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Clinically Inconsequential Alerts: The Characteristics of Opioid Drug Alerts and Their Utility in Preventing Adverse Drug Events in the Emergency Department

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Abstract

Study objective—We examine the characteristics of clinical decision support alerts triggered when opioids are prescribed, including alert type, override rates, adverse drug events associated with opioids, and preventable adverse drug events.

Methods—This was a retrospective chart review study assessing adverse drug event occurrences for emergency department (ED) visits in a large urban academic medical center using a commercial electronic health record system with clinical decision support. Participants include those aged 18 to 89 years who arrived to the ED every fifth day between September 2012 and January 2013. The main outcome was characteristics of opioid drug alerts, including alert type, override rates, opioid-related adverse drug events, and adverse drug event preventability by clinical decision support.

Results—Opioid drug alerts were more likely to be overridden than nonopioid alerts (relative risk 1.35; 95% confidence interval [CI] 1.21 to 1.50). Opioid drug-allergy alerts were twice as likely to be overridden (relative risk 2.24; 95% CI 1.74 to 2.89). Opioid duplicate therapy alerts were 1.57 times as likely to be overridden (95% CI 1.30 to 1.89). Fourteen of 4,581 patients experienced an adverse drug event (0.31%; 95% CI 0.15% to 0.47%), and 8 were due to opioids (57.1%). None of the adverse drug events were preventable by clinical decision support. However, 46 alerts were accepted for 38 patients that averted a potential adverse drug event. Overall, 98.9% of opioid alerts did not result in an actual or averted adverse drug event, and 96.3% of opioid alerts were overridden.

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Conclusion—Overridden opioid alerts did not result in adverse drug events. Clinical decision support successfully prevented adverse drug events at the expense of generating a large volume of inconsequential alerts. To prevent 1 adverse drug event, providers dealt with more than 123 unnecessary alerts. It is essential to refine clinical decision support alerting systems to eliminate inconsequential alerts to prevent alert fatigue and maintain patient safety.

INTRODUCTION

Background

Computerized provider order entry and clinical decision support systems are important tools developed to prevent drug errors. Clinical decision support intervenes at prescribing by generating alerts warning of potential adverse drug events and has been shown to decrease errors compared with traditional paper-based ordering.^{1–3} Along with government incentives, this supports the broad transition to electronic health records and electronic prescribing in clinical practice. However, ensuring that these new electronic processes fit into clinician workflow has become a paradoxical issue because electronic health record vendors are reluctant to modify or turn off medication alerts for fear of exposing themselves to increased liability, resulting in physicians' being faced with navigating warnings that are too frequent and of minimal clinical significance. This causes providers to repeatedly override these warnings and disregard the alert message.^{4–7} This "alert fatigue" inherently increases patient risk of adverse drug events.^{8,9}

High alert override rates have been observed since clinical decision support systems were first implemented in the early 2000s. Override rates of most drug alerts have remained stable, at 75% to 95% of total alerts from 2006 to 2011.^{10–13} Although those numbers seem alarming, the majority of the alert overrides do not result in an adverse drug event, defined as "an injury resulting from medical intervention related to a drug."¹⁴

Although not all adverse drug events can be avoided by implementing clinical decision support systems, *preventable* adverse drug events should be intercepted and eliminated by an effectively integrated computerized provider order entry and clinical decision support system. A preventable adverse drug event is an injury that results from an error at any stage of drug use.¹⁵ These compose 20% to 30% of all adverse drug events.¹⁴ Generating alerts to avert preventable adverse drug events is the main objective of clinical decision support systems. Unfortunately, familiar and frequently prescribed drugs generate a large number of alerts and contribute to alert fatigue.^{16,17}

Importance

One of the most frequently prescribed and most alerted drug classes in the emergency department (ED) are opioids.^{16,18–22} Despite the high frequency of alerts, opioids have twice the rate of adverse drug events compared with nonopioid analgesics,^{23–26} and override rates for opioid drug allergy alerts have increased from 50% to 90% in the last 20 years.²⁷ The Joint Commission and the US Department of Health and Human Services have highlighted the need for comprehensive treatment plans to prevent opioid adverse drug events.^{28,29} Additionally, opioids are on the Institute for Safe Drug Practices list of high-alert drugs that

have the potential of causing significant patient harm in acute care settings.³⁰ Therefore, opioids need an effective alert system that limits alert fatigue and improves patient safety.

