American Journal of Emergency Medicine 37 (2019) 38–44

Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

Original Contribution

Alternatives to opioids for pain management in the emergency department decreases opioid usage and maintains patient satisfaction

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ARTICLE INFO

Article history:
Received 28 February 2018
Received in revised form 16 April 2018
Accepted 19 April 2018

Keywords:
Opioid
Pain
Emergency department
Patient satisfaction

ABSTRACT

Objective: The objective of this study was to assess opioid use in an emergency department following the development and implementation of an alternative to opioids (ALTO)-first approach to pain management. The study also assessed how implementation affected patient satisfaction scores.
Methods: This study compared data collected from October to December of 2015 (prior to implementation) to data collected between October and December of 2016 (after the intervention had been implemented). Emergency department visits during the study timeframe were included. Opioid reduction was measured in morphine equivalents (ME) administered per visit. Secondary outcomes on patient satisfaction were gathered using the Press Ganey survey.
Results: Intravenous (IV) opioid administration during the study period decreased by >20%. The predicted mean ME use in 2016 was 0.25 ME less when compared to 2015 (95% CI −0.27 to −0.23). Estimated use for patients in the pre-implementation period was 1.45 ME mgs (SD 0.88), and 1.13 ME mg (SD 0.69) for patients in the post-implementation period. Patient satisfaction scores using the Press Ganey Scale also were assessed. There was no significant difference in the scores between 2015 and 2016 when patients were asked "How well was you pain controlled?" (−0.94, 95% CI −5.29 to 3.4) and "How likely are you to recommend this emergency department?" (−1.55, 95% CI −5.26 to 2.14).
Conclusion: In conclusion, by using an ALTO-first, multimodal treatment approach to pain management, participating clinicians were able to significantly decrease the use of IV opioids in the emergency department. Patient satisfaction scores remained unchanged following implementation.

1. Introduction

1.1. Background

Pain is the most common reason for US emergency department visits [1]. While many clinicians default to prescribing opioid medications in such cases, not all pain is adequately treated with opioids and, in some cases, these drugs may have deleterious effects [1-3]. Opioids are not only ineffective for some patients, but also can contribute to abuse and misuse [4].

The United States is currently in the middle of an opioid epidemic [5]. These agents — both prescription and illicit — are the main driver of drug overdose deaths, which have quadrupled since 1999. Opioids contributed to 33,091 deaths in 2015, 15,000 of which involved prescription medications [6,7]. In 2016, nearly half of all US opioid overdose deaths involved a prescription. An estimated 1.9 million Americans reported an opioid use disorder related to prescription medications in 2014, and an additional 586,000 suffered from heroin use disorder [4]. Four out of five heroin users cite prescription opioid abuse as what led to their addiction [8].

Although there are many initiatives in place to decrease opioid abuse and misuse, one of the most effective ways may be to change prescribing practices related to pain management. However, changing medical practice can be difficult when many physicians feel both financial and administrative pressures to increase patient satisfaction scores and control pain with opioids [5,9,10]. In 2012, healthcare providers wrote 259 million prescriptions for opioids, enough for every American to have their own bottle of pills [11]. According to the Centers for Disease Control and Prevention, overdose is now the leading cause of death for Americans under the age of 50 years. A paper published in the American Journal of Preventative Medicine recalculates opioid overdose deaths and reports that they are even higher than estimates, by almost 25% [12].

1.2. Importance

Many guidelines and recommendations have been published to try to address our country's increasingly deadly opioid epidemic [13-17].

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https://doi.org/10.1016/j.ajem.2018.04.043
0735-6757/

The Joint Commission has recommended using a multimodal treatment approach to pain management involving both non-opioid and opioid therapies, and early training in medical school to help prescribers practice safe and efficacious prescribing practices has been advocated [18]. The goal of each strategy is to decrease opioid use and prescribe safer and more effective medications for pain management.

