Sustained Implementation of a Multicomponent Strategy to Increase Emergency Department-Initiated Interventions for Opioid Use Disorder

Margaret Lowenstein, MD, MSHP*; Jeanmarie Perrone, MD; Ruiying A. Xiong, MS; Christopher K. Snider, MPH; Nicole O’Donnell, CRS; Davis Hermann, MD; Roy Rosin, MBA; Julie Dees, MBA, MA; Rachel McFadden, BSN, RN; Utsha Khatri, MD, MSHP; Zachary F. Meisel, MD, MS; Nandita Mitra, PhD; M. Kit Delgado, MD, MS

*Corresponding Author. E-mail: margaw@pennmedicine.upenn.edu.

INTRODUCTION

Opioid use disorder and overdose deaths are rapidly accelerating in the United States, with over 90,000 drug overdose deaths in 2020, largely due to opioids.1 Opioid use disorder-related emergency department (ED) visits have also increased 100% in the past decade, and there has been increased recognition that ED visits are critical opportunities to initiate evidence-based interventions for opioid use disorder.2,3 Medications for opioid use disorder, including methadone and buprenorphine, improve a number of outcomes in patients with opioid use disorder, including mortality, measures of physical and mental health, illicit drug use, and retention in treatment.4,5 Initiation of buprenorphine in a setting as accessible as the ED is particularly promising since it can be administered or prescribed from the ED and continued in general outpatient settings, such as primary care. Randomized controlled trial evidence has demonstrated that ED-initiated buprenorphine doubles rates of treatment engagement at 30 days compared to referral alone and is cost-effective.6,7 Importantly, the initiation of buprenorphine after a nonfatal overdose is associated with a 38% reduction in mortality at 1 year.8 The strength of the evidence has led to recent calls to action by professional and
government organizations for EDs to implement opioid use disorder treatment protocols.9,10 Despite calls to action, there is limited evidence on effective strategies to implement ED-initiated treatment for opioid use disorder and sustain increases in prescribing. Numerous barriers to opioid use disorder treatment have been described, including time, competing demands, lack of knowledge or comfort with opioid use disorder treatment, and lack of protocols or guidance.11-13 Treatment implementation is further complicated by regulatory requirements, including the need for a DATA 2000 waiver, better known as an X-waiver, required to prescribe buprenorphine for the outpatient setting after discharge. Although federal legislation in April 2021 eliminated the required training to obtain an X-waiver for prescribing buprenorphine to up to 30 patients, it is unclear how this will translate to practice change.14 Multiple studies in non-ED settings have demonstrated that even among X-waivered providers, the majority do not prescribe buprenorphine.15 Furthermore, even among X-waivered providers in the acute care setting, other commonly cited obstacles include lack of referral pathways for outpatient treatment and perceived patient barriers, such as lack of housing or social support.12,16 A critical challenge for widespread adoption is designing scalable strategies that overcome these multilevel barriers to treatment. Prior work from our team demonstrated that a financial incentive was effective in increasing X-waiver credentialing and buprenorphine prescribing in the immediate postperiod, increasing the percentage of X-waivered emergency physicians from 6% to 89%.17 However, it remained unclear whether this practice would be sustained and universally adopted across ED clinicians. Here, we describe the implementation of a multicomponent ED-based strategy for increasing the identification and treatment of patients with opioid use disorder at 3 urban EDs within a large, academic health system. Our objective was to evaluate the association of these interventions with increasing and sustaining treatment of opioid use disorder in our ED and explore provider-level variation in outcomes.

**METHODS**

**Study Design and Setting**

We conducted a retrospective evaluation of the implementation and maintenance of our multicomponent strategy to increase ED-based treatment for opioid use disorder. Our study design was informed by the Reach, Effectiveness, Adoption, Implementation, and Maintenance framework, which provides a structured approach to measuring the implementation of evidence-based practices.18 In evaluating our outcomes, we were interested in adoption (ie, the proportion of providers who administered buprenorphine in the ED and wrote buprenorphine prescriptions), implementation (ie, the use of the strategies), and maintenance (ie, the impact over time). The study was approved by the University of Pennsylvania Institutional Review Board and followed the Standards for Quality Improvement Reporting Excellence 2.0 reporting guidelines.19

Penn Medicine is a large, academic health system in Philadelphia, which has the highest overdose death rate of any large US city.20 The hospitals included in our study include a large tertiary referral hospital, a level I trauma center, and a third downtown hospital with an associated psychiatric crisis center. Together, these 3 EDs receive approximately 120,000 visits annually. Prior to the interventions, there was limited use of buprenorphine or take-home naloxone despite efforts of clinician champions and the implementation of health system guidelines for treatment initiation in patients with opioid use disorder.