Goals of This Investigation

The primary objective of this study is to determine characteristics of opioid drug alerts in the ED. Our secondary objectives are to measure how frequently adverse drug events occur and determine whether clinical decision support system alerts are successful at preventing opioid-related adverse drug events.

MATERIALS AND METHODS

Study Design and Setting

This was a retrospective chart review study performed in an urban academic ED with approximately 70,000 annual visits. The Epic electronic health record and computerized provider order entry system (Epic Systems Corporation, Verona, WI) was implemented in 2011 with the First Databank drug information plug-in (First Databank, Inc., San Francisco, CA). Drug orders are directly entered into the electronic health record by physicians, residents, physician assistants, or registered nurses. This study was approved by the local institutional review board.

Selection of Participants

Data were gathered from September 2012 through January 2013. We sampled a 24-hour period every fifth day from midnight to 11:59 PM (index days) during the study period. According to previous research, adverse drug event occurrence ranges from 0.16% to 6.0% in the ED.³¹ Using this range, 5,000 chart reviews were expected to capture between 6 and 300 adverse drug events, resulting in a manageable number of chart reviews across all days of the week while maintaining enough volume to capture adverse drug events. In adherence with the Health Insurance Portability and Accountability Act (HIPAA) regulations and local institutional review board requirements, all ED visits for patients aged 18 to 89 years were included. Charts generated for these visits were reviewed on the day of service and 30 days postdischarge. The purpose of the second chart review was to determine whether any drugs administered during the initial visit resulted in a return visit because of an adverse drug event. Data sources included patient data through manual chart review and electronic health record reports, which included patient safety network reports and queries provided through the Epic Crystal Reporting system.

Drug alerts were triggered and visible to the provider when drugs were ordered, scanned, or administered. The provider who initiated the drug order had the first opportunity to respond to an alert. The order went to a pharmacist or a registered nurse for drug administration. During the study period, pharmacists staffed the ED 16 hours per day on weekdays. During these times, all orders for boarding patients and all orders placed for critically ill or trauma patients were reviewed by pharmacists before administration. This represented a second opportunity to respond to an alert. Finally, a registered nurse had another opportunity to respond to an alert before administering the drug. Drug orders had at least 1, and up to 3, opportunities to trigger an alert.

Alerts for boarding patients were included in accordance with the fact that although orders were initialized by the inpatient team for these patients, medications were still administered and managed by the ED staff and reviewed by ED pharmacists. In addition, at the time of the study, the ED was boarding patients for a significant amount of time, so excluding boarding patients would have resulted in the loss of large amounts of data pertaining to ED staff. We considered ED nurses and ED pharmacists critical parts of the ED team and thus thought that excluding them would minimize their role in preventing adverse drug events.

Noninterruptive alerts could be seen if the provider chose by expanding a hidden field within the ordering screen, but a response from the provider was not required. Noninterruptive alerts included moderate and unknown drug-drug interactions and all dosing alerts.

This study focused on interruptive alerts, which resulted in a pop-up alert and required a response from the provider (Table 1). Physicians, physician assistants, and registered nurses saw contraindicated drug-drug interactions only as interruptive alerts, whereas pharmacists saw both contraindicated and severe drug-drug interactions as interruptive alerts.

In accordance with a subsample analysis, we excluded alerts that were viewed or canceled because the subsequent action of the provider was difficult to elucidate (see Appendix E1 and Table E1, available online at <http://www.annemergmed.com>, for definitions, subsample analysis, and rationale).

Forty-three visits were excluded because of incomplete or duplicate records, 104 visits were excluded because the patient left without being seen by a physician or physician assistant or left before triage, and 116 patients were excluded because they were younger than 18 years or older than 89 years.

