Postoperative opioid prescription patterns and new opioid refills following cardiac implantable electronic device procedures

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BACKGROUND  Prescription opioids are a major cause of the opioid epidemic. Despite the invasive nature of cardiac implantable electronic device (CIED) procedures, data on opioid prescription patterns after CIED procedures are lacking.

OBJECTIVE  The purpose of this study was to assess opioid prescribing patterns and the rates of new opioid refills (refills in previously opioid naïve patients) among patients undergoing CIED procedures.

METHODS  We performed a retrospective analysis of all patients undergoing CIED procedures from January 1, 2010, to March 30, 2018, at the Mayo Clinic (Minnesota, Arizona, and Florida). Procedures were categorized into new implant, generator change, device upgrade, lead revision or replacement, and subcutaneous implantable cardiac defibrillator (S-ICD) procedures. The rates of postoperative opioid prescription and new opioid refills were analyzed. Wilcoxon rank sum and χ² tests assessed variations.

RESULTS  A total of 16,517 patients (mean age 70 ± 15; 36% female) underwent CIED procedures. Opioids were prescribed to 20.2% of the patients, among whom 80% were opioid naïve. Among opioid naïve patients who received opioids, 9.4% (95% confidence interval [CI] 8.3%–10.5%) had subsequent opioid refills. The percentage of patients who received more than 200 oral morphine equivalents of prescription was 38.8% (95% CI 37.2%–40.5%). Temporal trends revealed increasing rates of any opioid prescription, peaking in 2015 at 25.9%, with subsequent downtrend to 14.6% in 2018 (P < .001).

CONCLUSION  Postoperative opioid prescription rate after CIED procedures was 20.2%, with most patients being opioid naïve. Among opioid naïve patients who received opioids, 9.4% had subsequent opioid refills. This finding suggests that perioperative pain management in CIED procedures warrants meticulous attention.

KEYWORDS  Cardiac implantable electronic devices; Opioid prescription; Pacemaker; Postoperative pain; Quality improvement (Heart Rhythm 2019;16:1841–1848) © 2019 Heart Rhythm Society. All rights reserved.

Introduction  Prescription opioid abuse is an epidemic in the United States. There has been an increase in pain medication prescriptions since the installment of pain as the “fifth vital sign” by the Joint Commission on Accreditation of Healthcare Organizations.2,3 This has led to increase in prescription opioid abuse, addiction, and deaths due to prescription opioid overdose, which has now surpassed those of cocaine and heroin.4,5

Multiple factors are associated with the increase in opioid prescriptions by health care providers. A conceptual framework rooted in the theory of planned behavior was created to understand the factors related to increase in opioid prescriptions (Figure 1).6 Provider attitudes about pain control may be influenced by pain management training and previous experiences. Patient factors, such as expectations of pain control, underlying comorbidities, and personal sensitivity to pain, are intertwined with the social norms about pain control and the perceived ability of the health care provider to provide pain control. All of these factors influence the provider’s decision to prescribe
Opioids. Depending on the ease of prescribing, this may ultimately lead to prescription of opioids. Opioid prescription following cardiac implantable electronic device (CIED) procedures has not been studied. The primary objective of this study was to gain an understanding of opioid prescription pattern following CIED procedures at a tertiary academic practice with sites across the United States. The secondary objectives were to understand various factors associated with opioid prescriptions and to evaluate continued opioid prescription rates (refills) after initial device surgery. This is a first step toward improving nonopioid-based pain management following CIED procedures and potentially reduce prescription opioid abuse.

**Methods**

We performed a retrospective cohort study of all patients undergoing device procedures at the Mayo Clinic Enterprise Heart Rhythm Practice. The study included patients at the 3 academic campuses in Rochester, Minnesota; Phoenix, Arizona; and Jacksonville, Florida. The study was exempt from the Mayo Clinic Institutional Review Board.

**Study population**

Adult patients (age ≥18 years) who underwent CIED procedures and were discharged between January 1, 2010, and March 30, 2018, were included in the study (Figure 1). Administrative billing data were used to identify patients who underwent CIED procedures using Current Procedural Terminology (CPT) codes (Supplemental Material). Procedures were categorized into 5 broad categories: new CIED implantation, generator change, device upgrade, lead revision/replacement, subcutaneous implantable cardiac defibrillator (ICD), and other CIED procedures. Patients younger than 18 years, in-hospital deaths, and transfers to another hospital were excluded. Lead and device extraction or removal procedures without reimplantation also were excluded, as patients may have more pocket revision surgeries and surgical debridement. Leadless pacemakers were not included.