**Selection of Participants**

For our analysis, we included adult patients (18 years or older) who were seen and discharged after opioid-related ED visits at any of 3 urban, academic EDs within Penn Medicine.
Medicine from March 2017 to July 2020. Opioid-related encounters were identified using International Classification of Diseases (ICD)-10 codes for opioid use disorder and overdose (Appendix E1, available at http://www.annemergmed.com). We included all patients, regardless of whether they were on medications for opioid use disorder before the index visit.

**Interventions**

Our implementation strategies were informed by principles of behavioral change and iteratively tested through a series of targeted pilots. Implementation strategies can be defined as “methods or techniques used to enhance the adoption, implementation, and sustainability of a clinical program or practice.” Our strategies focused on provider training, electronic health record decision support, integration of peer recovery specialists into clinical teams, and the use of automated prompts to streamline processes.

The design was influenced by the Fogg Behavior Model, which asserts that in order for behavioral change to occur, 3 things must be in place: (1) sufficient motivation, (2) the ability to perform the behavior, and (3) a trigger to perform the behavior. To inform the strategies, we used innovation and design methods, borrowing from industries outside health care that have developed approaches to design and refine techniques or products in a way that allows them to quickly learn and iterate before large-scale implementation. These methods often are referred to as “rapid-cycle innovation,” “fail fast,” or “user-centered design” and include multiple elements. The work included 4 phases: (1) contextual inquiry, (2) problem definition, (3) exploration of alternatives, and (4) rapid validation.

Contextual inquiry included conducting a survey of emergency physicians about barriers to treatment initiation as well as observing ED workflows, including monitoring patients on the ED tracking board and informally interviewing providers to understand how patients presented to the ED and where missed opportunities for patient engagement in treatment were. Using these initial inputs, we then refined our goals and conducted small, rapid pilots to iteratively refine the components below.

**ED treatment initiation (ability).** To build capacity among ED providers to administer and prescribe medications for opioid use disorder, our health system invested in X-waiver training for all emergency physicians. The details of this intervention are reported elsewhere, but briefly, providing a financial incentive for X-waiver training led to substantial increases in the number of waivered providers, from 6% to 90% over a 6-week period when the incentive was offered (November to December 2019). X-waiver training was also associated with increased physician confidence in initiating buprenorphine treatment in the ED. In addition, our team developed 2 order sets in the electronic health record, which provided clinical decision support and prepopulated orders for (1) initiation of buprenorphine and (2) discharge orders for patients with opioid use disorder.

**Integration of peer recovery specialists (ability).** We leveraged the expertise of trained peer recovery specialists working in the health system to increase engagement of patients in opioid use disorder treatment. Peer recovery specialists provide nonclinical support to people living with substance use disorders who are seeking recovery assistance and have expertise in engaging with patients and in navigating patient and system barriers to care. Core activities include system navigation, supporting behavior change, harm reduction, and relationship building.

Additional activities include referrals and support for treatment, housing, transportation, employment, drug court proceedings, and other community supports Peer recovery specialists facilitated follow-up for patients who initiated treatment in the ED, with referrals made to primary care practices in the health system, internal and external specialty substance use treatment programs, and a local harm-reduction organization that could provide care for uninsured patients. Peer recovery specialists were already employed in our health system but rarely worked in the ED, representing a missed opportunity to augment care for patients with opioid use disorder. During this study period, peer recovery specialists were available weekdays during business hours and evenings until 10 PM with on-call support on weekends.