We reviewed charts for adverse drug events during the initial ED visit and within 30 days of the initial visit to capture potential adverse drug events from drugs administered during the initial visit. All ED notes and all notes in the hospital system electronic health record (ED visits, primary care visits, hospital admissions, and telephone notes) were reviewed by trained chart abstractors. Chart abstractors were trained to identify drugs and key words that signaled a possible adverse drug event such as an “intervention with an antidote,” “antihistamine,” or “corticosteroid” (see Appendix E2, available online at <http://www.annemergmed.com>, for chart review guidelines). Any chart an abstractor thought was ambiguous or contained drugs or key words that were not explained by provider notes were flagged and then reviewed by a toxicologist (A.A.M.). In addition, all identified adverse drug events were reviewed and confirmed by the same toxicologist. After this process, 25% of all charts were secondarily reviewed by a separate medical toxicologist (K.J.H.) to ensure adverse drug event capture by the chart primary reviewer.

We evaluated 2 types of adverse drug events: averted and actual. They were evaluated to determine whether they were either prevented by the clinical decision support system (in the case of averted adverse drug events) or preventable by the clinical decision support system (in the case of actual adverse drug events) (Table 1).

For actual adverse drug events, Naranjo scores³² were calculated to determine the likelihood the adverse drug event was caused by the alerted drug.

Accepted opioid alerts were evaluated to determine whether there was a potential averted adverse drug event in an attempt to quantify the success of clinical decision support alerts in preventing adverse drug events (ie, an alert is accepted; therefore, an adverse drug event was potentially averted).

There is a significant increase in risk of opioid death in patients who receive more than 50 morphine equivalents in 24 hours.³³ Therefore, we classified orders that generated a duplicate therapy or duplicate drug alert as averted adverse drug events only if more than 50 morphine equivalents were administered before the current order was placed. Drug-allergy alerts were marked as an averted adverse drug event when the ordered drug was a base or exact ingredient match to the drug the patient had a documented allergy to. This determination was based on the extremely low risk that cross-sensitivity between opioids would lead to allergy.³⁴ For instance, listed allergy to codeine rarely results in an adverse drug event when morphine is administered.^{16,19,35}

Primary Data Analysis

Because alerts within each patient visit are not independent, 1 randomly selected alert per patient visit was used to calculate the risk of overriding an opioid alert versus nonopioid alert (n=1,576 alerts). Results were similar when the independence assumption was ignored and the entire sample was used (n=12,829 alerts) (Table E2, available online at <http://www.annemergmed.com>).

For continuous variables, Student's *t* test was used to compare means, with the exception of length of stay, for which the Wilcoxon Mann-Whitney was used because of skew. For categorical variables, the χ^2 statistic was used. Relative risks were calculated with the Mantel-Haenszel method.³⁶ All tests were 2-tailed, with a significance level of .05, and run with SAS (version 9.4; SAS Institute, Inc., Cary, NC).

RESULTS

Characteristics of Study Subjects

Of 4,844 total visits, there were 4,581 eligible visits to the ED during the 4-month study period. Of those, 3,970 patients (86.7%) had at least 1 drug ordered or prescribed, and 1,576 of those patients (39.6%) had at least 1 visible alert. These patients generated a total of 13,719 alerts, resulting in a median of 4 alerts per patient (range 1 to 120 alerts). The total proportion of overridden alerts was 93.5% (n=12,829) of alerts overall.

In this study, 46.8% of patient visits (n=2,144) in the total data set had an opioid ordered in the ED, prescribed at discharge, or both. For visits with at least 1 opioid order, an average of 2.2 opioid orders was given. Patients who received an opioid (versus those who did not) were older (42.0 versus 41.3 years; $P<.001$), more likely women (58.3% versus 55.8%; $P<.001$), more likely non-Hispanic white (47.1% versus 40.7%; $P<.001$), and more likely to be admitted to the hospital from the ED (25.2% versus 11.3%; $P<.001$). As expected, patients

who received an opioid had a longer length of stay in the ED (4.6 versus 3.5 hours; $P<.001$) and had more drugs ordered or prescribed on average (5.2 versus 2.3; $P<.001$).