One such strategy is the alternatives to opioids (ALTO) approach. This protocol was launched with the hope of utilizing non-opioid options as the first-line therapy for pain management, and educating patients on the side effects and addiction potential of these drugs [19]. A second strategy to reduce opioid use in the emergency department (ED) has emerged from Dr. Sergey Motov, who headed the first “opioid-free ED” shift in September of 2014. The CERTA (channels/enzymes/receptor targeted analgesia) approach targets patient-specific analgesia by utilizing a combination of non-opioid analgesics that work synergistically to not only decrease opioid use, but to also reduce side effects, dosages of each medication used, and length of stay in the emergency department. By switching from a symptom-based to a biological and mechanistic approach to pain management, clinicians can effectively target different sites, resulting in better pain control with more judicious use of opioids [20].

1.3. Goals of the investigation

This study assesses opioid use in a level 1 trauma center following the development and implementation of an ALTO-first protocol for pain management. In the study, clinicians were trained to use a multimodal treatment approach for controlling different types of pain (see Appendix 1). As a secondary endpoint, data was gathered and compared to gauge the effect of an ALTO-first approach on patient satisfaction scores. Through the changes in clinical practice, treating providers hoped to better control pain and decrease opioid use in a population of ED patients. To the authors' knowledge, this represents the first study in the emergency department to address opioid reduction through the implementation of a comprehensive ALTO strategy.

2. Materials and methods

2.1. Study design and setting

The researchers performed an observational cohort study comparing pre-implementation data to data collected following the intervention. A retrospective chart review was conducted, utilizing information collected from electronic health records. The participating facility is a 386-bed tertiary care hospital, which serves as a level 1 trauma, burn, stroke, and acute care medical center. The emergency department sees more than 60,000 patient visits per year.

2.2. Interventions

Following the development of an ALTO-first protocol, clinicians were trained to use a multimodal treatment approach to pain management for controlling different types of pain (see Appendix 1). An order set was built in the computerized provider order entry (CPOE) system, split up by indication, to facilitate efficient use of the ALTO-first approach.

2.3. Participant selection and measurements

All ED visits during the study timeframe were included. Patient opioid use was identified using an electronic report generated by the computer order entry system. Morphine equivalents were calculated using formulas (see Appendix 2). Pain control and patient satisfaction scores were measured using the Press Ganey survey. The opioid reduction initiative was initiated in the ED in September of 2016 following a 9-month preparation period that involved completion of an extensive “prelaunch checklist;” this included tasks such as creation of an order set in CPOE, updates to various hospital policies, addition of entries to the “smart” pump library, stocking of ALTO medication in the ED automated dispensing machines, provision of training classes to all nurses, pharmacists, and physicians, among others. Data was collected from October through December of 2015 (pre-implementation) and October through December of 2016 (post-implementation). The study participants were patients treated in the emergency department between October and December of 2015 and 2016.

2.4. Outcomes

The primary outcome of this study was an ED-wide change in IV opioid administration pre- and post-implementation of the opioid reduction protocol; this was determined by computing mean ME over all ED visits during the study timeframe. Pre-protocol data collected in 2015 was compared to post-protocol implementation in 2016. Secondary outcomes included additional opioid use data (ME/patient that received opioids, percentage of patients seen in the ED that received opioids) and pre- and post-implementation patient satisfaction scores.

2.5. Analysis

Continuous and categorical data were characterized with students' tests and chi-square tests, respectively. Comparisons of age, sex, race, triage level, and mode of arrival were computed. Due to violations of normality and the extreme skewness of the ME data, wherein a large number of patients received zero ME, a generalized linear model (GLM) analysis was conducted to assess the incremental ME differences between the pre and post ALTO implementation time periods after controlling for race/ethnicity, and severity status measured by triage level. A modified Park Test was used to assess the appropriate GLM family, and Pearson correlation, Pregibon link, and modified Hosmer Lemeshow tests were conducted to assess GLM link fit. The method of recycled predictions was utilized to estimate patient level mean morphine equivalents (SD) after adjusting for covariates.