**Use of automated alerts to amplify connections with peer recovery specialists (prompts).** To increase the connection of patients with opioid use disorder to peer recovery specialists, we developed a system for real-time, automated identification of patients with known or suspected opioid use disorder. Based on the literature and chart review, we identified a simple set of criteria that could predict patients who might be appropriate for peer recovery specialist consultation. These included (1) a chief complaint suggestive of opioid use disorder (ie, overdose, detox), (2) a diagnosis or visit for opioid use disorder in the electronic health record within the past year based on ICD code criteria, and (3) receipt of naloxone or buprenorphine during their ED visit. Using the program Agent, which integrates into the electronic health record and can scan ED patient charts in real time, we used these criteria to generate messages that went directly to the peer recovery specialists through a secure, Health Insurance Portability and
Accountability Act-compliant mobile application. The peer recovery specialists were then able to review patient charts, contact the care team, and go directly to the patient bedside for a consultation without additional steps on the part of ED providers. This system runs in the background and complements other forms of patient identification, such as traditional consults initiated by individual ED providers.

**Culture change (motivation).** Facilitating culture change to both motivate and reinforce positive changes was a final element of our strategy. We employed several methods to achieve this. First, we provided public appreciation and acknowledgment when ED clinicians started medication for opioid use disorder or initiated referrals. Second, we created wearable buttons to distribute to physicians the first time they wrote a prescription for buprenorphine. Finally, we promoted professional relationships between peer recovery specialists and ED clinicians through frequent communication and follow-up. During the first several months of the rollout, our team provided feedback to ED providers for patients they had seen through email or in-person communication, including when they attended follow-up appointments or experienced other positive outcomes related to treatment.

**Data Source**

We used data from the Epic electronic health record pulled from Clarity, a reporting database for Epic (Hyperspace 2017; Epic Systems Corporation, Verona, WI). Rates of missingness for our primary and secondary outcomes were 0%, and no patients were excluded because of missing data.

**Outcomes**

We assessed both clinical care measures and process measures based on previously identified quality measures for ED-based opioid use disorder care, including diagnosis, assessment and acute stabilization, treatment, and implementation of harm-reduction interventions. For the clinical care measures, our primary outcome was the buprenorphine treatment rate per opioid-related ED encounter, a composite metric that included buprenorphine administration in the ED and/or a prescription for buprenorphine at discharge. We also assessed the proportion of patients receiving methadone administered in the ED, which included either a continuation of methadone treatment after confirmation with a patient’s opioid treatment program or a one-time, low dose of methadone for treatment of withdrawal as allowed by federal law for patients in the hospital. The choice to use methadone as opposed to buprenorphine was left to the providers; our ED does not provide direct referrals to opioid treatment programs, so buprenorphine is recommended in ED guidelines as first-line treatment due to flexibility in options for follow-up, and methadone is not part of the electronic health record decision support. There are internal guidelines for methadone dosing available for providers in the ED and hospital, with psychiatric consultation required only for those admitted with a plan for dose increases for initiation of methadone maintenance. Finally, we measured the proportion of patients receiving naloxone prescriptions at discharge, a measure of harm reduction implementation. In addition, we assessed adoption by measuring provider-level prescribing of buprenorphine per opioid use disorder-related encounter before and after the implementation of our interventions. We also evaluated process measures, including assessment of withdrawal (as measured by nurses using the clinical opioid withdrawal scale [COWS], which was recorded in the electronic health record) and the use of either of 2 ED order sets for treatment in the ED and at discharge. Order sets contained decision support and prepopulated orders for 2 pathways, buprenorphine initiation in the ED and discharge orders for opioid use disorder. Clinicians could also initiate medications outside the order set pathway.

**Other Variables**

We extracted demographic and other patient characteristics from the electronic health record, including age, sex, race/ethnicity, and insurance status. We also extracted comorbid mental health and substance use disorders using ICD-10 codes and calculated Charlson comorbidity index scores based on previously coded diagnoses in patient records. We characterized patient visits in terms of presentation type: overdose, withdrawal, and other, based on ICD-10 codes (Appendix E1), and extracted urine drug screen results from the electronic health record in cases for which this was available. Finally, we reported length of stay for the index visit as well as repeat ED visits and hospital admissions at 30 days from the index visit. ED length of stay was an important balancing measure to ensure that increasing treatment interventions for opioid use disorder did not have a detrimental impact on ED throughput.