For patients with an opioid order, characteristics differed between those who had no alerts and those with at least 1 opioid alert. Patients with an opioid alert were slightly older, more likely to be women or white, had a longer length of stay, and were prescribed more total drugs. Triage level and ED disposition were not significantly different between visits with alerts and those without (Table 2).

Of the 13,719 alerts generated during the study period, 4,742 (34.6%) resulted from 4,741 opioid orders and prescriptions (Figure). In a random sample of 1 alert per patient, drawn from all alerts in all patients, opioid alerts were more likely to be overridden compared with nonopioid alerts for all alert and provider types, except registered nurses and other providers (which included anesthesiology assistants, technicians, medical students, and respiratory therapists). Providers who most frequently overrode opioid drug alerts were pharmacists and physician assistants. Residents overrode opioid drugs least often (Table 3). Compared with non-opioid drug allergy alerts, opioid drug allergy alerts made up a higher proportion of total alerts, (23.6% vs. 6.8%) and proportions were comparable between opioid and non-opioid drug alerts for duplicate drug order alerts (72.5% vs 82.5%), drug-drug interaction alerts (0.7% vs 5.7%), lactation or pregnancy alerts (2.9% vs 3.3%), and other alerts (0.3% vs 1.6%). Physicians, registered nurses, and physician assistants saw opioid alerts more frequently than nonopioid ones. Pharmacists saw opioid alerts less often compared with nonopioid ones. Because pharmacists verified opioid orders only for patients who were boarding in the ED (ie, admitted to the hospital and awaiting a medical floor bed), this difference is expected. Additionally, because residents, physicians, and physician assistants were the primary prescribers, it was expected that they would see the majority of opioid alerts.

Only 14 of the total 4,581 visits had adverse drug events (0.31%; 95% confidence interval [CI] 0.15% to 0.47%). Of those, 8 (57.1%) were attributed to opioids. None of the identified adverse drug events were fatal. According to Naranjo scores, 5 (62.5%) adverse drug events were considered probable and 3 (37.5%) were considered possible. None of the adverse drug events were considered preventable by clinical decision support because the nature of their reaction was not related to the opioid alerts that were triggered by clinical decision support. For example, opioid-related itching is not caused by duplicate doses of opioids (Table E3, available online at <http://www.annemergmed.com>, for a brief description of adverse drug events).

One adverse drug event may have been preventable by clinical decision support if the drugs had been charted accurately. In this case, 4 alerts for 1 visit were found to be associated with an adverse drug event, and all were overridden. The patient received 100 µg of fentanyl from emergency medical services that was not documented electronically, and an additional 3 mg of hydromorphone was administered. If the fentanyl had been entered electronically, it would have exceeded the morphine equivalent threshold, but because the medication was not entered, the adverse drug event was considered not preventable by clinical decision support.

Overall, 98.9% (4,691/4,742; 95% CI 98.6% to 99.2%) of opioid alerts were not associated with an actual or averted adverse drug event. Of accepted opioid alerts, 46 of 175 alerts (26.3%; 95% CI 19.8% to 32.8%) associated with 38 patient visits met criteria for an averted adverse drug event. The majority of averted adverse drug events were prevented by drug-allergy alerts (90.0%; n=40), and the remaining 6 alerts (10.0%) were prevented by duplicate therapy or duplicate drug order alerts. Of the drug-allergy alerts, 85.5% (955/1,117; 95% CI 83.4% to 87.6%) were drug class matches, and the remaining 14.5% (162/1,117; 95% CI 12.4% to 16.6%) were exact or base ingredient matches. All of the drug-drug interaction, pregnancy or lactation, and other alerts were overridden. Therefore, according to our criteria, none of them could have averted an adverse drug event.

