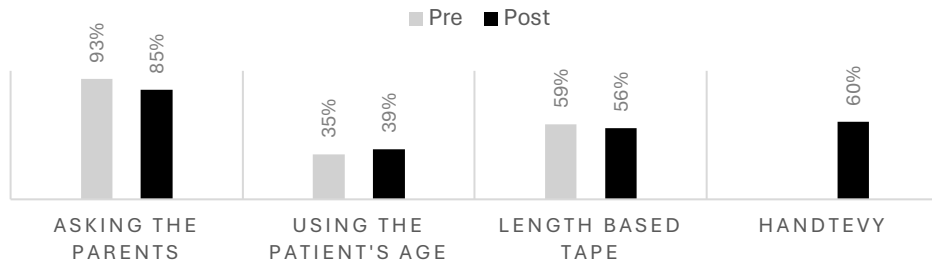
**By Acuity**

What is your overall comfort level with critically ill pediatric patients?

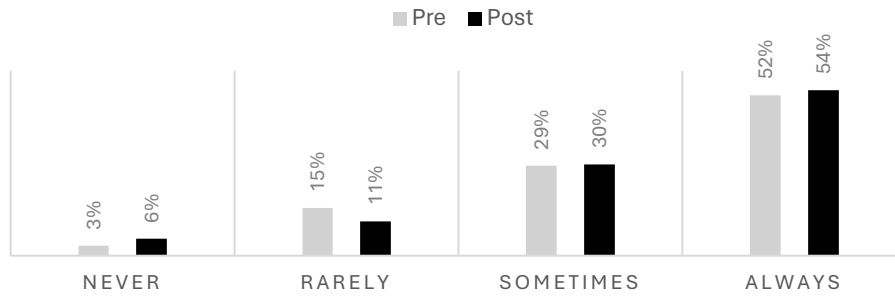


## Weight Estimation and Drug Calculations

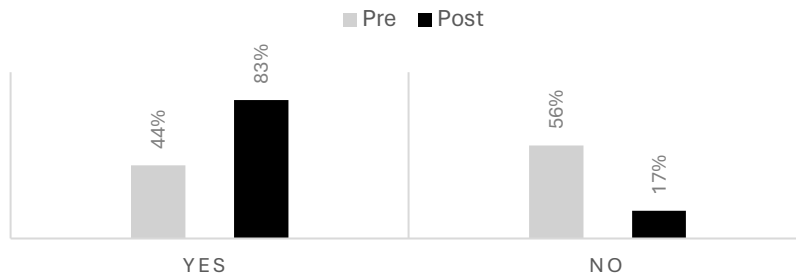
In the last year, I have estimated a pediatric patient's weight by: (check all that apply)



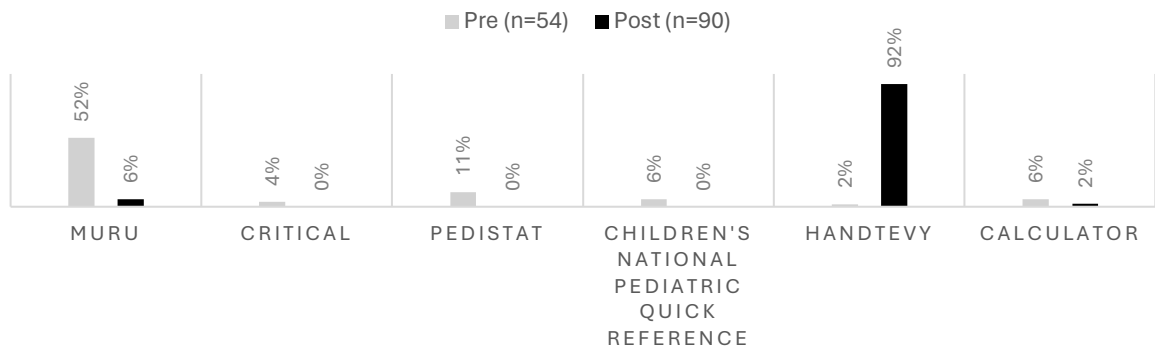
When caring for a critically ill pediatric patient, how often do you use length-based tape?



Do you currently use an application to aid in drug calculations?



If Yes (Use an App), Which App?