**Analysis**

We used descriptive statistics to characterize the sample and compared patient and visit characteristics between the preperiod and postperiod using difference in proportions for independent samples, reporting mean deltas and 95% confidence intervals (CIs). In addition, we included...
descriptive analysis of trends in our key quality indicators over time. For buprenorphine prescriptions, we also included a provider-level analysis of rate of buprenorphine prescriptions per opioid use disorder-related encounter after the interventions after restricting the reporting to providers with 10 or more opioid use disorder-related encounters.

We conducted an interrupted time series analysis (ITSA) using multivariable logistic regression to assess changes in our primary outcome, total buprenorphine use, and other treatment and process measures as secondary outcomes. We used a patient-level logistic regression model, controlling for patient characteristics and calendar time with fixed effects at the hospital level, to model the association of the interventions with treatment and process outcomes. The unit of analysis was the study month, and the model included calendar time (study month), time period (pre versus post), and an interaction term between calendar time and time period. We looked at standardized mean differences over time among patient characteristics and included covariates with standardized mean differences of more than 0.1 in the final model. The preperiod went from March 2017 to November 2018, and the postperiod went from December 2018 to July 2020, the last data available at the time of analysis. The time interval reflected the month that both the X-waivering campaign and the patient identification alerts went into effect, automating the process of connecting ED patients with peers in recovery. We report adjusted outcomes and adjusted marginal probabilities associated with intervention implementation. We also included a simple ITSA using linear regression for the purposes of illustration. For the simple ITSA, we modeled the change in proportion of visits demonstrating each outcome of interest per month before and after the implementation period. The unit of analysis was the study month, and the proportion of visits with each outcome of interest was treated as a continuous variable. Analyses were conducted using Stata (version 15.1; StataCorp) and R statistical software.35

RESULTS

Patient and Visit Characteristics

Over the study period, there were 2,665 total opioid use disorder-related visits in the study EDs. Characteristics of patients seen in the EDs for opioid use disorder-related visits are shown in Table 1. The majority of patients were men, middle-aged, and publicly insured. Fifty-five percent of patients were White and 41% identified as Black, with low comorbid mental health disorders, substance use disorders, and chronic conditions captured in our health system. In the prior year, the mean number of ED visits was 3.5, and that of hospital admissions was 0.4, within the study health system. Patient characteristics did not differ significantly across the pre and post periods (Table 1).

There were 1,326 total unique visits in the preperiod and 1,339 in the postperiod (Table 2, Figure 1). There was some variation by season and across time, with higher monthly visits toward the end of the study period. We also broke visits down by presentation type, including overdose, withdrawal, and other opioid use disorder-related visits. There were 737 (28%) visits for drug overdose, 213 (8%) for opioid withdrawal, and 1,715 (64%) for other opioid use disorder-related conditions, with the proportion of patients with overdose decreasing by 15.8% (95% CI –22.3% to –9.3%) and other presentations increasing by 13% (95% CI 8.9% to 17.9%) in the postperiod.

Urine drug screens were collected for 29%, and of those tests collected, 25% contained fentanyl, 69% other opioids, 22% stimulants, and 32% with benzodiazepines, with many containing multiple substances. Of note, our institution did not routinely perform urine fentanyl testing until December 2019, so our data likely underreport the actual prevalence of fentanyl, which was known to be widely available in Philadelphia during the study period.

ED length of stay averaged 5.4 hours and did not change significantly over time despite the introduction of our interventions (5.5 hours in the preperiod and 5.3 hours in the postperiod, 95% CI −0.2 to 0.5 hours). Finally, 30-day ED revisits and hospital admissions were 35% (preperiod 35.3% and postperiod 34.9%, 95% CI −6.5% to 5.7%) and 7% (preperiod 6.6% and postperiod 6.5%, 95% CI −7.4% to 7.2%), respectively, with no significant differences across time periods.

Treatment and Process Outcomes

Next, we examined the impact of the multicomponent strategy on treatment and process outcomes for patients with opioid use disorder-related encounters over the study period (Table 2, Figure 2). Following implementation, we observed increases in both ED administration and discharge prescribing of buprenorphine as well as naloxone prescriptions at discharge. We also observed increases in all the process measures, including COWS measurement and use of order sets, a minor increase in the ED opioid use disorder induction order set, and substantial use of the discharge order set.