LIMITATIONS

There are several limitations of this study. The internal validity is limited because the chart review and admission data post-ED discharge were used to determine adverse drug events. If a patient experienced an adverse drug event and did not come back to the same health system, their adverse drug event would not have been captured. However, most life-threatening reactions to opioids (anaphylaxis or respiratory depression) are expected to occur in the ED. In addition, subclinical adverse drug events or those that were not explicitly documented as caused by the opioid would not have been captured by this retrospective chart review methodology. Therefore, mild reactions such as nausea or dizziness are underrepresented in this data set. However, our adverse drug event rate of 0.31% was similar to that of other studies conducted in the ED, which range from 0.16% to 6.0%,³¹ suggesting that we captured the majority of clinically significant adverse drug events. The external validity of this study is limited by heterogeneity across computerized provider order entry and clinical decision support systems. However, opioids are commonly prescribed and result in adverse drug events across all hospital systems; therefore, evaluation and revision of clinical decision support systems for opioid alerts is important for all hospitals.

DISCUSSION

We examined drug alerts in a new way, by drug class rather than by alert type (eg, only drug-drug interactions). By studying alerts in this way, we found that the profile of opioid drug alerts differs significantly from that of nonopioid drug alerts. Drug-allergy alerts compose a much larger proportion of total opioid alerts compared with nonopioid alerts. For opioid orders, allergy, duplicate therapy, and duplicate drug order alerts make up almost three quarters of drug alerts. Additionally, opioid drug alerts were more likely than nonopioid ones to be overridden across most provider types and all alert types. This high override rate across the board is evidence that alert fatigue is associated with these interruptive alerts. Actual opioid-related adverse drug events identified in our study were not preventable by clinical decision support systems, which further demonstrates a need to improve the signal-to-noise ratio of these alerts.

A recent study found that drugs on the Institute for Safe Drug Practices list of high-alert drugs were more likely to be overridden.³⁷ This is consistent with our findings that almost every type of provider is more likely to override a drug alert for an opioid. Additionally,

opioid drug-allergy alerts are twice as likely to be overridden compared with nonopioid alerts, likely because opioid intolerances were charted as drug allergies.²⁷ The high override rate suggests that providers think the risk of overriding these alerts is low. This attitude is supported by our results that 99.9% of overridden alerts (4,563/4,559) were not associated with an actual adverse drug event.

Forty-six alerts were triggered for 38 patients that may have averted an adverse drug event (Figure), but none of the observed adverse drug events identified in this study were preventable by the clinical decision support system. This underscores the value of clinical decision support and computerized provider order entry systems in intercepting preventable adverse drug events. However, the consequence of this high sensitivity is low specificity, confirmed by our finding that providers sorted through 4,692 alerts to avert 38 adverse drug events. In other words, to prevent just 1 adverse drug event, providers had to deal with more than 123 unnecessary alerts. Additionally, 98.9% of opioid alerts were not associated with an actual adverse drug event, nor were they thought to have averted one. This is in alignment with a recent meta-analysis demonstrating that overriding alerts did not result in adverse drug events in more than 97% of cases,⁵ highlighting the need for alert redesign to decrease the number of alerts that are clinically insignificant and contribute to alert fatigue.

To increase selectivity and accuracy, future research should focus on testing a tiered approach to decrease the overall volume of interruptive alerts and increase specificity. This approach moves less clinically significant alerts to a noninterruptive format, and only the most critical, high-severity alerts result in hard stops or interruptive alerts. This strategy has been shown to significantly increase compliance to drug-drug interaction alerts^{38–41} and may be beneficial for other alert types as well.

For drug-allergy alerts, retaining only exact and base ingredient matches as interruptive alerts could decrease the alert volume without sacrificing sensitivity. If applied to our data set, this would decrease the volume of interruptive drug-allergy alerts by 85.5% without eliminating alerts that resulted in an actual or averted adverse drug event. Eliminating intolerances from the electronic health record entirely results in loss of information that may harm patients, suggesting the need to maintain this information in a noninterruptive manner. Providers should have the option to classify an opioid reaction as an intolerance or a true opioid drug allergy.