3. Results

3.1. Characteristics of study subjects

A total of 29,552 visits to the emergency department were analyzed (14,918 from October–December 2015 and 14,634 from October– December 2016). Baseline characteristics are displayed in Table 1. Mean age (43.2 vs 44.0) was not substantively different between years, although it was *significantly* different due to the large sample size. There was no significant variance in the proportion of females between years; however, there were more females than males in both years. White and non-white Hispanic patients comprised approximately 90%

Table 1
Baseline characteristics of pre- and post-protocol implementation patients.

	2015 $n = 14{,}918$	2016 $n = 14{,}634$	p-value
Age (mean, SD)	43.2 (23.7)	44.0 (24.0)	<0.01
Sex, female (n, %)	8454 (56.7)	7992 (54.6)	0.06
Race (n, %)			
White	10,515 (70.5)	10,572 (71.3)	<0.01
Non-white Hispanic	2986 (20.0)	2698 (18.4)	
Black	663 (4.5)	743 (5.1)	
Other	754 (5.0)	621 (4.2)	
Triage level			
Non + semi-urgent	3495 (23.4)	3069 (20.9)	<0.01
Urgent	7706 (52.0)	7377 (51.0)	
Emergent + resuscitative	3717 (24.9)	4189 (28.6)	
Arrival mode			
Walk-in + police	11,377 (76.3)	10,912 (74.6)	<0.01
Ambulance + helicopter	3541 (23.7)	3715 (25.4)	

Table 2
Morphine equivalent use pre- and post-implementation of opioid reduction protocol.

	2015	2016	*p*-value
ME per visit, all patients (mean, SD)	1.45 (3.48)	1.13 (3.62)	<0.01
October	1.35 (3.17)	0.98 (2.85)	<0.01
November	1.45 (3.33)	1.18 (3.0)	<0.01
December	1.54 (3.90)	1.23 (4.73)	<0.01
ME per visit, patients with opioids (mean, SD)	6.42 (4.68)	6.38 (6.36)	0.7
Administrations per visit (mean, SD)	1.8 (1.06)	1.7 (1.2)	0.09

of the sample in both years. Approximately 50% of patients were triaged at the urgent care level, and the majority of patients transported themselves to the hospital.

3.2. Primary results

IV opioid administration during the study period decreased by more than 20%. Adjusted patient level ME milligrams pre- and post-implementation were estimated using the method of recycled predictions in order to avoid introduction of covariate imbalance.

Estimated use for patients in the pre-implementation period was 1.45 ME mg (SD 0.88), and for patients in the post-implementation period 1.13 ME mg (SD 0.69), after adjusting for age, sex, race, and triage level ($p < 0.01$). Opioid use decreased significantly in October, November, and December of 2016 compared to each month respectively in 2015 ($p < 0.05$), as seen in Table 2 and Fig. 1. Of the patients requiring IV opioids, 2015 ME use was 6.42 (SD 4.68), and 2016 ME use was 6.38 (SD 6.36). This was not significantly different overall or per month.

To further examine the relationship between the implementation of the protocol and opioid use, the proportion of patients admitted to the ED who received an IV opioid and the mean amount of opioid administered to each patient was calculated for each month of data collection in 2015 and 2016. As shown in Fig. 1, not only did mean opioid dose decrease, but the proportion of patients receiving these drugs decreased as well (3,360 patients [22.5%] in 2015 compared to 2,596 patients [17.7%] in 2016). This represents 764 patient visits in which opioids were avoided (see Figure 2).

To further examine the relationship between the implementation of the protocol and ALTO use, the proportion of patients admitted to the ED who received an ALTO medication was calculated for each year. As shown in Table 3, the percentage of patients receiving the ALTO medications increased significantly between 2015 and 2016. The percentage of patient visits where acetaminophen and/or ketorolac was administered increased by 29.5% and 73.7%, respectively. Ketamine IV and lidocaine IV were almost exclusively used post-implementation, both specifically for the ALTO treatment pathways.