## HANDTEVY USAGE

**I Have access to the Handtevy Application.**

	n	%
No	4	4%
Yes	104	96%

**If YES, then:**

**I received the following training for Handtevy App Use:**

	n	%
Asynchronous only	19	18%
Hands On only	22	21%
Asynchronous & Hands On	60	58%
No training at all	4	4%
Total	104	

**I have used the Handtevy application during a clinical encounter, involving a PEDIATRIC (age < 18 yo) patient for drug dosage calculations:**

	n	%
Never	17	16%
Rarely	46	44%
At least once a month	37	36%
At least once a week	4	4%
At least once per shift	0	0%

**I have used the Handtevy application during a clinical encounter, involving an ADULT patient for drug dosage calculations:**

	n	%
Never	32	31%
Rarely	22	21%
At least once a month	34	33%
At least once a week	14	13%
At least once per shift	2	2%
Total	104	

**I have used the Handtevy application during a clinical encounter, involving a PEDIATRIC (age < 18 yo) patient to reference a protocol:**

	n	%
Never	33	32%
Rarely	37	36%
At least once a month	30	29%
At least once a week	4	4%
At least once per shift	0	0%
Total	104	

**I have used the Handtevy application during a clinical encounter, involving an ADULT patient to reference a protocol:**

	n	%
Never	40	38%
Rarely	23	22%
At least once a month	26	25%
At least once a week	13	13%
At least once per shift	2	2%
Total	104	

**I have used the Handtevy application for assistance in running a cardiac arrest (e.g. metronome use):**

	n	%
Yes	19	18%
No	59	57%
N/A (have not had a cardiac arrest)	26	25%
	104	

**If yes, how many times?**

# of times	Responses
1	5
2	4
3	4
4	3
5	2
6	1
TOTAL	19



APPENDIX E: Pre- and Post- Free Text Responses to “What are the barriers to safe pediatric medication dosing in our system?”

**PRE-IMPLEMENTATION SURVEY RESPONSES:**

Low frequency procedure, few training opportunities, little to no access to simulation training at most agencies. Overall it doesn't seem to be a priority among agency leaders
Lack of required annual refresher training, lack of required simulation training.
Inability to accurately estimate weight for dosing and inconsistent metabolism and/or absorption of medications across pediatric patients.
Consistency in evaluating patient weight, accessibility to and use of dosing calculation tools, frequency with which we see and care for routine and critically ill pediatric patients.
Broslow tapes have differing medication dosing than our NCP. I also feel another barrier is comfortability. Due to low frequency critically ill pediatric pt's provider's get very anxious and make mistakes. Also, I know not all provider's are utilizing medication cross checks.
1) Lack of a uniform standard. Sure there's protocols, but every agency keeps their meds in a different place, there might be different concentrations, there are different incarnations of length-based tapes, different apps... I could go on and on. 2) Inexperience - providers RARELY use weight based meds in peds 3) people can't do math anymore, even with an app.
Infrequently used
Lack of some of our medications that we carry in the field being on the length based tape
Lack of training, lack of Pt call volume within this demographic compared to the number of adult Pt's that we see.
not being allowed to give meds to pediatrics. rarely are we given approval to give meds outside of a Cardiac arrest or asthma.
Needing to pay attention to patient's condition, signs, symptoms, vitals NYS protocols are only on Muru and I haven't downloaded it yet due to multiple steps required
Having to convert to kg and do it all in a specific timeframe
ongoing education due to lack of frequency.
It is a fairly low frequency skill without as much training as there should be.
Ensure a tape (not pad wheel) in all gear Ensure a printed weight based med chart for all ped meds
Safe ways to draw up 1:10,000 epi on a code
A reliable length based dosage tape that doesn't get lost or worn down over time. As well as costs an fair amount of dollars.
Having to dose in high stress situations with parents and onlookers causing more scene chaos.
The meds are usually mg/kg but then you need to covert it to mls to draw up and admin
I don't know if it is really a safety barrier but a barrier in general is the attitude that is sometimes received in the peds ED when you have brought a pediatric pt in and tell them that you have given medications.
confirm dose, age, weight, allergies use length based tape confirm medication. expiration, and dose out loud