**CIED procedures**

CIED procedures were performed per American College of Cardiology/American Heart Association/Heart Rhythm Society guidelines. The procedures may be performed as inpatient or outpatient procedures. Local anesthesia and intraprocedural opioids were administered per the discretion of the provider. The patients underwent procedures using standard techniques. Starting 2014, it was common for the Mayo Clinic Rochester practice to administer liposomal bupivacaine (Exparel; Pacira Pharmaceuticals, San Diego, CA) for all subcutaneous ICD implants. Postprocedure, patients were evaluated by the health care provider team, which included physicians and allied health providers. Typically, patients had standing orders for pain medications on an as-needed basis per electronic medical record order entry, which usually include nonopioid-based medications as first line and opioids-based medications as second line. For inpatient procedures, patients were evaluated the next day after CIED implantation. Upon discharge from the inpatient or outpatient procedure, opioids were prescribed based on the health care provider team’s discretion, following all applicable state and federal laws. There is no fixed institutional practice guideline on opioid prescription. During the study period, there was also no change in provider requirements or limitations on prescribing opioids.

**Data collection**

Patient demographic parameters and comorbidities were collected. Comorbidities were identified using International Classification of Diseases, Ninth Revision (ICD-9) and International Classification of Diseases, Tenth Revision (ICD-10) codes (Supplemental Material).

Medications in the pharmaceutical subclass of "opioid agonist," "opioid partial agonist," and "opioid combinations" with a Drug Enforcement Administration schedule II or III were considered prescription opioid medications. Data on opioid prescription written in the 90 days before the procedure and up 30 days after discharge were collected, such as characteristics of the opioid prescription, including type, dosage, frequency, quantity, and oral morphine equivalents (OME).
Discharge opioid prescriptions were defined as outpatient opioid prescriptions written during admission and on the day of discharge. Comparable with previous studies, opioid prescriptions provided preoperatively for postoperative pain control were accounted for by including opioid prescription written 7 days before surgery as discharge prescriptions.\textsuperscript{9,10} Patients were categorized into opioid naïve and preoperative users. Opioid naïve was defined based on patients who did not receive any opioid prescription 90 days before the CIED procedure (up to 7 days before surgery).\textsuperscript{11,12} Patients who received opioids before that time period were considered preoperative users. Refills were defined based on any opioid prescribed from 1 to 30 days after discharge. Opioid naïve patients who received opioid prescriptions and subsequently refilled their opioids were defined as new opioid refills. Opioid prescriptions were converted to OME in milligrams (Supplemental Material). High-dose opioid prescription was defined as discharge prescription with OME $>200$. The cutoff of 200 was based on the State of Minnesota guidelines for acute postoperative pain released in 2017, with recommendations to limit the entire prescription of opioids for postacute pain to no more than 200 OME (approximately 1 week of opioids or 26 tablets of 5 mg oxycodone).\textsuperscript{13}

The primary outcome was opioid prescription following discharge from the device procedure. Secondary outcomes were rates of opioid prescription among the 5 categories of

Figure 2  Patient inclusion and categorization CONSORT (CONsolidated Standards Of Reporting Trials) flow diagram. CPT = Current Procedural Terminology; ICD = implantable cardiac defibrillator.
CIED procedures, rate of new opioid refills, patient variables associated with opioid prescription, association between CIED complication rates and opioid refills, 30-day readmission rates, regional variation, and temporal trends of opioid prescription.

Statistical analysis
Categorical variables are expressed as percentages, whereas continuous variables are expressed as mean ± SD. Univariate analysis of demographic characteristics, comorbidity, and discharge prescriptions was performed using $\chi^2$ tests for categorical variables and Wilcoxon rank sum tests for continuous variables. All $P$ values were 2-sided, and $P < .05$ was considered significant. All statistical analysis was performed using SAS statistical software, version 9.4 (SAS Institute, Cary, NC).

