Assessing Medication Error Rates in Pediatrics Pre and Post Implementation of the Handtevy App within the San Antonio Fire Department

Bailey Cooper
University of Nebraska Medical Center

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Assessing medication error rates in pediatrics pre and post implementation of the Handtevy app within the San Antonio Fire Department.

Bailey Cooper, BS, December 3, 2018.
Abstract

Goal: The goal of this project was to determine if the implementation of the Handtevy app reduced medication error rates on calls run by the San Antonio Fire Department in the pediatric population with a diagnosis involving pain management or seizure.

Background: Prior to the implementation of the Handtevy app, first responders used a tool called the Broselow tape to estimate a child’s weight and to determine the appropriate medication dose. Run reports were analyzed prior to the implementation of the Handtevy pediatric standard to determine medication error rates for Fentanyl and Versed in pediatric patients 13 years or younger. Run reports were also analyzed after the implementation of the Handtevy app to determine medication error rates for Fentanyl and Versed in pediatric patients 13 years or younger. Medication error rates were compared pre and post Handtevy app implementation to determine if there was a difference.

Methods: This was a retrospective study comparing a 3-month time period prior to the deployment of the Handtevy pediatric standard with a 3-month time period following full implementation of Handtevy. The dates of data being used were calls run from January 1, 2016 through March 31, 2016 and January 1, 2018 through March 31, 2018. 2017 was the implementation period. A call was defined as any response where the San Antonio Fire Department treated a pediatric patient for pain or seizure. No intervention was implemented in this study and no in-person recruitment of subjects was needed. SAFD electronic medical records were collected from the Southwest Texas Regional Advisory Council (STRAC) database. Data extraction begun by selecting all SAFD EMS run reports in the STRAC region involving pain management or a seizure within the time period of January 1, 2016 through March 31, 2016 and January 1, 2018 through March 31, 2018. Eligibility criteria included: children 13 years or younger treated by the San Antonio Fire Department. Children not treated for pain or seizure or children over the age of 13 and adults were excluded from data collection and analysis.

Impact: Cumulative medication error rates decreased from 83% in Q1 2016 to 44.4% in Q1 2018 and medication usage increased by 58% from 2016 to 2018. This could be due to the increase in patients seen in 2018 versus 2016. This study revealed a disproportionate use of narcotics to reported pain in children and in turn may promote more frequent use of narcotics in children with the use of the Handtevy app in the future. The results of this study could also potentially encourage the shift from using the Broseloe Tape for weight estimation leading to medication dosage calculations to using only the Handtevy app to provide predetermined medication dosages.
Introduction

The San Antonio Fire Department (SAFD) was founded in 1891. Today, SAFD protects approximately 1.4 million residents and visitors each day, with an annual EMS call volume of approximately 160,000. Their motto is “Our Family, Protecting Your Family.” The Office of the Medical Director, housed within The University of Texas Health Science Center San Antonio’s Department of Emergency Health Sciences is contracted by SAFD. The Office of the Medical Director provides “initial and continuing EMS education, QA and Performance Improvement, and online and offline medical control for the San Antonio Fire Department.”

One issue many people outside of emergency medicine may be unaware of is medication error rates in children in the prehospital setting. First responders have difficulty with administering pediatric medications due to the constant need for conversions based on the child’s weight, which is not always readily available in the field. The problem addressed in this project was whether the implementation of the Handtevy app within the San Antonio Fire Department decreased medication error rates in pediatric calls with a diagnosis involving pain management or seizure. Investigators chose the diagnoses of pain management and seizure treated by Fentanyl and Versed, respectively, for this study because they are the two most commonly used drugs in pediatric calls within SAFD. Fentanyl and Versed cause concern within EMS personnel due to the potential for toxicity in children. This concern leads to the drugs being underutilized and results in under treatment for children with diagnoses involving pain management or seizure. Both Fentanyl and Versed are tracked by the Drug Enforcement Agency (DEA) and are used within the San Antonio Fire Department for protocol compliance tracking. Due to these tracking measures, it is important for paramedics to be administering the correct dose. The hypothesis of this project was that the implementation of the Handtevy app reduced medication error rates within the San Antonio Fire Department, specifically in children 13 years of age or younger who received Fentanyl or Versed for pain management or a seizure.