The results of the GLM analysis of ME use are displayed in Table 5 (Appendix). The mean incremental ME associated with the implementation of ALTO after controlling for age, race/ethnicity, and of ALTO was −0.25 ME (95% CI −0.27 to −0.23).

Patient satisfaction scores using the Press Ganey Scale also were assessed, specifically focusing on the questions of "How well was your pain controlled?" and "How likely are you to recommend this emergency department?" Overall, no difference in patient satisfaction scores related to the question "How well was your pain controlled?" was found pre- and post-implementation of the ALTO-first guidelines, after adjusting for age, sex, and race (−0.94, 95% CI −5.29 to 3.4). There also was no significant difference in scores related to the question "How likely are you to recommend this ED?" between 2015 and 2016 (−1.55, 95% CI −5.26 to 2.14). However, the race category, which included "black" and "other," was associated with a 6.34 lower score (95% CI −12.34 to −0.34) when compared to "white."

4. Discussion

Our study of an ALTO-first treatment strategy for pain control in a busy Level-1 trauma center is the first to show that implementation of ALTO protocols is associated with a significant decrease in opioid usage. IV opioid administration decreased by more than 20% during the study period, and the protocol was able to decrease the overall number of patients that were exposed to these agents. Subsequently, ALTO use was shown to significantly increase. The findings also align with existing literature that refutes the link between patient satisfaction and the use of opioid pain medications [10,21]. This knowledge can be used to support pain treatment guidelines that align with the ALTO approach. If such guidelines could be introduced in a widespread manner, it might be assumed that opioid usage would decrease and opioid addiction and overdose deaths would subsequently decrease.

The staggering opioid-related statistics presented have led to the argument that the prescribing behavior of providers has driven the current opioid epidemic. A paradigm shift began in the late 1980s that likely drove the increase in opioid prescriptions. A one-paragraph letter published in the *New England Journal of Medicine* became widely invoked in support of the claim that the risk of addiction was low when opioids were prescribed for pain [22]. An additional paper was published in 1986 in *Pain: the Journal of the International Association for the Study of Pain*. This was a small study of 38 patients in which the authors concluded that the risk of addiction when treating chronic pain was less than one percent [23]. These two articles guided many prescribing practices over the next decade, since the risk of addiction with opioids seemed virtually disproven. It was also during this time that the Veterans Administrations released guidelines that defined pain as the "fifth vital sign." These efforts eventually led to aggressive pain

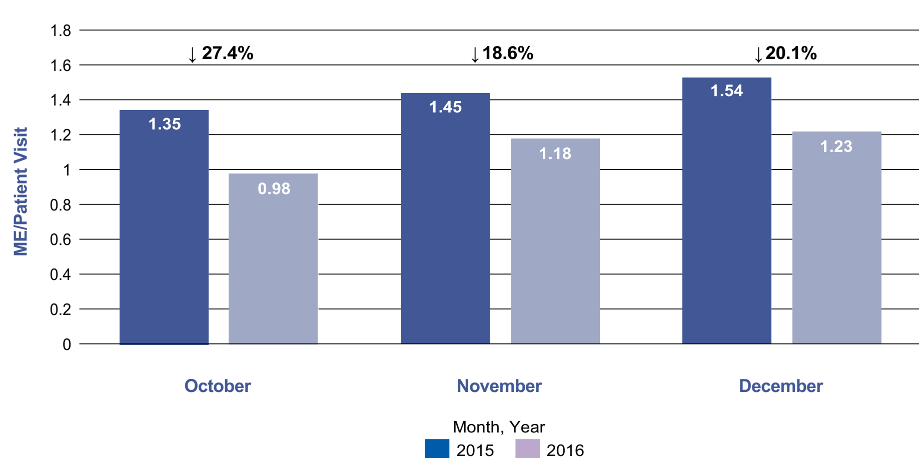

Fig. 1. Mean morphine milligram equivalents administered per patient visit by month.

management, often times focusing primarily on the use of opioids [24]. The combination of these two happenings was a driving factor in the increase of opioid prescriptions over the past two decades. Due to the lack of clinical guidelines on prescribing opioids for pain management in the ED, this argument is not unexpected [2]. ED providers are at the forefront of healthcare and are often a patient's first encounter with the medical system, and subsequently an opioid. Rates of opioid prescribing by emergency physicians within the same hospital has been shown to vary significantly, with increased rates of long-term opioid use among patients treated by high-intensity opioid prescribers [2]. With the majority of heroin users citing prescription opioids as what led to their addiction, this introduces an opportunity for significant impact [8].

