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John N. Insall Award: MARCQI's Pain-Control Optimization Pathway (POP): Impact of Registry Data and Education on Opioid Utilization

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ABSTRACT

Background: In 2019, the Michigan Arthroplasty Registry Collaborative Quality Initiative (MARCQI) recommended an evidence-based opioid pain pathway to participating physicians and hospitals for patients undergoing total joint arthroplasty (TJA). The purpose of this study was to determine if the education could influence and have lasting effects on the prescribing patterns for TJA patients.

Methods: Using the MARCQI database, the number of oral morphine equivalents (OMEs) prescribed at discharge were collected from January 2018 through December 2019 for all primary arthroplasty procedures. Periods compared included before and after July 2018 Michigan opioid laws as well as before and after the March 2019 MARCQI recommendations. The data compared total hip arthroplasty (THA) and total knee arthroplasty (TKA) patients, opioid-naïve vs opioid-tolerant patients, individual surgeons, and MARCQI sites.

Results: The data included 84,998 TJAs: 22,774 opioid-naïve THAs, 9124 opioid-tolerant THAs, 40,882 opioid-naïve TKAs, and 12,218 opioid-tolerant TKAs. In all the groups and at all time periods there were a significant decrease in prescriptions ($P < .001$). Individual surgeons and participating sites also demonstrated decreased OMEs on discharge after the recommendations. Between the first and last months of collection, this represented an overall decrease of opioid OMEs for THA by 47.1% for opioid-naïve patients and 53.4% for opioid-tolerant patients. For TKA patients, the OME decrease was 48.3% for opioid-naïve patients, and 48.4% for opioid-tolerant patients.

Conclusion: The MARCQI pain control optimization pathway (POP) program has been successful in drastically reducing opioid prescribing with lasting effects, which has substantially limited the overall opioid prescription burden for patients undergoing arthroplasty.

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Total joint arthroplasty (TJA), while extremely successful in reducing joint pain and improving function, is an invasive procedure which requires a period of appropriate pain management to ensure optimal outcomes. In an effort to curb the excessive use of narcotics,

orthopedic surgeons have begun exploring multimodal pain protocols that target multiple pain pathways as a comprehensive approach to pain management. These pathways may incorporate spinal analgesia, peripheral nerve blocks, periarticular injections, cryotherapy, acetaminophen, non-steroidal anti-inflammatory drugs, gabapentinoids, tramadol and opioids among other things. Multimodal pain protocols have been shown in multiple studies to be effective in providing adequate pain control after TJA [1–10].

The Michigan Arthroplasty Registry Collaborative Quality Initiative* (MARCQI) is the largest statewide database for arthroplasty in the United States. Currently, there are 64 hospital participants and 15 ambulatory surgery centers (ASCs) capturing over 96% of all

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cases done within the State. Approximately, 370,000 cases have been fully abstracted to date. As a quality improvement initiative, MARCQI is set forth to alter prescription patterns on discharge after elective arthroplasty in March 2019 with the Pain Optimization Pathway (POP). The registry organized multiple collaborative meetings for an open dialogue and shared reports on prescription variation and guidelines. This provided a forum for creating the best practice patterns and sharing opinions for integration of this new pathway to change prescription practice.

Included in this, MARCQI made specific recommendations to its members in March of 2019 to change opioid prescribing patterns for TJA patients. These included preoperative opioid education, Michigan Automated Prescription System (MAPS) screening of high-risk patients, encouraging limitations on the number and duration of opioid prescriptions, provision of weaning programs, and encouraging integration with the patient's primary care provider to transition off-of opioids. MARCQI also encouraged the formation of institutional specific perioperative pain protocols.

As part of these recommendations, MARCQI set specific guidelines for opioid prescription after arthroplasty. For total hip arthroplasty (THA), it was recommended that, prescription on discharge be less than 240 oral morphine equivalents (OMEs), and for total knee arthroplasty (TKA) 320 OMEs. These discharge OME goals were set as the pay-for-performance (P4P) incentive cutoff. The purpose of this study was to determine if MARCQI physician education could influence and have lasting effects on the prescribing patterns for patients undergoing THA or TKA.