Length based tape not always matching with the medications we carry and not always the same concentration. Not having a "cheat sheet" for all potential medications used for Peds with dose/weight
-lack of daily familiarity that we have with adult meds -lower frequency/higher acuity/higher anxiety when meds ARE required
Assuring a double check is completed Med Math Anxiety (both with sick kids and parents watching)
Lack of high fidelity simulation training, providers feeling less prideful/knowledgeable when using reference materials, lack of reference materials designed specifically for EMS.
The barriers that I encounter with medication dosing in our system is that I don't encounter many pediatric patients.
Need universal use of tape and calculation tables
I don't think there are any barriers. We have tools, specifically length-based tape, that, if used and used properly, will allow for safe dosing. Are there better tools than length-based tape? Probably; and I wouldn't mind adopting those as they should only help us provide more accurate pediatric dosing.
Accurate knowledge of the patient's weight. The math is relatively easy
Carelessness
Inaccurate weights and conversions between measurement systems.
Not enough education
Lack of education
just not done often enough
that it's not a heavily used practice, there are not many scenarios that are more stressful than a critically ill Pediatric patient.
Obtaining an accurate weight. Outside of placing a pediatric on a scale, asking a parent or using a Braslow's tape is very subjective.
different sources with different dosing.
Not having good information on weight of a patient
Knowledge
Other than comfort and familiarity with pediatrics in general, there is different equipment and concentrations of medications between agencies, and the lack of consistent equipment at some agencies (3 way stop cock). A consistent process across ALL agencies would help to overcome some of the problems.
Low frequency of pediatric calls
Man power of the pt is critical there and only one paramedic and 15 things to do plus calculations
Proper weights and accurate history reported by caregivers
Experience, frequency of pediatric patient care, consistency of equipment and medications, consistency in organizational culture.
Infrequent experiences with pediatric patients. Disorganized trainings within agencies.
Getting an accurate weight, especially with obese pt's, where I suspect the Broselow tape underestimates pt weight, calculating drug dosing when under stress, medics being unfamiliar with standard weight-based dosages in protocols and infrequency of pediatric calls that require med administration

Double and triple checking drug dosages. Dealing with parents and explaining in simple terms what my plan of care is. Remembering different treatments for adults vs. peds.

I do not feel there is a standardized method for doing this, discussions / direction regarding the care of pediatrics pre-hospital certainly has been provided, but the rarity of these encounters makes it difficult to retain the information learned and be able to apply it.

Barriers to safe pediatric dosing is irregular use/ practice of Broselow Tape by EMS and Fire. Limited education and clinical SIM rounds. Lack of pediatric calls. Lack of pediatric clinical offered in Paramedic school.

Variations in weight dosing based on protocols versus length-based tape versus national standards, lack of certain medications on "standard" length based tapes, inability to adjust to medication shortages or substitutions as a result of shortages or changes in protocol, variations due to use of ML/CC dosing versus MG dosing and varying concentrations of drug available.

No good tools (apps)

Limited interactions with this population, even more limited training opportunities.

Not having easy access to tools to help calculate dosages properly

Protocols don't always align with Pedi-mate or medications needed are not on them. Protocols change which then don't line with pediatric tools.

changes in concentrations

Lack of training. Most providers go through PALS once every couple years and otherwise have no further pediatric exposure.

Lack of practice and exposure

Medics comfort of providing the care.... Take time to do it right but when you have a very short transport people rush or don't sit on scene to give them correct care

Not used enough

Calculating dosages in critical Moments due to the rarity of severely sick pediatric patients

Lack of exposure, as a whole EMS sees much fewer pediatric patients than adults. This results in a lack of exposure and ability to practice skills in the field.

Lack of reference material other than Broslo tape

quick access to weight and dosage levels in high acuity/low frequency patients

having to estimate weight and parent reactions to their child receiving medications

The barriers to safe pediatric medication dosing in our system revolves around generalized overall satisfaction in access to continuing education, quarterly simulation, access to pediatric experts, and hands on training with equipment.

Weight estimations and correct dosing when it differs from adult dosing protocols.