Overall, 13% of patients over the study period received medications for opioid use disorder during or after their ED visit. Prior to implementation, this was just 3%, whereas 23% received medications for opioid use disorder following
implementation of the interventions. This net increase of 20% was statistically significant (95% CI 12.9% to 27.1%). The majority received buprenorphine, either in the ED, at discharge, or both. There were no significant changes in rates of ED methadone administration. Trends were similar when we looked at absolute numbers of the outcomes rather than as a proportion of total opioid use disorder-related visits.

In the patient-level ITSA before and after implementation, there was an immediate increase in the adjusted marginal probability of total buprenorphine use of 24.5% (95% CI 12.1% to 37.0%) in association with the implementation of our multicomponent strategy to increase the identification and treatment of patients (Figure 2), and increases were sustained throughout the postperiod. We also saw significant increases in ED buprenorphine administration, with the buprenorphine administration increasing 14.6% (95% CI 4.8% to 24.3%) following the interventions and rising steadily throughout the study period (Figure 2). Naloxone prescribing at discharge did not increase significantly in association with the interventions but did increase over time (Figure 2). Details of the models are shown in Table E1 (available at http://www.annemergmed.com.) Process outcomes, including COWS measurement and use of the induction and discharge order sets, also increased significantly following the implementation period (Figure E1, available at http://www.annemergmed.com.) We also performed a simple ITSA at the visit level modeling the change in the proportion of visits, demonstrating each outcome of interest per month before and after implementation of the interventions. Following implementation, there was an immediate and statistically significant increase in total buprenorphine use of 11.8% (95% CI 6.0% to 17.5%) in association with the implementation of our multicomponent strategy to increase identification and treatment of patients (Figure E2, available at http://www.annemergmed.com.) We also saw significant increases in ED buprenorphine administration in association with the interventions, and