Results
A total of 16,517 patients (mean age 70 ± 15 years; 36.5% female) underwent CIED procedures during the 9-year study period (Figure 2). Overall, 20.2% of patients who underwent CIED procedures were discharged with an opioid prescription following the procedure. Of the patients who received an opioid prescription, 79.7% were opioid naïve. Among opioid naïve patients who received an opioid prescription, 9.4% had new opioid refills (opioid naïve patients who refilled their opioid prescriptions).

Compared to patients who were not prescribed opioids, patients who were opioid naïve and were prescribed opioids were younger, were more likely to be female, and had fewer comorbidities (Table 1). This included lower rates of hypertension, coronary artery disease, chronic kidney disease, chronic obstructive pulmonary disease, peripheral vascular disease, and diabetes.

Among patients who received an opioid prescription, the mean OME prescribed was 243 ± 346. The average OME was higher in patients who were preoperative opioid users compared to patients who were opioid naïve (335 vs 219; $P < .001$). Overall, 38.8% of patients who were prescribed opioids received a high-dose opioid prescription (OME ≥200).

About one-third (36.9%) of new opioid users (opioid naïve patients who received opioids) were prescribed a high-dose opioid prescription. The proportion of patients who received a high-dose opioid prescription was higher among patients with preoperative opioid use (46.3%).

Among all CIED procedures, patients who underwent subcutaneous ICD implantation had the highest rate of opioid prescription (25.0%), followed by new implants (23.2%), lead revision or replacement (22.4%), device upgrade (18.3%), and generator change (11.6%) ($P < .001$) (Table 2). The rates of opioid refills were also higher in patients who were preoperative opioid users compared to patients who were opioid naïve (335 vs 219; $P < .001$). Overall, 38.8% of patients who were prescribed opioids received a high-dose opioid prescription (OME ≥200).

### Table 1 Demographic, clinical characteristics, and outcomes of patients who underwent cardiac electronic device implantation

<table>
<thead>
<tr>
<th></th>
<th>Overall</th>
<th>No opioids prescribed</th>
<th>Opioid naïve</th>
<th>Preoperative opioid users</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>16,517</td>
<td>13,182</td>
<td>2657</td>
<td>678</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Age (y)</td>
<td>70.5 ± 15.1</td>
<td>72.1 ± 14.3</td>
<td>63.7 ± 16.6</td>
<td>66.4 ± 15.8</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Female gender</td>
<td>6017 (36.4)</td>
<td>4663 (35.4)</td>
<td>4056 (39.7)</td>
<td>298 (44.0)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Hypertension</td>
<td>12930 (78.3)</td>
<td>10421 (79.1)</td>
<td>1947 (73.3)</td>
<td>562 (82.9)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>CAD</td>
<td>10567 (64.0)</td>
<td>8449 (64.1)</td>
<td>1646 (61.9)</td>
<td>472 (69.6)</td>
<td>.0008</td>
</tr>
<tr>
<td>CHF</td>
<td>9857 (59.7)</td>
<td>7813 (59.3)</td>
<td>1589 (59.8)</td>
<td>455 (67.1)</td>
<td>.0003</td>
</tr>
<tr>
<td>CKD</td>
<td>3666 (22.2)</td>
<td>3002 (22.8)</td>
<td>461 (17.4)</td>
<td>203 (29.9)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>COPD</td>
<td>2839 (17.2)</td>
<td>2288 (17.4)</td>
<td>381 (14.3)</td>
<td>170 (25.1)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>PVD</td>
<td>2519 (15.3)</td>
<td>2082 (15.8)</td>
<td>300 (11.3)</td>
<td>137 (20.2)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Diabetes</td>
<td>5086 (30.8)</td>
<td>4093 (31.0)</td>
<td>718 (27.0)</td>
<td>275 (40.6)</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

### Table 2 Prescription of opioids following various categories of CIED procedures

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Opioid prescription rate</th>
<th>OME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>16,517</td>
<td>3335 (20.2)</td>
<td>243.2 ± 346.0</td>
</tr>
<tr>
<td>Subcutaneous ICD</td>
<td>504</td>
<td>126 (25.0)</td>
<td>194.0 ± 122.8</td>
</tr>
<tr>
<td>New implants</td>
<td>9624</td>
<td>2234 (23.2)</td>
<td>244.6 ± 300.3</td>
</tr>
<tr>
<td>Lead revision or replacement</td>
<td>728</td>
<td>163 (22.4)</td>
<td>215.7 ± 206.4</td>
</tr>
<tr>
<td>Device upgrade*</td>
<td>1309</td>
<td>240 (18.3)</td>
<td>254.9 ± 486.2</td>
</tr>
<tr>
<td>Generator change</td>
<td>3862</td>
<td>448 (11.6)</td>
<td>249.7 ± 485.8</td>
</tr>
<tr>
<td>Others</td>
<td>490</td>
<td>124 (25.3)</td>
<td>259.7 ± 463.0</td>
</tr>
</tbody>
</table>

Values are given as n, n (%), or mean ± SD.