Literature Review

The most popular tool used for pediatric weight estimation in the field is a tool called the Broselow Tape. The Broselow Tape is an estimator of weight based on the patient’s height and provides equipment sizes and medication dosages based on the corresponding “reference bar.” Pediatric medications require calculations for medication administration because each medication has a different dose per kilogram of a child’s weight. There has been concern that the Broselow Tape may not be providing accurate weight estimation, resulting in the administration of inaccurate medication doses. A study published in 2011 out of Ottowa, Canada found that the Broselow Tape was not always accurate in estimating the child’s weight and that it “underestimated their weight almost half of the time (Bourdeau, Copeland, Milne, 2011).” Another study published in 2012 out of Los Angeles County compared Broselow Tape weight estimations to the patient’s weight on the scale in the emergency department and found that the “Broselow weight correlates well with scale weight (Heyming, Bosson, Kurobe, Kaji, Gausche-Hill, 2012),” meaning they found that the Broselow Tape did agree with the weight found on the scale. Based on these two studies there does not appear to be a general consensus on the accuracy of weight estimation using the Broselow Tape. Dr. Peter Antevy is a Pediatric Emergency Medicine Physician at Joe DiMaggio Children’s Hospital in Florida. He is also the EMS Medical Director for numerous Florida based fire departments as well as Associate Medical Director for three other fire departments in that same area. With his knowledge and expertise in the pediatric
pre-hospital setting, he designed a mobile application called Handtevy, which is a competitor of the Broselow Tape and could become the standard for pediatric care in the prehospital setting. Handtevy delivers a “customized, predetermined approach to the critically ill child (www.handtevy.com),” which is built based on a department’s specific protocol. This app allows first responders to deliver customized care based solely on age and a child’s ideal weight at that age, which negates the need for any calculations in the field. First responders simply find the medication and follow the recommended dose in the app. The importance of this project is to determine if the Handtevy app reduces medication error rates by negating the need for the patient’s weight and using only the patient’s age. If it is found that the Handtevy app does reduce medication error rates, then it could lead to the discontinuation of a controversial tool such as the Broselow tape.

Along with the concern for medication errors in pediatrics, a second concern of pediatrics in the prehospital setting is the under treatment of pain. A study published in 2015 out of Alberta, Canada, states that “despite evidence that a child’s experience of pain is comparable to that of an adult, children’s pain remains disproportionately undertreated (Rahman, Curtis, DeBruyne, Sookram, Thomson, Lutz, Ali, 2015).” The most common barriers their EMS personnel gave for undertreatment of a child’s pain was limited clinical experience, difficulty communicating with the child, and the inability to properly assess a child’s pain. Dosing errors were listed in the top three fears of not treating pain in children. In another study of 310 children, approximately two-thirds of pediatric patients with extremity injuries did not receive any pain medication prior to arriving to the hospital (Rogovik, Goldman, 2007). Another study revealed that children under 5 years of age with limb fractures or burns did not receive prehospital analgesia (Watkins, 2006). Lastly, in a retrospective chart review of 696 children with reports of trauma, “there were no documented pain interventions by EMS providers for 86.6% of all patients, including the 85% with documented pain (Izsak, Moore, Stringfellow, Oswanski, Lindstrom, Stombaugh, 2008).” The results from these studies show that there is a significant need for first responders to feel more comfortable in treating children with pain. Along with improving medication error rates, another goal of this project was to determine if under treatment rates for children with pain is of concern within the SAFD.