Duplicate drug order and duplicate therapy alerts may also benefit from a tiered approach. In a cohort of opioid-naïve patients and those receiving long-term opioid treatments, patients with a dose of 50 morphine equivalents per day had a 3- to 6-fold increased risk of opioid overdose death, increasing further at morphine equivalents doses higher than 100 morphine equivalents/day.^{33,42} In accordance with these results, we suggest that future research explore moving duplicate drug order and therapy alerts to a noninterruptive format if morphine equivalent in the past 24 hours is less than 50, and interruptive alerts should be triggered for duplicate doses equal to or higher than 50 morphine equivalents/day.

In summary, all of the opioid-related adverse drug events identified in our study were not preventable by clinical decision support systems. This is not because systems failed to

intercept potentially dangerous opioid drug orders; rather, clinical decision support systems may have actually prevented 38 adverse drug events by firing 46 alerts. However, to prevent those adverse drug events, the clinical decision support system fired 4,692 alerts, and this is where the clinical decision support system is failing: overwhelming providers with unnecessary and clinically inconsequential alerts.

It is well established that clinical decision support prevents adverse drug events. It is essential to refine alerting systems to highlight clinically significant alerts and eliminate inconsequential alerts, thereby preventing alert fatigue and maintaining patient safety.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Editor's Capsule Summary**What is already known on this topic**

Electronic ordering systems allow real-time alerts to help improve safety during emergency care, but these alerts are often overridden.

What question this study addressed

Do electronically triggered drug dosing alerts during emergency department (ED) care improve care as assessed by adverse drug events recorded, particularly for alerts about opioids?

What this study adds to our knowledge

Using a retrospective assessment of 4,581 patients during 5 months at 1 site, the authors saw opioid alerts overridden much more than those for other agents, but without an increase in reported adverse events. Some opioids alerts appeared to help avoid potential adverse events.

How this is relevant to clinical practice

Further honing of ED drug warnings, especially those for opioids, is warranted.

Figure.
Relationship between opioid prescriptions, overridden alerts, adverse drug events, and clinical decision support preventability.

Table 1

Description of alert and adverse drug event types.

Alert type	Description
Duplicate therapy	An alert when a provider prescribes a drug that acts by similar mechanisms or is in the same pharmacologic group as an active drug already on the patient's drug list
Duplicate drug order	An alert when a provider prescribes the same drug as an active drug already on the patient's drug list
Drug allergy	The patient has an allergy listed in his or her record for which a provider prescribes the same or similar drug. These drug-allergy alerts are triggered for drug class matches, as well as for exact and base ingredient matches.
Drug-drug interactions	An alert when the prescribed drug or its metabolites may interact with another drug on the patient's drug list. Unknown drug-drug interactions refer to combinations of drugs that are not known to interact with one another but have also not been confirmed to be a safe combination.
Pregnancy/lactation	For a woman who is pregnant or breastfeeding, an alert that is triggered for drugs that may have a teratogenic effect or be harmful to a breastfeeding infant. These are 2 separate alerts that were combined for the purposes of this study.
Other	Alerts such as "drug-disease" and "geriatric." These alerts were combined for the purposes of this study.
ADE type	
Actual ADE	Experienced by a patient and identified by chart review
Averted ADE	Derived from the definition of potential ADE ¹⁵ : "a medication error with the potential to cause an injury but which does not actually cause an injury...because the error is intercepted and corrected"
	Duplicate therapy or duplicate drug alerts criteria: more than 50 morphine equivalents were administered before the current order was placed in the 24 h before drug order
	Drug-allergy alerts criteria: the ordered drug was a base or exact ingredient match to the drug the patient had a documented allergy to
ADE preventable by CDS	An ADE was considered preventable if all of the below were true: <ol style="list-style-type: none"> 1 an actual ADE occurred 2 the ADE was due to a drug error and did not occur spontaneously 3 the drug associated with the ADE was ordered electronically
ADE prevented by CDS	An ADE was considered prevented if: <ol style="list-style-type: none"> 1 an alert was generated by the CDS system 2 the alert was accepted 3 the alert averted an ADE, as defined above

ADE, Adverse drug event; *CDS*, clinical decision support.