CIED = cardiac implantable electronic device; ICD = implantable cardiac defibrillator; OME = oral morphine equivalent.

*Device upgrade includes procedure in which an existing pacemaker system is upgraded to a dual-chamber, cardiac resynchronization therapy, or defibrillator system.
patients who had complications from CIED procedures (14.4% vs 9.9%; \( P < .001 \)) (Supplemental Material). Opioid refill rates were higher in patients with pneumothorax (2.4% vs 1.7%; \( P = .043 \)), lead dislodgment (8.0% vs 5.2%; \( P < .001 \)), pericardial effusion (4.6% vs 3.3%; \( P = .01 \)), and who required lead revision after the CIED procedure (2.5% vs 1.2%; \( P < .001 \)). Patients who received opioid prescriptions at discharge also had higher 30-day readmission rates compared to patients who did not receive opioid prescriptions at discharge (9.5% vs 7.7%; \( P < .001 \)).

From 2010 to 2015, the rate of opioid prescription showed an increasing trend. At the peak in 2015, 25.9% of patients who underwent device procedures were discharged with opioids (Figure 3). The rate subsequently decreased to 14.6% in 2018 (\( P < .001 \)). However, the rate of opioid prescription for subcutaneous ICD continued to increase to 39.1% in 2018.

Regional variation in opioid prescription was observed (Table 3). The opioid prescription rate was 15.7%, 17.2%, and 56.6% in Rochester, Minnesota; Phoenix, Arizona; and Jacksonville, Florida, respectively. The average OME among patients who received opioids was 255, 267, and 330.3 in Minnesota, Arizona, and Florida respectively. The rate of opioid refills in previously opioid naïve patients was 8.1%, 12.1%, and 10% in Minnesota, Arizona, and Florida respectively.

### Discussion

Our analysis of 16,517 patients who underwent CIED procedure showed that (1) 20.2% had opioid prescription after device procedure; (2) 80% of patients who received opioids were opioid naïve and 9.4% of opioid naïve patients had opioid refills; (3) 38.8% of patients who were prescribed opioids received a high-dose opioid prescription; and (4) temporal and regional variations in opioid prescription patterns were observed.

Our study showed that 20.2% of patients were prescribed opioids following CIED procedures. In comparison with other studies on postoperative opioid use, the opioid prescription rate was 59% after endovascular aneurysm repair and 77% after hand surgery procedures. In another study among general surgical procedures, ranging from partial mastectomy to open inguinal hernia repair, 90.5% of patients were prescribed an opioid. The rates of opioid prescription following CIED seems to be lower than after other surgical procedures. This may be due to the relatively less invasive nature of CIED procedures compared to other surgical procedures. However, it may be higher compared to interventional radiology procedures. In a study of opioid prescribing behaviors of interventional radiologists, the average annual prescription of opioids was only 5.4 prescriptions per interventional radiologist.

Among opioid naïve patients who were prescribed opioids, patients were younger, were more likely to be female, and had fewer comorbidities. This group of patients generally is more active, and providers may have a lower threshold for prescribing opioids for better pain relief so that these patients can return to their baseline physical functioning. Another possible explanation could be provider perception of a lower

### Table 3  Regional variation in opioid prescription

<table>
<thead>
<tr>
<th></th>
<th>Minnesota</th>
<th>Arizona</th>
<th>Florida</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>11,021</td>
<td>3829</td>
<td>1667</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Percentage of opioid naïve patients</td>
<td>9721 (88.2)</td>
<td>3270 (85.4)</td>
<td>1387 (83.2)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Opioid prescription rate</td>
<td>1735 (15.7)</td>
<td>657 (17.2)</td>
<td>943 (56.6)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Opioid naïve patients prescribed opioids</td>
<td>1394 (14.4)</td>
<td>495 (15.1)</td>
<td>768 (55.4)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>New opioid refills</td>
<td>113 (8.1)</td>
<td>60 (12.1)</td>
<td>77 (10.0)</td>
<td>.02</td>
</tr>
<tr>
<td>OME prescription</td>
<td>255.1 ± 330.3</td>
<td>267.4 ± 497.2</td>
<td>204.6 ± 220.4</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Opioid prescriptions with OME &gt;200</td>
<td>774 (44.6)</td>
<td>277 (42.2)</td>
<td>244 (25.9)</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

Values are given as \( n, n(\%) \), or mean ± SD unless otherwise indicated.