### Table 1. Characteristics of patients seen for opioid use disorder-related visits in study EDs.

<table>
<thead>
<tr>
<th>Patient Characteristics</th>
<th>Overall (n=2,665)</th>
<th>Preperiod (n=1,326)</th>
<th>Postperiod (n=1,339)</th>
<th>Delta 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD)</td>
<td>41.2 (14.3)</td>
<td>41.5 (14.3)</td>
<td>40.9 (14.2)</td>
<td>0.6</td>
</tr>
<tr>
<td>Male sex, n (%)</td>
<td>1,771 (66.5)</td>
<td>864 (65.2)</td>
<td>907 (67.7)</td>
<td>2.6%</td>
</tr>
<tr>
<td>Hispanic ethnicity, n (%)</td>
<td>147 (5.5)</td>
<td>67 (5.1)</td>
<td>80 (6.0)</td>
<td>0.9%</td>
</tr>
<tr>
<td>Race, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>1,471 (55.2)</td>
<td>709 (53.5)</td>
<td>762 (56.9)</td>
<td>4.4%</td>
</tr>
<tr>
<td>Black/African American</td>
<td>1,085 (40.7)</td>
<td>576 (43.4)</td>
<td>509 (38.0)</td>
<td>-5.4%</td>
</tr>
<tr>
<td>Asian/Pacific Islander</td>
<td>22 (0.8)</td>
<td>14 (1.1)</td>
<td>8 (0.6)</td>
<td>-0.5%</td>
</tr>
<tr>
<td>Other/unknown</td>
<td>87 (3.3)</td>
<td>27 (2.0)</td>
<td>60 (4.5)</td>
<td>-5.5%</td>
</tr>
<tr>
<td>Insurance status, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicaid</td>
<td>1,664 (62.4)</td>
<td>801 (60.4)</td>
<td>863 (64.5)</td>
<td>4.1%</td>
</tr>
<tr>
<td>Medicare</td>
<td>351 (13.2)</td>
<td>192 (14.5)</td>
<td>159 (11.9)</td>
<td>-2.6%</td>
</tr>
<tr>
<td>Commercial</td>
<td>426 (16.0)</td>
<td>219 (16.5)</td>
<td>207 (15.5)</td>
<td>-1.0%</td>
</tr>
<tr>
<td>Uninsured/unknown</td>
<td>224 (8.4)</td>
<td>114 (8.6)</td>
<td>110 (8.2)</td>
<td>-0.4%</td>
</tr>
<tr>
<td>Comorbidities, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>96 (3.6)</td>
<td>52 (3.9)</td>
<td>44 (3.3)</td>
<td>-0.6%</td>
</tr>
<tr>
<td>Anxiety</td>
<td>83 (3.1)</td>
<td>26 (2.0)</td>
<td>57 (4.3)</td>
<td>2.3%</td>
</tr>
<tr>
<td>Bipolar disorder</td>
<td>24 (0.9)</td>
<td>4 (0.3)</td>
<td>20 (1.5)</td>
<td>1.2%</td>
</tr>
<tr>
<td>Schizophrenia</td>
<td>21 (0.8)</td>
<td>9 (0.7)</td>
<td>12 (0.9)</td>
<td>0.2%</td>
</tr>
<tr>
<td>Stimulant use disorder</td>
<td>158 (5.9)</td>
<td>81 (6.1)</td>
<td>77 (5.8)</td>
<td>-0.3%</td>
</tr>
<tr>
<td>Alcohol use disorder</td>
<td>106 (4.0)</td>
<td>53 (4.0)</td>
<td>53 (4.0)</td>
<td>0%</td>
</tr>
<tr>
<td>Benzodiazepine/sedative use disorder</td>
<td>62 (2.3)</td>
<td>38 (2.1)</td>
<td>24 (1.8)</td>
<td>-1.1%</td>
</tr>
<tr>
<td>Charlson, mean (SD)</td>
<td>0.9 (1.9)</td>
<td>0.90 (1.9)</td>
<td>0.85 (1.9)</td>
<td>0.1</td>
</tr>
<tr>
<td>Previous ED visit in last 12 months, mean (SD)*</td>
<td>3.5 (10.1)</td>
<td>3.9 (11.1)</td>
<td>3.2 (8.8)</td>
<td>0.7</td>
</tr>
<tr>
<td>Previous hospital admissions in last 12 months, mean (SD)*</td>
<td>0.40 (1.55)</td>
<td>0.35 (1.52)</td>
<td>0.45 (1.57)</td>
<td>-0.10</td>
</tr>
</tbody>
</table>

CI, confidence interval.

*Denotes ED visit and hospital admissions within the study health system only.
while naloxone prescribing at discharge did not increase significantly in association with the interventions, prescribing did increase over time. 

**Provider-Level Variation**

Finally, to understand provider-level variation in the adoption of practice changes, we performed a provider-level

![Image](image-url)
Figure 2. Adjusted treatment outcomes before and after implementation. Multivariable logistic regression models were adjusted for patient characteristics and calendar time with hospital-level fixed effects. The dashed line represents the implementation period. A, Total buprenorphine administration. B, Buprenorphine administration in the ED. C, Naloxone prescription at discharge.
analysis of buprenorphine prescriptions per opioid use disorder-related encounter. Among attending physicians with 10 or more opioid use disorder-related encounters over the study period, we found that only 7% of providers wrote any buprenorphine prescriptions in the preperiod. In the postperiod, 70% of providers wrote at least 1 buprenorphine prescription (Figure 3).

Despite this strong uptake, the mean rate of prescribing per opioid use disorder-related encounter varied substantially among providers. Overall, we saw buprenorphine prescriptions for 11% of opioid use disorder-related encounters (median 11%, interquartile range 0% to 29%). Individual provider-level prescribing rates ranged from 0% to 61% of opioid use disorder-related encounters.