Lack of skilled providers on a scene to provide double check of dosing

## POST-IMPLEMENTATION SURVEY RESPONSES:

Remembering to use the Handtevy app.
low frequency results in agencies being more hesitant to stocking pediatric predose medications or pediatric concentration vials so we often have paramedics who have to rely on med math that an average road crew may not use as often as say an SCT, RSI, or acute care tech does. This seems to be a contributing factor to the dosing errors, or hesitation to administer medications. If there were money available through grant or regional/state donations of medications, I feel agencies would be more likely to buy, use and stock Ped dosed medications and train on them to be more comfortable and less hesitant to administer to all ages.
Right drug, right patient, right age and to not panic
I haven't found any yet
Several exist. 1- language 2- beliefs in modern day medicine of the parents. 3- calculating appropriate dose of weight based medications. 4- good and thorough history taking. 5 - the 5 rights of medication administrations.
exposure
Low occurrence
Getting accurate weights. Even the Handtevy tape and app frequently give inaccurate dosages compared to what the patient actually weighed at the ED.
Lack of critical care experience because most calls are nonsense. Inability to do basic math. Inability to control emotions. Overconfidence. There are very few emergent pediatric drugs, A laminated dosage chart would probably be simpler and take less time away from monitoring patients than a phone app.
Lack of familiarity and practice.
Knowing accurate weight, fear.
Have more pediatric based classes and cmes
My level of comfort is low with pediatric medications because I rarely have the opportunity to administer them. Super low frequency with high probability of error adds to that stress.
Assuring the medication concentrations are all the same
Handtevy. Once again, not a streamlined app. The way the medication doses are written is confusing. I could see a medication error happening easier with the handtevy app.
We just don't deal with PED patients that frequently..use it or lose it, as they say. It is extremely intimidating trying to do ped drug calculations when ped patients are very few and far between and we don't practice those drug calcs/actually drawing up the med that often.
None
Not being able to change the concentration to match the ones we have in stock on the rig. I know we try to match the app to what we have in stock but with recent shortages of medications, the concentrations can vary in our meds. I think this would add an additional level of safe medication administration
There are not a lot of peds encounters to get practice.
We do not spend enough time training our paramedics on medication calculation and administration.
Stress.
Frequency, comfortability.
Lack of frequency treating very ill pediatric patients and lack of sufficient review and practice at the agency level

1) Lack of provider experience 2) Single paramedic units (no knowledgeable person available for cross-check, a basic EMT two months out of "academy EMT training" is not useful)
I believe we could benefit from more pediatric simulated scenarios, and more hands on practice with skills such as using the stop-cock for epi dosing.
Stress at the scene can lead to mistakes/ trying to move too fast. Most medications are weight based/ obtaining that prior to the app with the length based tape was more difficult especially if the medication needed wasn't listed on the tape.
low frequency of encounters, not a lot of training in the county
overworked, fatigue.
No barriers in my practice
Conversions
Lack of high fidelity training
Not having an actual scale for an accurate weight.
Check double check meds/dosage / Use tape
None
inability to guesstimate weight, no easy way to verify
Well lack of folks using the hand tevy app otherwise I'd say ignorance by the provider not using the tools at their disposal
Single provider care during transports limits the ability to double check dosing with a second provider. This barrier of course isn't specific to our system though.
Infrequency use of the skill, infrequency of exposure to pediatric patients, and lack of availability of pediatric-specific education.
Not having medication infusion pumps.
Right patient, right drug, right weight, right calculation
Lack of opportunity
Lack of exposure to pediatric patients and lack of competency among providers due to lack of pediatric focused pharmacokinetic studies and training and lack of hands on scenario based training in real time with real (expired versions) medications.
Fear due to low amount of critical pediatric calls
Either a lack of sick kids, or failure to realize how sick a kid really is.
all of the medications carried were not in Handtevy
Lack of exposure/practice.
Minimal due accessibility of handtevy app
Lack of repetition, very low amount of pediatric calls
Relying on to much technology. People should learn and use math, during critical situations. Technology should be a back up . We have a lot of tech we use to care for patients, adding more, instead of teaching and learning basic algebra, seem an easy way out.
Poor compliance with crosscheck. Poor understanding of crosscheck among BLS providers.
guessing yourself at the time of emergency
Low frequency