**Research Methods**

This was a balanced retrospective study using quarter one (Q-1) 2016 and Q-1 2018 as the time intervals with 2017 being the wash-in period of Handtevy deployment. The source population was all eligible children under the age of 13 within the SAFD responding district. Eligibility criteria for the analytic sample included: all children 13 years of age or younger treated by the San Antonio Fire Department for pain management or a seizure with Fentanyl or Versed. The anticipated sample size was 300 run reports, with 150 from the first quarter of 2016 and 150 from the first quarter of 2018. A run report is generated for every call that the fire department responds to and is a summary of the call from start to finish no matter if an intervention was provided. Only run reports that met all inclusion criteria were analyzed. The actual sample size was 39 eligible run reports from Q-1 2016 and 57 eligible run reports from Q-l 2018 for a total of 96 run reports. The reason for the sample size being much smaller than originally anticipated was unable to be determined. The children included in the two samples were all different. One patient included in the study was responded to twice by different paramedics, but both responses were within the same year. Many patients received multiple
doses of a medication, which gave a total of 132 medication administrations for the analysis. 51 of these medication administrations were from 2016 while 81 were from 2018 for a total of 132.

Data were collected from the Southwest Texas Regional Advisory Council (STRAC) database. The data set is owned by the San Antonio Fire Department but is stored within STRAC. Data extraction began by selecting all SAFD EMS run reports involving pain management or seizure management within the time period of January 1, 2016 through March 31, 2016 and January 1, 2018 through March 31, 2018. Then, EMR’s were filtered for children 13 years or younger. If a child had been responded to multiple times within the data collection period by the same medic, only the run report from the first response was included in the study. If a child had been responded to multiple times within the data collection period but by different medics, each run report was included in the total sample. By only including the first call run by the same medic lessened the concern that the medic calculated medication doses were based on memory. This specific time period was chosen because it includes three months of data collection the year prior to the app implementation in January 2017, and it seasonally balances the two-study period. It also allowed for a year of training for EMS personnel using the new app prior to the post data being collected. Variables collected included time dispatched, time at patient, zip code, patient age, chief complaint, source of pain, pre and post vital signs (heart rate, blood pressure, respiration rate, SPO2, EtCO2), pre and post pain level, medication provided, time of administration, medication route, dose given, and percent medication error. The percent medication error was calculated based on the dose given compared to the dose specified by Handtevy if it was determined that a medication error had occurred. This percentage was negative if it was an under dose and positive if it was an overdose. SAS University Edition programming version 9.4 was used to analyze the data.

Project team members had access to the 18 HIPAA identifiers when reviewing charts but information that could potentially identify the patient was excluded from all data collected. IRB approval allowed investigators to look at protected health information (PHI) but recording of PHI was not done for the research project. Investigators also had an IRB approved HIPAA waiver to be able to access PHI but not to record it. Ethical considerations for this study included keeping the patient’s information anonymous throughout the analysis. Identifying data was removed by the investigators from the subject’s chart when data was extracted. Subject consent was not needed for this type of study. IRB approval from UT Health Science Center San Antonio was required and the project was completed as a “Human Research Determined Exempt” study. IRB approval from University of Nebraska Medical Center (UNMC) was not be necessary for this project (see Appendix).

Descriptive statistics were used to describe the demographics of the two sample groups. Chi-square analysis was used to test for the difference between medication error rates pre and post Handtevy. Chi-square analyses were also used to test for the difference in medication error rates based on time of call. Time of call was treated as a nominal variable with two categories for analysis. Category 1 includes times from 12:00am to 11:59am, category 2 includes times from 12:00pm to 11:59pm. Due to the potential for multiple vital signs being taken after medication administration, only the post vital signs taken between four and five minutes after medication administration are included. This time-period was chosen for taking post vitals because the peak effect for both drugs is approximately 5 minutes. Multicollinearity was tested for by assessing the correlations between predictor variables using the correlation procedure in SAS. A strong correlation was considered to be 0.8 or higher in the correlation matrix. After reviewing the correlation matrix, multicollinearity continued to be examined through the Variance Inflation
Factor (VIF). A linear regression model output was used to assess VIF. A VIF value greater than 10 is cause for concern of multicollinearity. After analysis, there was no concern for either set of data, 2016 or 2018, of multicollinearity. Multiple logistic regressions were conducted separately for each sample population to examine which predictor variables were significant within each time period. An alpha of 0.05 was used for a reference point but any decrease in medication errors was considered a success even if it did not meet the appropriate alpha.