LIMITATIONS

Our study has several important limitations. First, we present results from a single urban, academic health system in a city highly affected by the opioid crisis and our local patient population, so the results may not be generalizable to all settings. Second, our interventions could not have been implemented without financial support, which included the salaries of our peer recovery support staff, the time and resources of the Center for Health Care Innovation, and the investment from the health system to provide financial incentives for obtaining an X-waiver. Third, we were unable to measure all components of the interventions, including, most notably, the frequency of peer recovery specialist consults or linking peer recovery specialist consults with individual patient visits. Fourth, all intervention components were implemented in close proximity, making it difficult to disentangle the impacts of individual elements. Additionally, we lacked a control group and, therefore, cannot determine whether the interventions caused changes in our outcomes or whether they were due to secular trends. However, we did see an immediate and sustained increase that was closely temporally associated with the implementation of the interventions. Finally, we only had access to electronic health record data from within our health system; therefore, we did not capture measures from other hospitals, and our patient identification algorithm likely missed some patients with opioid use disorder and incorrectly identified others. There is also potential for misclassification from the use of electronic health record data that relied on diagnostic codes or chief complaint data, including missing patients with opioid use disorder or inappropriately including people without opioid use disorder, a known limitation of electronic health records for the identification of patients with opioid use disorder. However, our process and treatment outcomes still required clinical decision making on behalf of providers, reflecting real changes in provider practice.

DISCUSSION

Our study demonstrated that a combination of strategies to increase evidence-based opioid use disorder care in the
ED was associated with increases in ED initiation of treatment that were sustained over time. We observed these increases in ED interventions for patients with opioid use disorder—including absolute increases in buprenorphine use by 20% and naloxone prescription upon discharge by 14%—without increased ED length of stay. However, we also saw that uptake varied substantially at the provider level, suggesting opportunities for continued improvement.

Our study adds to the literature in several key ways. First, to our knowledge, this is the first study to describe the automation of patient identification and peer recovery specialist consultation. Much of the work describing the implementation of ED buprenorphine has focused on initiatives for education, guidelines, or consultative staff models. While addressing barriers to opioid use disorder treatment identified in prior studies, these interventions alone may not be sufficient to significantly alter provider practices, as was the case in our study EDs prior to the interventions described in this study. The peer recovery specialists likely reduced the typical friction involved in initiation treatment by addressing both providers’ ability to prescribe buprenorphine (assisting with patient engagement and linkage to longitudinal care) and their motivation to do so (by providing support for not only the patient but also the prescriber in implementing practice change).

Further, although peer specialists are increasingly used for opioid use disorder-related ED interventions, the automated consultation process in our study helped to ensure that the connection was made in the setting of numerous competing priorities. Automation makes consultation an “opt-out” rather than “opt-in” process, capitalizing on the status quo bias that makes individuals more likely to go with the default option. This principle has been effectively leveraged for other health care interventions, from opioid prescribing to end-of-life decisionmaking. Because all information used to identify patients is found within the electronic medical record, this is a scalable strategy that other EDs could implement to identify eligible patients with opioid use disorder and connect them with services.

Despite these successes and the strong institutional support for implementation, there was still substantial provider-level variation in the adoption of buprenorphine prescribing. Even among those who obtained X-waivers, there was still wide variability among prescribers, with buprenorphine prescribing rates ranging from 0% to more than 60% of opioid use disorder-related encounters. In the literature, it is unclear what an appropriate target goal for treatment is and what targets should be for future quality improvement initiatives. Similar data are limited—1 recent study of the implementation of a clinical decision-support tool demonstrated 6.6% of potentially eligible patients with opioid use disorder-related visits received buprenorphine. Similarly, naloxone was dispensed, on average, to 25% of patients across our study but to more than 30% of opioid use disorder-related visits by the end of the study period. Prior literature has demonstrated that naloxone is prescribed to less than 2% of patients at risk of overdose overall, with low rates nationally in ED settings.

Although our interventions resulted in rates of treatment comparable to or better than many reported in the literature, the provider-level data suggest that by targeting variability, there are likely opportunities to increase treatment. For example, studies in other areas have demonstrated that peer-comparison data can be presented to individuals to increase their adoption of evidence-based practices. There may be opportunities to employ similar strategies to prompt treatment with medication for opioid use disorder or provision of naloxone to at-risk patients in the ED.