Despite the promise of these findings, there are limitations. This was a retrospective study of a practice that was previously implemented. The association between intervention and results may have been influenced by the challenges in identifying and controlling for all confounding factors. This analysis controlled for known measurable confounders; however, unknown factors such as the increasing climate of decreased opioid use may have also have contributed to the decrease in ME, yet this is difficult to measure. The pilot was implemented during a time when the “opioid epidemic” was less recognized but still may have influenced prescribing patterns. Additionally, the GLM analysis is efficient when comparing the timeframes identified, and is robust to the skewness and clustering around zero of the ME. The authors feel confident that the results reflect the intervention due to the timing of staff training and the creation of an “Opioid-free Pain Treatment” order set built in the CPOE system for providers to use. This order set was divided by indication (see Appendix 1), facilitating simple and efficient ordering by providers. Easily identifiable order strings were also created within CPOE, such as “Lidocaine IV – for pain” and “Ketamine IV – for pain” to facilitate individual orders in alignment with the ALTO approach. All of these strategies were implemented during the time between the pre- and post-time periods studied. The substantial increase in prescribing of the ALTO therapies supports the theory that the decrease in opioid administration was due to ALTO implementation. An additional observation made was that the mean opioid dose administered remained unchanged, although fewer patients received an opioid. This suggests that the pain of patients who did receive an opioid may have been significant enough to require a rescue dose. Last, this study was completed at an urban level 1 trauma center, whose patient population may not represent all EDs. However, the success shown in this pilot led to a practice model that has now become more widespread throughout Colorado. These other pilot sites are diverse in size, location, and patient population and subsequent results could lead to better generalizability.

Other groups and organizations are working to provide comprehensive pain management and opioid reduction recommendations. The Colorado Chapter of the American College of Emergency Physicians (CO ACEP) released its 2017 *Opioid Prescribing & Treatment Guidelines*, the first clinical protocol in the country to endorse utilizing ALTO and CERTA approaches to pain control [25]. These guidelines stress the importance of limiting opioid use in the emergency department as well as educating patients on the addiction potential and side effects associated with opioids. The other important focus of these guidelines is on how best to help the patients who misuse or are addicted to opioids. Recommendations include dispensing clean needles/syringes and naloxone kits out of the emergency department and expanding the treatment and referral programs in Colorado surrounding the use of naloxone [25]. This study and the CO ACEP guidelines now serve as the basis for a much larger pilot study in 11 Colorado EDs, aimed at demonstrating how implementation of the ALTO-first approach can decrease opioid usage.

Table 3
ED patient visits where an “ALTO” medication was received.

	2015 (n)	2016 (n)	% change	p-value
Total patient visits	14,918	14,634	–	–
Acetaminophen oral	657	841	+29.5	<0.01
Ketamine IV	22	112	+420	<0.01
Ketorolac IV	976	1663	+73.7	<0.01
Lidocaine IV	2	203	+10,200	<0.01

5. Conclusions

In summary, IV opioid administration in the emergency department was significantly reduced upon the implementation of an ALTO-first approach to pain control without compromising patient satisfaction scores related to pain control and overall satisfaction with the visit.