OME = oral morphine equivalent.
pain tolerance in this group of patients. Other studies have shown that women were more likely to be prescribed opioids than men.17,18

We found that patients with a subcutaneous ICD had the highest rate of postoperative opioids prescription (Table 2). This is likely because of the larger device footprint of the subcutaneous ICD, highly innervated midaxillary chest wall, and the procedural technique, which typically requires 2 or 3 incisions, dissection of tissue planes, and tunneling from the pocket for parasternal positioning of the lead.

In our study, most patients who received opioids were opioid naïve, and 9.4% of patients had new opioid refills. The rate of opioid refills in our study is similar to that in other studies, ranging from 13% following hand surgery procedures to 17.5% among various elective surgical procedures ranging from total knee arthroplasty to parathyroidectomy.12,15 The rate of new persistent opioid use, defined as use of opioids between 90 and 180 days, was 5.9% following minor surgery.10

The temporal trend in opioid prescription reveals a peak in 2015, with a subsequent decrease in prescription rate since then. Recent studies have shown similar patterns of recent decrease in opioid prescription rates, probably reflecting the increased provider and health care practice awareness of the opioid epidemic.19,20 Our study also showed regional variation in opioid prescription, which reflected data from the Centers for Disease Control and Prevention, showing the highest to lowest opioid prescription rate being Duval County, Florida; Maricopa County, Arizona; and Olmsted County, Minnesota.21 This may be due to variations in patient population, hospital protocols, and provider practice patterns.

The management of postoperative pain should begin preoperatively (Table 4). Patients should be evaluated with a thorough history and physical examination, which includes history of chronic pain and previous postoperative treatment regimens and responses.22 Patients also should be educated on treatment options for management of postoperative pain and goals of postoperative pain management. Oral gabapentin (600 or 1200 mg) or pregabalin (150 or 300 mg) administered 1–2 hours before the procedure has been associated with reduced opioid requirements postsurgery.22,23 Similarly, preoperative oral celecoxib 200 to 400 mg administered 30 minutes to 1 hour before the procedure has been associated with reduced opioid requirements.22,24 However, celecoxib may not be appropriate for many patients undergoing device implantation who often have significant cardiovascular history.

Intraprocedurally, the main factors to consider are operative technique, local medication, and regional anesthesia.25 Meticulous technique with placement of the device in the fascial layer as opposed to near the skin as well as adequate control of hemostasis will reduce postoperative pain (Figures 4A and 4B). Liposomal bupivacaine is an extended release bupivacaine that may have a clinical effect for 72 hours after a single infiltration (Figure 4C).26 Combined use of lidocaine and liposomal bupivacaine for local anesthetic infiltration may help achieve short- and longer-term local pain relief. Regional anesthesia techniques, such as truncal plane blocks (Figure 4D), also may be a feasible alternative to general anesthesia for subcutaneous ICD implantation.27 For transvenous pacemakers or defibrillators, local anesthetic infiltration is adequate, although cervical and pectoral nerve block may be an alternative option.28,29 Intravenous ketamine has been suggested to reduce postoperative opioid use.22 However, this should be avoided in patients undergoing device implantation because it may cause myoclonus leading to oversensing and interference with pacemaker function or intraprocedural device testing.