**Results**

Below is a breakdown of patient age and medication administrations by year. On average, patients were younger in 2018 and there was a significant increase in medication administrations in 2018 when compared to 2016. Table 1.2 provides a visual of medication errors based on age for each of the years. As shown in Table 1.1, the average age of patients receiving Fentanyl is the same for both years but the average age for patients receiving Versed decreased from 2016 to 2018. This could be due to the overall average age of patients in 2018 was 2 years younger than in 2016 meaning the department responded more often to a younger population in 2018.

<table>
<thead>
<tr>
<th></th>
<th>2016</th>
<th>2018</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average patient age (years)</td>
<td>8</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>3.27</td>
<td>4.16</td>
<td></td>
</tr>
<tr>
<td>Average patient age (years)</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>receiving Fentanyl</td>
<td>2.52</td>
<td>2.91</td>
<td></td>
</tr>
<tr>
<td>Average patient age (years)</td>
<td>7</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>receiving Versed</td>
<td>3.26</td>
<td>3.53</td>
<td></td>
</tr>
</tbody>
</table>

**Table 1.1**

<table>
<thead>
<tr>
<th></th>
<th>2016</th>
<th>2018</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Fentanyl</td>
<td>18</td>
<td>28</td>
<td>+56%</td>
</tr>
<tr>
<td>Administrations (all ages included)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Number of Versed</td>
<td>33</td>
<td>53</td>
<td>+60%</td>
</tr>
<tr>
<td>Administrations (all ages included)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Number of Medication</td>
<td>51</td>
<td>81</td>
<td>+58%</td>
</tr>
<tr>
<td>Administrations (all ages included)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 1.2

Medication Errors by Age 2016

<table>
<thead>
<tr>
<th>Medication Error</th>
<th>Patient Age (Years)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td>0</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>8</td>
<td>2</td>
<td>3</td>
<td>10</td>
<td>2</td>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>10</td>
<td>3</td>
<td>4</td>
<td>51</td>
</tr>
<tr>
<td>% of Total</td>
<td></td>
<td>2%</td>
<td>12%</td>
<td>4%</td>
<td>8%</td>
<td>8%</td>
<td>20%</td>
<td>8%</td>
<td>5%</td>
<td>20%</td>
<td>5%</td>
<td>8%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Testing for a difference between medication error rates in 2016 and 2018, the chi-square analysis provided evidence (p-value = 0.0007) that there is a difference in medication error rates pre and post Handtevy implementation. Table 1.3 provides the observed and expected values for medications errors based on each year. After the implementation of the Handtevy app in 2018, it is clear in the table that the department fell below their expected value for medication errors and surpassed their expected value for not having medication errors. This is an improvement from the 2016 results. There was no difference found between time of call and medication error rates.

Table 1.3

<table>
<thead>
<tr>
<th>Medication Error</th>
<th>Year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2016</td>
<td>2018</td>
</tr>
<tr>
<td>Yes</td>
<td>Observed: 29</td>
<td>Expected: 21.13</td>
</tr>
<tr>
<td></td>
<td>Observed: 23</td>
<td>Expected: 30.88</td>
</tr>
<tr>
<td>No</td>
<td>Observed: 10</td>
<td>Expected: 17.88</td>
</tr>
<tr>
<td></td>
<td>Observed: 34</td>
<td>Expected: 26.13</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>57</td>
</tr>
</tbody>
</table>
Findings from data extraction found that in Q1 2016, SAFD had a Fentanyl medication error rate of 72.2% and a Versed medication error rate of 81.9% for a cumulative Q1 2016 medication error rate of 78.4%. In Q1 2018, SAFD had a Fentanyl medication error rate of 42.9% and a Versed medication error rate of 45.3% for a cumulative Q1 2018 medication error rate of 44.4%. Of the medication errors in Q1 2016, 90% were under doses, with 75% being under by 50% or greater. Of the medication errors in Q1 2018, 69.4% were under doses with 52.8% being under by 50% or greater. Medication usage increased by 58% from 2016 to 2018. Even with the increase in usage between the two years, there was still a large decrease in medication errors. Cumulative medication errors rates decreased by 38.6% from 2016 to 2018.