Acknowledgements

The authors of this paper would like to acknowledge Rachel Donihoo for her thoughtful contributions to the formatting of this paper.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Presentations

Poster and Abstract Presentation, 2016 University Health-System Consortium Annual Meeting

December 2016 – Las Vegas, NV

Abstract and Results Presentation, 2017 Western States Annual Conference

May 2017 – San Diego, CA

Poster and Abstract Presentation, 2017 ACCP Virtual Symposium

May 2017 – online

Platform Presentation, 2017 Colorado Pharmacists Society Annual Meeting

June 2017 – Denver, CO

Poster and Abstract Presentation, 2017 Emergency Nurses Association Conference

September 2017 – St. Louis, MO

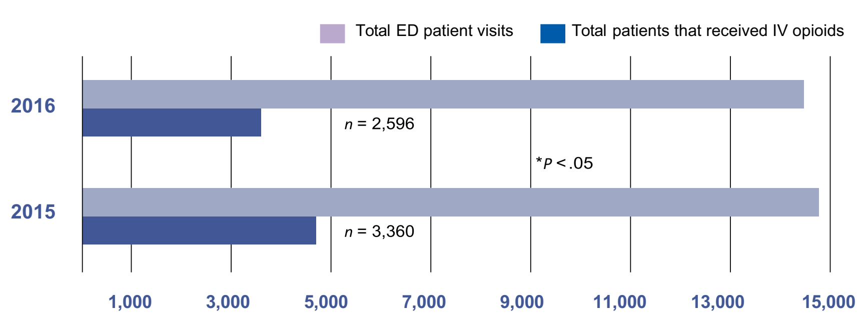

Fig. 2. Proportion of all ed patients who received an IV opioid.

Declaration of interest

None.

Appendix A. Pain pathways by indication

Headache/migraine

Immediate/First-Line Therapy	Second-Line IV Therapy	Alternative Options (if tension component)
APAP 1000 mg PO + ibuprofen 600 mg PO	Ketorolac 15 mg IV	Cyclobenzaprine 5 mg ***OR*** diazepam 5 mg PO/IV
1 L 0.9% NS + high-flow oxygen	Metoclopramide 10 mg IV	Trigger-point injection
Sumatriptan 6 mg SC	Promethazine 12.5 mg IV ***OR*** prochlorperazine 10 mg IV	Lidoderm patch
Trigger-point injection with lidocaine 1%	Dexamethasone 8 mg IV	
	Haloperidol 2.5-5 mg IV	
	Magnesium 1 g IV	
	Valproic acid 500 mg IV	

Musculoskeletal pain

Immediate/First-Line Therapy	Second-Line IV Therapy	Alternative Options
APAP 1000 mg PO + ibuprofen 600 mg PO	Ketamine 0.2 mg/kg IV + 0.1 mg/kg/hr gtt	Lidoderm patch (max 3 patches)
Cyclobenzaprine 5 mg PO ***OR*** diazepam 5 mg PO	Ketorolac 15 mg IV	Gabapentin 300 mg PO
Ketamine 50 mg IN	Dexamethasone 8 mg IV	
Trigger-point injection with lidocaine 1%	Diazepam 5 mg IV	

Renal colic

Immediate/First-Line Therapy	Second-Line IV Therapy	Alternative Options
APAP 1000 mg PO	Lidocaine 1.5 mg/kg IV (max 200 mg)	DDAVP 40 mcg IN
Ketorolac 15 mg IV		Ketamine 50 mg IN
1 L 0.9% NS bolus		

Chronic abdominal pain

Immediate/First-Line Therapy	Second-Line Therapy
Metoclopramide 10 mg PO/IV	Haloperidol 2.5–5 mg IV
Prochlorperazine 10 mg PO/IV	Ketamine 0.2 mg/kg + 0.1 mg/kg hr gtt
Diphenhydramine 25 mg PO/IV	Lidocaine 1.5 mg/kg (max 200 mg)
Dicyclomine 20 mg PO/IM	

Extremity fracture/joint dislocation

Immediate/First-Line Therapy	Ultrasound-Guided Regional Anesthesia
APAP 1000 mg PO	Lidocaine 0.5% perineural infiltration (max 5 mg/kg)
Ketamine 50 mg IN	
Nitrous oxide (titrate up to 70%)	

Appendix B. Equianalgesic opioid dosing (Mg)

Drug	Parenteral	Oral
Morphine	10	30
Buprenorphine	0.3	0.4 (sl)
Codeine	100	200
Fentanyl	0.1	NA
Hydrocodone	NA	30
Hydromorphone	1.5	7.5
Meperidine	100	300
Oxycodone	10*	20
Oxymorphone	1	10
Tramadol	100*	120

*Not available in the US.