For postoperative pain management, the use of multimodal analgesia (ie, a variety of analgesic medications) to target a different mechanism of action in the peripheral and central nervous systems may have a synergistic effect and provide better pain relief compared to use of a single agent alone.22 The use of around-the-clock nonopioid analgesics may be adequate for pain relief. Appropriate postoperative patient education on arm movement is important, as prolonged restricted arm movement may lead to adhesive capsulitis (frozen shoulder) leading to prolonged postoperative pain.30

Table 4 Outline of strategies to improve postoperative pain management

<table>
<thead>
<tr>
<th>Preoperative evaluation</th>
<th>Obtain comprehensive history, which includes medical and psychiatric comorbidities, chronic pain, substance abuse, and previous treatment regimens and responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient education</td>
<td>Provide information and discuss treatment options for postoperative pain; establish goals for postoperative pain management</td>
</tr>
<tr>
<td>Preoperative medications</td>
<td>Administer oral gabapentin or pregabalin 1–2 hours before the procedure, or oral celecoxib 30 minutes to 1 hour before the procedure</td>
</tr>
<tr>
<td>Intraprocedural</td>
<td>Placement of generator in the fascial plane and meticulous hemostasis to prevent postoperative hematoma</td>
</tr>
<tr>
<td>Operative technique</td>
<td>Use of long-acting local anesthetic (liposomal bupivacaine)</td>
</tr>
<tr>
<td>Local anesthesia</td>
<td>Use of site-specific peripheral regional anesthetic</td>
</tr>
<tr>
<td>Regional anesthesia</td>
<td>Use of variety of analgesic medication may have additive and synergistic effects; nonopioid medications includes acetaminophen, NSAID, and gabapentin or pregabalin</td>
</tr>
<tr>
<td>Postoperative</td>
<td>Appropriate degree and duration of arm restriction for prevention of both lead dislodgment and adhesive capsulitis</td>
</tr>
</tbody>
</table>

NSAID = nonsteroidal anti-inflammatory drug.
Multiple statements on recommendations for opioid use in managing acute postoperative pain have been published. The Dr. Robert Bree collaborative categorized procedures into various types, based on expected duration of recovery. In procedures in which rapid recovery is expected, such as inguinal hernia repair or breast lumpectomy, nonopioid analgesics are recommended as first-line therapy. If opioids are necessary, 3 days of short-acting opioids in combination with a nonsteroidal anti-inflammatory drug or acetaminophen is recommended.

Multiple unintended consequences to the prescription of opioids for pain relief include an increase in opioid addiction and opioid-related death. Beyond the potential for addiction, the side effect profile of opioids includes constipation, sleep-disordered breathing, depression, somnolence, and dizziness leading to unintended consequences such as falls and fractures. There is also the economic cost of prescription opioid overdose, abuse, and dependence, at an individual level and at a societal level, from increased health care costs, criminal justice costs, and loss of productivity costs. There is also a risk of opioid diversion, which is transfer of opioids by patients who received legitimately prescribed opioids to family members or friends who are trying to self-medicate. Diversion of opioids can be intentional or it can be unintentional in the form of theft, related to the improper storage or disposal of opioids.

Study limitations
Our study analyzed data on opioid prescription but was not able to attain data on patient utilization of the prescribed opioids. A single or even repeated opioid refills do not necessarily signal addiction or dependence. Patient refill rates were also likely underestimated as we were unable to evaluate opioid refills outside of our health care systems. Data on use of nonopioid analgesic medications, such as acetaminophen or nonsteroidal anti-inflammatory drugs, were not captured due to the limited accuracy of these data as they are available over the counter. We also did not capture data on intraprocedural medications and therefore were not able to analyze associations between various kinds of intraprocedural analgesic medications and impact on opioid prescription rates at discharge. Furthermore, this study was based on data from 3 tertiary referral centers that are part of the same health system. There may be limited extrapolation to hospitals with a different patient population, hospital protocol, and procedural mix.

Conclusion
Among patients who underwent CIED procedures, the overall opioid prescription rate was 20.2%, with 80% of patients being opioid naïve. This study shows that perioperative pain management in CIED procedures warrants attention. More studies are needed to evaluate various methods to decrease opioid prescription rates following CIED procedures, such as development of protocols emphasizing nonopioid means of pain relief that can reduce the use of opioids following CIED procedures. Other studies on nonpharmacologic methods of pain relief, such as cognitive behavioral therapy, are important. Our study showed that 9.4% of opioid naïve
patients who received opioids subsequently refilled their opioids. This highlights that short-term opioid prescription may have a longer-term impact on patients. More studies are needed to assess the link between prolonged opioid use and risk of addiction or dependence.

Appendix
Supplementary data
Supplementary data Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrthm.2019.08.011.

References