In 2016, for every one-year increase in patient age, the odds of making a medication error increased by 1.22. In 2018, the odds of making a medication error are 1.10 times greater for every one-year increase in patient age. In 2016, if Fentanyl was used, the odds of making a medication error rate was 0.76 and in 2018, the odds decreased to .62. Based on these numbers, the implementation of the Handtevy app appears to have improved the odds of making a medication error. Table 1.4 below, shows the odds of medication error rates for each year based on the time of call.

In 2016, calls run between 12:00 am and 11:59 am, and medications administered intramuscularly had the highest odds of making a medication error. In 2018, calls run between 12:00 am and 11:59 am, and medications administered intranasally had the highest odds of making a medication error. Due to small cell counts, a Fisher’s exact test was used to determine if there was a difference in error rates between medication routes. For 2016, Fisher’s exact test provided a p-value of 0.0444, meaning we can there is an association between at least two of the medication routes. The Fisher’s exact test was followed by pairwise comparisons with a Bonferroni adjustment which revealed that IN and IV were most closely associated with a p-value equal to 0.0829. For 2018, Fisher’s exact test provided a p-value of 0.26, meaning there is not an association between each of the medication routes.

Table 1.4

<table>
<thead>
<tr>
<th>Odds Ratio Estimates</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of Call – 2016</td>
<td></td>
</tr>
<tr>
<td>(using Category 2: 12:00 pm – 23:59 pm as reference)</td>
<td></td>
</tr>
<tr>
<td>Category 1: 00:00 am – 11:59 am</td>
<td>1.68</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Odds Ratio Estimates</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of Call – 2018</td>
<td></td>
</tr>
<tr>
<td>(using Category 2: 12:00 pm – 23:59 pm as reference)</td>
<td></td>
</tr>
<tr>
<td>Category 1: 12:00 am – 5:59 am</td>
<td>2.26</td>
</tr>
</tbody>
</table>

Discussion

The results found in this study support the original hypothesis that the implementation of the Handtevy app reduced medication error rates within the San Antonio Fire Department, specifically in children 13 years of age or younger who received Fentanyl or Versed for pain management or a seizure. There was an increase in medication usage from 2016 to 2018, which could be indicative of under treatment of pain in pediatrics in 2016. After the implementation of the Handtevy app with the SAFD, medication usage in pediatrics with pain or seizures increased,
and medication error rates decreased. This is important because it shows that children received the proper medication doses more often after the Handtevy app was implemented within the department. Accurate dosing is important because it reduces the risk of the child overdosing or being under treated for their specific diagnosis. Further research needs to be conducted on the Handtevy app to determine if it lowers medication error rates for all diagnoses or only specific diagnoses. Research also needs to be conducted to determine the medications with the highest error rate across departments and if implementing the Handtevy app for those specific drugs would lower the error rate.

The limitations of the study include lack of randomization and the inability to generalize the results to the entire pediatric population. Since this is an interrupted time series study design, there could be other factors that contribute to the potential differences in medication error rates such as change in staff over the two-year period of time with potentially more or less experience and increased time for training, not including Handtevy training, from the first sample to the second sample. Upon initial review of the results of this project, it was brought to the attention of the SAFD medical director, that there was an error in their Zoll EPCR (Electronic Patient Care Report) system. It was found that there was no option to enter in manual medication dosage amounts and that paramedics had to select a specified number from a drop-down menu within the system. Paramedics relayed to the medical director that they had been selecting the number closest to the dose they gave in the drop-down menu and then manually writing the actual dose given in the narrative portion of the report. The fire department believes this system error occurred when they updated their software in January of 2017. Therefore, all of the data collected from 2018 could be inaccurate. Due to this error in the reporting system, it is unclear whether the results properly reflect the medication error rate of the department. Run report narratives need to be examined to determine if the dosages differ from the dosages reported in the drop-down menu and used in this analysis. This means that the results of this analysis will need to be reanalyzed with the correct information to obtain an accurate assessment of error rates. The Office of the Medical Director is currently working with their IT department to fix this reporting issue in order to allow paramedics to chart medication doses accurately.