Appendix C. Additional statistical analysis

Table 4
Characteristics of patients who received opioids vs those who did not.

	2015 no ME group $n = 11{,}558$	2015 ME group $n = 3360$	2016 no ME group $n = 12{,}038$	2016 ME group $n = 2596$	p-value
Age (mean, SD)	42.5 (24.8)	45.7 (19.0)	43.0 (24.8)	48.4 (19.2)	<0.01
Sex, female (n, %)	6353 (54.9)	2111 (62.8)	6421 (53.3)	1571 (60.5)	>0.05
Race (n,%)					
White	8053 (69.7)	8596 (71.41)	2462 (73.3)	1976 (76.1)	<0.01
Non-white Hispanic	2332 (20.2)	2283 (19.0)	654 (19.5)	415 (16.0)	
Black	513 (4.4)	615 (5.1)	150 (4.5)	128 (4.9)	
Other	660 (5.7)	544 (4.5)	94 (2.8)	77 (3.0)	
Triage level					
Non + semi-urgent	3307 (28.8)	2939 (24.8)	159 (4.8)	85 (3.3)	<0.01
Urgent	5337 (46.4)	5624 (47.4)	2369 (71.0)	1753 (68.0)	
Emergent + resuscitative	2850 (24.8)	3312 (27.9)	808 (24.2)	742 (28.8)	
Arrival mode					
Walk-in + police	8824 (76.4)	9040 (75.14)	2553 (76.0)	1872 (72.1)	<0.01
Ambulance + helicopter	2734 (23.7)	2991 (24.9)	807 (24.0)	724 (27.9)	
ME per visit (mean, SD)	0	6.42 (4.68)	0	6.38 (6.36)	

The results of the GLM analysis of ME use are displayed in Table 4. The modified Park Test identified log as the appropriate link. Pearson correlation, Pregibon link, and modified Hosmer Lemeshow tests identified Poisson as the appropriate GLM family for analysis.

Table 5
Comparison of effect of coefficients on me milligram dose received.

	Coefficient	Std. error	p> z	95% confidence interval
2016 ME vs 2015	−0.250	0.010	<0.001	−0.271 to −0.230
Age (<20 years old referent)				
20–59 years	1.552	0.030	<0.001	1.493 to 1.610
>60 years	1.073	0.031	<0.001	1.012 to 1.134
Sex (female referent)	−0.117	0.011	<0.001	−0.138 to −0.097
Race (white referent)				
Non-white Hispanic	−0.083	0.014	<0.001	−0.111 to −0.056
Black	−0.200	0.026	<0.006	−0.251 to −0.149
Other	−0.564	0.032	<0.001	−0.628 to −0.500
Triage level (non-urgent referent)				
Urgent	1.925	0.027	<0.001	1.873 to 1.977
Emergent	1.663	0.028	<0.001	1.608 to 1.718

The predicted mean ME use in 2016 was 0.25 ME mg less when compared to 2015 (95% CI −0.27 to −0.23). Age was found to be a significant predictor of ME use. When compared to patients who are <20 years old, patients between the ages of 20 and 59 used 1.55 ME more (95% CI 1.49 to 1.61); and patients older than 60 used 1.07 mg more than the referent category (95% CI 1.01 to 1.13). Females used less than males (−0.12, 95% CI −0.14 to −0.01). Overall non-white Hispanic/black/other race used fewer ME mgs than “white” race. Triage level was included to adjust for severity of visit, and when compared to the non-urgent reference, both urgent and emergent levels used more ME mgs respectively (1.92 and 1.67 ME respectively).

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