Study population characteristics for patients who were prescribed an opioid and whose data either triggered no opioid-related alerts or triggered at least 1 opioid-related alert.

Table 2

Patient Characteristic	Patient Visits With No Opioid Alerts			Patient Visits With at Least 1 Opioid Alert		
	No.	%	95% CI	No.	%	95% CI
All patients prescribed an opioid	1,318	61.5	59.4–63.6	826	38.5	36.4–40.7
Age, mean, y	1,318	41.1	40.2–42.0	826	43.4	42.3–44.5
Male sex	587	44.5	41.2–47.8	299	36.2	32.9–39.5
Race						
Non-Hispanic white	594	45.1	42.4–47.8	416	50.4	47.0–53.8
Black	322	24.4	22.1–26.7	219	26.5	23.5–29.5
Hispanic white	326	24.7	22.4–27.0	148	17.9	15.3–20.5
Asian	23	1.8	1.1–2.5	8	0.97	0.3–1.6
Other	53	4.0	2.9–5.1	35	4.2	2.8–5.6
Triage level, ESI						
1–2	384	29.1	26.7–31.6	228	27.6	24.6–30.7
3	573	43.5	40.8–46.2	383	46.4	43.0–49.8
4–5	361	27.4	25.0–29.8	215	26.0	23.0–29.0
Patient ED length of stay, median (IQR), h	1,318	4.4	2.9–6.7 (IQR)	826	4.8	3.1–7.8 (IQR)
Total drugs prescribed or ordered, mean	1,318	4.9	4.7–5.1	826	5.7	5.4–6.0
ED disposition						
Admit	332	25.2	22.9–27.5	209	25.3	22.9–28.9
Discharge	966	73.3	70.9–75.7	605	73.2	70.2–76.2
Left before discharge or admit	9	0.68	0.24–1.1	9	1.1	0.4–1.8
Transfer	8	0.61	0.19–1.0	1	0.12	0–0.36
Missing	3	0.23	0–0.49	2	0.24	0–0.57
Location of ordered and prescribed opioids						
In ED and discharge	442	33.5	31.0–36.1	455	55.1	51.7–58.5
Only at discharge	141	10.7	9.0–12.4	78	9.4	7.4–11.4
Only in ED	735	55.8	53.1–58.5	257	31.1	27.9–34.3
No opioid received [*]	0	0	0	36	4.4	3.0–5.8

* These are patients who either had accepted opioid alerts or were prescribed an opioid in the ED, but the drug was administered in a different department.

ESI Emergency severity index.

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Table 3

Interruptive nonopioid and opioid drug alerts: relative risk of override stratified by provider type and alert type in a random sample of 1 alert per patient visit.

n=1,576	Opioid Overrides, % (n)	Nonopioid Overrides, % (n)	Relative Risk	95% CI
Overall total	95.7 (628)	89.7 (818)	1.35	1.21–1.50
Provider type				
Pharmacist	97.6 (80)	89.4 (236)	1.25	1.11–1.40
PA	97.0 (64)	89.2 (58)	1.64	1.10–2.43
RN	90.7 (49)	98.6 (70)	0.28	0.05–1.71
Physician	96.6 (200)	91.1 (164)	1.54	1.15–2.07
Resident	94.8 (219)	87.3 (289)	1.37	1.16–1.61
Other *	100 (2)	94.1 (16)	1.13	0.96–1.32
Alert type				
Duplicate therapy	98.6 (342)	94.3 (377)	1.57	1.30–1.89
Duplicate med order	98.9 (93)	91.5 (246)	1.32	1.19–1.47
Drug allergy	87.4 (153)	58.1 (68)	2.24	1.74–2.89
Drug-drug interaction	100 (2)	97.6 (41)	1.05	0.98–1.12
Lactation/pregnancy		All alerts overridden; n=46 nonopioids, n=24 opioids		
Other		All alerts overridden; n=57 nonopioids, n=3 opioids		

PA, Physician assistant; RN, registered nurse.

*“Other” includes anesthesiology assistants, technicians, medical students, and respiratory therapists.