In conclusion, the implementation of the Handtevy application within the San Antonio Fire Department has reduced the number of medication errors in children 13 years of age and younger with a diagnosis or seizure or pain management. Even though the study found that Handtevy has helped improve medication error rates, supervising staff should continue to assess training methods and encourage users to utilize the app correctly and execute medication administration correctly. This is especially important after the clinical discovery was made that the reporting system had an error. Supervising staff need to make sure the reporting error remains fixed and that the paramedics are accurately charting doses. The cumulative error rate for Q1 2018 was still 44.4%, which means there is room for improvement. Further studies will need to be conducted to continue assessing the effectiveness of the Handtevy app such as broaden the analysis to include other drugs and/or diagnoses.
References

Bourdeau, Stephanie, MD; Copeland, Julie, MD, CCFP; Milne, W Ken, MD, MSc, CCFP(EM), FCFP. (2011). Accuracy of the Broselow tape in estimating the weight of First Nations children. Canadian Journal of Rural Medicine, 16(4), 121-5.


Appendix A

Bailey

Per the information provided in the emails below in which you are doing QI/program evaluation, the UNMC IRB determined it does not constitute human subject research as defined at 45CFR46.102. Therefore, it is not subject to the federal regulations. No further action is required. **No Application needs to be submitted.**

Please be advised that should anything change which would result in the project meeting the definition of human subject research, the IRB must be notified before any further research activity continues.

Should you have any questions please do not hesitate to contact the Office of Regulatory Affairs at 559-6463.

Sincerely,

Gail Kotulak, BS, CIP  
IRB Administrator III  
UNMC IRB  
Office of Regulatory Affairs (ORA)
Appendix B