## APPENDIX F: HANDTEVY APPLICATION FEEDBACK

no
Need more adult weights
Add more weights for adults please, also being able to select between IBW and TBW, For the cardiac arrest "submit" option, can a feature be added to submit that to our email or "export as attachment to charts" similar to a monitor upload? I have only used that feature 1 time and at the end the person using the app submitted the data thinking it would give an email option or something so we ended up having to rely on hand written times anyway. Can we also please stop changing protocol apps every 2-3 years. This seems to be a good one, so lets stick to it and build on it or take features and build them into a better priced app if thats the issue.
no
This is an app that all providers should have. It provides an additional level of comfort when providing care to peds and is easy to know what dose and what amount (ml) of medications to administer. Just having this app has made me a lot more comfortable responding to pediatric calls. This is also a fantastic resource for running adult cardiac arrests.
It seems like a good app to use and utilize
No
I love using this for all pediatric patients even if I do not administer a medication. I like to prepare and love using the app to "request" medications that I might need.
not at this time, it is a usefull tool. I am very confident and keep up with current events and pharm to be comfortable with adults I have occasional pediatric contacts maybe 1-2 less than 11 y/o in a months time and most do not require medication administrations therefore have not had need to use app up to this point. I do take comfort knowing that I have this tool in my reach if every needed.
are the protocols actually in there or just the medications for that protocol?
No
Would love to see drip rate calculations (similar to Muru).
no
No
no
I have grave reservations in using ANY phone app in the process of treating a critical patient. As a reference, yes; as an ongoing tool that I need to interact with in order to record data during a critical incident, no. I think that there are too many steps one needs do in order to record all data correctly. Granted, on the surface it seems seductively wonderful to push one button and have ALL the data load, including meds, routes, times, and dosages loaded in. I'm afraid that the paramedic would spend more time fiddling with the phone and less time with the pt. Also, you must get EVERY data point entered correctly, or the trustworthiness of the whole data dump is flawed.
So far just browsing through it it looks really useful. Haven't had much need to use it so far, but definitely will be relying on it heavily in the future
It is a good app and system for reducing potential errors.
Best app we have ever used. Muru is awful
Difficult to change update information bc they defer to Mlrems people
Good tool!

I don't use it for adults because the weight options are static. I also find it a little clunky to get to the protocols so I utilize Muru for Protocols and Handtevy for dosing of pediatrics.
Once creating a patient profile and in the app, if you "swipe back" (to return to a previous page), the app asks if you want to exit the app. Rather that, have it bring you back to the set up patient profile page with the choice for adult/peds
No feedback at this time - need more experience before I could offer constructive suggestions.
Curious if for drips we can have an option for use of both a 250 bag and a 100mL bag.
haven't seen any benefit to it over Muru or regular dose calculators. Unless you are very familiar with the app it is very confusing to use and has a lot of steps to get to the page of the protocols PDF you need to be. There are a lot less steps to get to the same page on the PDF with other apps.
I really like it! It is helpful!! - though I wish there were some more adult ideal body weight options...
Make other, most common, intervention "markers" more easily accessible for cardiac arrest.
Very useful!
No
No, overall the system is very easy to use and helps take the stress out of medication dosage
It would be helpful to have more weight options for adults.
no feedback
None
used it for drug dosing of a 9 month old. easy to use. works great.
No
none
I have very much liked the application. It makes dosing and drip rates so much easier to do and much safer.
expand the weight options for adult patients
no
no
I think the ketamine dosing sections need to be changed. Way too many chances for error with all the different dosing options right next to eachother.
No
I can't stress this enough: IT IS NOT ACCEPTABLE TO ONLY LIST VOLUME IN FINAL DOSING CALCULATIONS. This app does not save me any time when I still need reverse-engineer the dose for crosscheck. This app has concentration errors and even though it is a good start it is not reliable enough. I am using it less for medication administration once I discovered this problem. Overall, it's a great app if this could be fixed.
I haven't had the opportunity to use it on a pediatric call.
No
nice app to have and use on my phone
No

I like it. I think it makes drug calcs much easier, and frees up brainpower as a result.
No
It's great.
I very much like Handtevy, it is very useful tool and reference aid in the EMS field. IT is very user friendly and easy to use.
Needs more robust adult dosing besides just patients who are 75 and 100kg. I realize it was originally made for peds, but I'm thinking most providers rarely see peds patients and even more rarely actually give them weight based meds. The way to get providers comfortable/experienced with Handtevy is for them to use it every day so it becomes automatic in a critical situation. That's only going to happen if we can use it on adults without feeling like we're shoehorning them into the 75 or 100kg category.
None
The Handtevy application is a very useful tool, and has improved my comfort with pediatric patients. I would prefer if there was a wider range of adult weights than just 75 kg and 100 kg.
Makes med calculations simple. Is helpful to reference under stress.
add easy access to the nys protocols, fix the metronome,
n/a
Valuable tool
Fairly easy to use once you understand how to navigate it but some of the functionality is not intuitive such as clicking Edit to see all of the dosing information.
I like this app during training however I have not used it on a call due to my infrequency of pediatric patients.
No feed back at this time
None at this time.
No
No
Great application
I think its very helpful running cardiac arrests and when faced with the rare critical pediatric patient to assist with weight based calculations
More weight selections in the adult range
IMO the Handtevy app is essential in ensuring appropriate dose calculations and appropriate use of protocols for all patients, particularly pediatrics. It is particularly useful to someone such as myself who's primary organizational role isn't clinical in nature and as such, my frequency of encounters with critical pediatric patients is extremely infrequent at best. As such, this resource is almost absolutely necessary.
Easy to use
None at this time
I like the handtevy application a lot. I have had issues with the app crashing when attempting to open it. Other than that no issues.
n/a
Not as user friendly and easy to navigate or understand as Muru. Appears out dated and not as easy to get to what you need.
No feedback