Finally, our study provides important evidence of X-waiver training for emergency physicians. This is particularly important in light of the recent announcement from the Department of Health and Human Services eliminating training requirements for the X-waiver for buprenorphine providers prescribing for up to 30 patients—which would likely include the majority of ED providers. Following the implementation period in our study, buprenorphine prescribing rates increased substantially, and the majority of physicians wrote at least one prescription. However, the substantial variability described above demonstrates that like in other settings, many providers who receive an X-waiver frequently do not make use of it and rarely prescribe close to their full capacity. These findings suggest that while the X-waiver is necessary, it is not sufficient. Adoption of prescribing by 70% of prescribers this study in the postperiod is higher than the 50% rates cited in a recent national study, suggesting that the additional interventions in our setting contributed to wider adoption of prescribing practices. As discussions of completely eliminating - or “X-ing” - the X-waiver continue at the federal level, it is critical to remember that the regulatory barriers around prescribing comprise only one of many challenges that needs to be addressed to promote practice change among clinicians. Although this policy change is an important step to substantially expand access to evidence-based care for opioid use disorder, it will likely be most successful if coupled with other initiatives to support providers and patients with opioid use disorder.
In conclusion, the implementation of a multicomponent, multidisciplinary strategy to increase the delivery of opioid use disorder treatment and harm-reduction practices was associated with a sustained increase in the initiation of medications for opioid use disorder and naloxone provision. Our results underscore the importance of implementing multiple components to influence and sustain behavioral change and are potentially scalable across a variety of EDs nationally. The next stages for implementation may benefit from a focus at the policy and system levels on reducing provider variation and strategies to move providers closer to higher treatment rates.

Acknowledgments

The authors would like to acknowledge the Penn Medicine Center for Health Care Innovation for the support in its accelerator program and, specifically, team members Pamela Caccione, Manik Chhabra, Yeegeny Gitelman, Kelli Murray-Garant, Carolina Garzon, Austin Kilaru, Bryant Rivera, Dunia Tonob, Madeline Snyder, and Srikanth Gowda. The authors would also like to thank ED leadership at Penn Presbyterian Medical Center, including Christopher Edwards and Sean Foster, for their support of these efforts. Dr. Edwards was also instrumental in the development of order sets.

Supervising editor: Donald M. Yealy, MD. Specific detailed information about possible conflict of interest for individual editors is available at https://www.annemergmed.com/editors.

Author affiliations: From the Division of General Internal Medicine (Lowenstein, Xiong), the Department of Emergency Medicine (Perrone, O’Donnell, McFadden, Meisel, Delgado), and the Department of Biostatistics and Epidemiology (Mitra), Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA; the Center for Health Care Innovation (Snider, Hermann, Rosin), Penn Medicine, Philadelphia, PA; the Family Service Association of Bucks County (Dees), Langhorne, PA; and the Department of Emergency Medicine (Khatri), Mount Sinai Icahn School of Medicine, New York, NY; the Leonard Davis Institute of Health Economics (Lowenstein, Perrone, Rosin, Meisel, Mitra, Delgado), University of Pennsylvania, Philadelphia, PA; and the Center for Addiction Medicine and Policy (Lowenstein, Perrone), University of Pennsylvania, Philadelphia, PA

Author contributions: ML and MKD were responsible for the study concept and design. ML, CS, and MKD were responsible for acquisition of the data. ML, RAX, NM, and MKD analyzed and interpreted the data. ML and MKD drafted the manuscript, and JP, NO, DH, RR, JD, RM, UK, and ZFM critically revised the manuscript for important intellectual content. RAX and NM were responsible for statistical expertise. MKD and JD were responsible for acquisition of funding. ML takes responsibility for the paper as a whole.

All authors attest to meeting the four ICMJE.org authorship criteria: (1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (2) Drafting the work or revising it critically for important intellectual content; AND (3) Final approval of the version to be published; AND (4) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Funding and support: By Annals policy, all authors are required to disclose any and all commercial, financial, and other relationships in any way related to the subject of this article as per ICMJE conflict of interest guidelines (see www.icmje.org). This work was supported by the Penn Injury Science Center (CDC 19R49CE003083), Penn Medicine Center for Health Care Innovation Accelerator Program, and SAMHSA (H79T081596-01). Dr. Delgado was also supported by the National Institute of Child Health and Human Development (grant K23HD090272001) and by a philanthropic grant from the Abramson Family Foundation.

Publication dates: Received for publication April 7, 2021. Revision received July 15, 2021. Accepted for publication October 18, 2021.

REFERENCES