SAS Coding:
proc import datafile = '/folders/myfolders/Data Sets/SAShandtevy2016.xlsx'
DBMS = xlsx OUT = handtevy2016 replace;
run;
/*proc print;
run;*/
data handtevy1;
set handtevy2016;
if medication_error = "Y" then medication_error_1 = 1;
else medication_error_1 = 0;
if medication_error = "N" then medication_error_2 = 1;
else medication_error_2 = 0;
if medication_provided = "Fentanyl" then medication_provided_1 = 1;
else medication_provided_1 = 0;
if medication_provided = "Versed" then medication_provided_2 = 2;
else medication_provided_2 = 0;
if medication_route = "IV" then medication_route_1 = 1;
else medication_route_1 = 0;
if medication_route = "IM" then medication_route_2 = 1;
else medication_route_2 = 0;
if medication_route = "IN" then medication_route_3 = 1;
else medication_route_3 = 0;
format time_dispatched hhmm.;
format time_at_patient 1.;
format time_of_admin_ hhmm.;
format date mmddyy.;
if '00:00't<= time_at_patient <= '05:59't then time_at_patient = 1;
if '06:00't<= time_at_patient <= '11:59't then time_at_patient = 2;
if '12:00't<= time_at_patient <= '17:59't then time_at_patient = 3;
if '18:00't<= time_at_patient <= '23:59't then time_at_patient = 4;
run;
proc print data = handtevy1;
run;
proc sgplot data=handtevy1;
vbar patient_age /group=year groupdisplay=cluster;
run;
proc freq data = handtevy1;
tables medication_error*patient_age;
title "Medication Errors by Age 2016";
run;
pd reset reset
proc freq data=handtevy1 order=data;
  tables medication_error*medication_provided / expected chisq;
  output out=data n nmiss;
  exact pchi or;
title 'Chi-Square Tests for Medication Errors by Medication Provided 2016';
run;
proc print data=data;
run;
proc sort data = handtevy1;
by patient_age;
run;
proc sort data = handtevy1;
by year;
run;
proc means data = handtevy1;
var patient_age;
title "Mean patient age";
run;
proc corr data = handtevy1;
var time_dispatched time_at_patient pre_pain_level post_pain_level patient_age;
title "Medication error predictors - Examination of Correlation Matrix";
run;
proc reg data = handtevy1;
model medication_error_1 = time_at_patient patient_age medication_provided_1 medication_route_1 medication_route_2 /
                      vif tol collin;
title 'Medication Error Predictors - Multicollinearity Investigation of VIF and Tol';
run;*/
proc logistic data=handtevy1;
class medication_route medication_provided time_at_patient;
model medication_error (event = "Y") = time_at_patient patient_age medication_provided medication_route;
title "Logistic Regression";
run;
proc import datafile ='/folders/myfolders/Data Sets/SAShandtevy2018.xlsx'
  DBMS = xlsx OUT = handtevy2018;
run;
data handtevy11;
set handtevy2018;
if medication_error = "Y" then medication_error_1 = 1;
else medication_error_1 = 0;
if medication_error = "N" then medication_error_2 = 1;
else medication_error_2 = 0;
if medication_provided = "Fentanyl" then medication_provided_1 = 1;
else medication_provided_1 = 0;
if medication_provided = "Versed" then medication_provided_2 = 2;
else medication_provided_2 = 0;
if medication_route = "IV" then medication_route_1 = 1;
else medication_route_1 = 0;
if medication_route = "IM" then medication_route_2 = 1;
else medication_route_2 = 0;
else medication_route_2 = 0;
if medication_route = "IN" then medication_route_3 = 1;
else medication_route_3 = 0;
format time_dispatched hhmm.;
format time_at_patient 1.;
format time_of_admin_ hhmm.;
format date mmddyy.;
if '00:00't <= time_at_patient <= '05:59't then time_at_patient = 1;
if '06:00't <= time_at_patient <= '11:59't then time_at_patient = 2;
if '12:00't <= time_at_patient <= '17:59't then time_at_patient = 3;
if '18:00't <= time_at_patient <= '23:59't then time_at_patient = 4;
run;
proc print data = handtevy11;
run;
proc sgplot data=handtevy11;
vbar patient_age /group=year groupdisplay=cluster;
run;
proc freq data = handtevy11;
tables medication_error*patient_age;
title "Medication Errors by Age 2018";
run;
proc freq data=handtevy11 order=data;
tables medication_error*medication_provided / expected chisq;
output out=data n nmiss;
exact pchi or;
title 'Chi-Square Tests for Medication Errors by Medication Provided 2018';
run;
proc print data=data;
run;
proc sort data = handtevy11;
by patient_age;
run;
proc sort data =handtevy11;
by year;
run;
proc means data = handtevy11;
var patient_age;
title "Mean patient age";
run;
proc corr data = handtevy11;
var time_dispatched time_at_patient pre_pain_level post_pain_level patient_age;
title "Medication error predictors - Examination of Correlation Matrix";
run;
proc reg data = handtevy11;
model medication_error_1 = time_at_patient patient_age medication_provided_1 medication_route_1 medication_route_2
/ vif tol collin;
title 'Medication Error Predictors - Multicollinearity Investigation of VIF and Tol';
run;
proc logistic data=handtevy11;
class medication_route medication_provided time_at_patient;
model medication_error (event = "Y") = time_at_patient patient_age medication_provided medication_route;
title "Logistic Regression";
run;
proc freq data=handtevy1 order=data;
tables medication_error*time_at_patient / expected chisq;
output out=data1 n nmiss;
exact pchi or;
title 'Chi-Square Tests for Medication Errors by Time of Call: 2016';
run;
proc print data=data1;
run;
proc freq data=handtevy11 order=data;
tables medication_error*time_at_patient / expected chisq;
output out=data2 n nmiss;
exact pchi or;
title 'Chi-Square Tests for Medication Errors by Time of Call: 2018';
run;
proc print data=data2;
run;