I would like to see more weight options for adults
n/a
Very helpful
It's a useful tool to have.
No
Just downloaded last week.
no
Haven't had many situations to really use it, but getting more used to it as times goes on
I think it is unprofessional on our part to have our cell phones in our possession while dealing with patients. Regardless of what we're using it for, it is not a good look during patient care. I also don't like that I have to use my personal device on calls for work based data collection which can potentially leave a foot print on my personal device opening me up for potential liability during discovery purposes. I feel that applications have limitations while on calls and as noted with the adult weight in Handtevy having only 2 weights with the general population far exceeding those weights. I also have noticed some contradictions between the Handtevy and Muru apps in terms of medications to be administered to pediatrics.
Great asset for the system and our providers
love the app
It's better than most. Please be consistent with updates to the platform.
Seems like a decent tool so far.
I think this is a very good application and is very useful
struggled to pull up protocols so I ended up using Muru to access the protocol.
I enjoy using this app. It replaced another PEDs app I had been using before.
Fantastic tool that all providers should have, and there is no excuse for them not to.
standardizing medication concentrations regionally would allow one option per drug rather than multiple concentrations to choose from
No
Great app and easy to use
Modifiable weight adjuster
Works great! Super helpful!
No
None at this time
no
No
None at this time
Super easy to use
More adult weights, easier access to protocols, medications with multiple uses need to be separated differently.



## MEDICATION DOSING SAFETY FOR PEDIATRIC PATIENTS

### BACKGROUND/PURPOSE

Prehospital medication dosing errors in pediatric patients are a common occurrence, including in our own region. Dosing errors are the result of multiple causes that include infrequent exposure to pediatric patients and complex calculations for weight-based dosing performed in a stressful environment. Evidence-based best practices for pediatric medication dosing have been developed in order to reduce the incidence of pediatric medication errors in the prehospital environment that include the following:

1. **Confirm patient weight at the time care is delivered** (should be done for all pediatric patients). Methods to confirm patient weight include asking the parent, using a length-based tape, or by age (least accurate).
2. **Use kilograms as the standard of weight used.** Precalculated tools should be used to convert from pounds (lbs) to kilograms (kgs).
3. **Use tools that provide pre-calculated weight-based dosing with reported doses in mL** that can be modified quickly when drug shortages force substitutions.
4. **Increase opportunities for EMS clinicians to practice performing weight based dosing,** utilizing the tools and equipment that they would actually use in the field.

The purpose of this policy is to reduce medication dosing errors in our region by implementing these best-practices. While they are focused on pediatric medication dosing errors, the same principles apply to all patients. This clinical guideline is intended to be used in conjunction with the Medication Cross check process outlined in Advisory 21-04.

### CLINICAL GUIDELINE

Indications: This clinical guideline is intended to be used for all pediatric patients, regardless of whether a medication is administered.

Weight estimation: As part of initial patient assessment, pediatric patient weight should be determined and recorded in kilograms for all patients. Patient weight may be obtained preferably by asking parents or determining through the use of a length-based tape. Less preferably, it may be estimated by the age. A reference tool should be available to convert lbs to kg without need for calculation, especially in circumstances where patient weight is determined by asking parents who are most likely to give this information in lbs. We recommend storing the Length-based tape in a location where it will be available as part of the initial assessment of all pediatric patients.

Volume-based dosing reference: A volume-based dosing reference, which provides the appropriate dose in ml to be administered based on drug concentration, should be used for medication-dosing to avoid calculation errors that otherwise inevitably occur during the course of patient care. Such a volume-based dosing tool should be rapidly changeable in context of change in medication concentration due to drug shortages. We encourage the use of such a tool for all patients, including adults, to help clinicians become more facile and familiar with the tool through more frequent use as well as reducing the chance of a medication dosing error across all age groups.

Medication Cross-Check: We strongly encourage the use of a medication cross-check process with each medication administration for all patients, including pediatrics. The volume-based dosing reference can be used as an adjunct during this process.



Hands-on simulation and competency assessment: All EMS clinicians responsible for the administration of pediatric medications should undergo training and competency assessment in determining patient weight (including the use of length-based tape), use of volume-based dosing reference and medication cross-check performance.

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