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Material and Methods

Using the MARCQI total joint database [11], the quantity of opioid medications was evaluated from January 2018 through December 2019. The collected demographics included age, sex, and body mass index (BMI) for all cases. Patient characteristics were descriptively summarized by procedure type, time period and opioid patient history group. ANOVA tests were used to compare OME prescriptions by time interval in the opioid-naive and opioid-tolerant patient populations for primary TJA.

For this period, the number of OMEs prescribed upon discharge were collected to compare average opioid prescription before and after MARCQI recommendations in March 2019. Cases with incomplete prescription data such that a total OME could not be calculated were excluded. Prescription trends were summarized with standard descriptive statistics using surgical date and date

partitions surrounding significant events in opioid prescription patterns such as Michigan's July opioid laws and the MARCQI's POP release.

TKA procedures included in the data are as follows: primary TKA, primary unicompartamental knee arthroplasty (UKA), bicompartamental knee arthroplasty, and patellofemoral arthroplasty. THA procedures included, primary THA, primary hip resurfacing arthroplasty, and conversion THA. Exclusion criteria consisted of cases performed outside of the date range collected and revision arthroplasties.

The average OMEs upon discharge were differentiated between patients undergoing THAs and TKAs, since each respectively had their own OME recommendations. These were collected monthly and averaged during collection. The data differentiated between opioid-naive and opioid-tolerant patients to note any potential discrepancies. MARCQI defines opioid-naive as a patient that has not taken opioids in the thirty- days leading up to the surgery. Cases with unknown preoperative patient history were excluded.

In addition, data was obtained on the surgeon level using random Surgeon IDs in the MARCQI database. Two time periods were compared for average OME prescriptions; January 2018 through March 2019 (pre-recommendation) was compared with April 2019 through December 2019 (post-recommendation). This data was differentiated for both THA and TKA. Only surgeons with 30 or more cases during each time period were included, and only opioid-naive patients were included in this analysis. Statistics were performed to measure the number of physicians who were able to meet OME goals set forth by MARCQI's last recommendations.

The data was further analyzed to compare variations based on the registry site before and after the MARCQI POP recommendations. This analysis involved only opioid-naive patients and for both THA and TKA. This was analyzed to determine if sites were able to meet goals, and to determine the overall opioid prescription decrease in each region.

An overall alpha-level of 0.05 was used to determine statistical significance and statistical tests were two-sided. All statistical analyses were performed in the SAS software version 9.4 (SAS Institute Inc, Cary, NC).

Results

Data was collected from 63 hospitals and 2 ASCs (all sites that were enrolled at the timepoints of the study) and included a 84,998 TJAs. This included 22,774 opioid-naive THAs, 9124 opioid-tolerant THAs, 40,882 opioid-naive TKAs, and 12,218 opioid-tolerant TKAs. For THA, there was a monthly average of 949 opioid-naive and 380 opioid-tolerant patients. For TKA, there was a monthly average of 1703 opioid-naive and 509 opioid-tolerant patients.

For THA patients, there were 18,278 females and 15,321 males. At the time of surgery, the mean age at time of case performed was

Table 1
Background Demographics.

Description	All Patients	Opioid Naive	Opioid Tolerant
THA Procedures	n = 33,599	n = 23,739	n = 9860
Female	54.4	52.8	58.8
Age at case, mean (std dev)	65.3 (10.9)	65.7 (10.7)	64.3 (11.2)
vBMI, mean (std dev)	30.7 (6.3)	30.4 (6.1)	31.5 (6.9)
TKA Procedures	n = 56,845	n = 43,472	n = 13,373
Female	61.4	60.0	65.9
Age at case, mean (std dev)	66.5 (9.5)	67.1 (9.3)	64.7 (9.7)
BMI, mean (std dev)	33.2 (6.6)	32.9 (6.5)	34.1 (7.1)

This table presents the background demographic data collected for all patients during the study period, by type of arthroplasty and opioid-naive versus opioid-tolerant.

Table 2

Total Hip Arthroplasty Analysis for Average Opioid Morphine Equivalents.

Date	Number	Average OME for Opioid Naive Patients	Number	Average OME for Opioid Tolerant Patients
Jan 18	830	530.2	419	684.6
Feb 18	749	513.4	417	688.7
Mar 18	721	508.2	438	647.1
Apr 18	746	467.2	393	594.7
May 18	867	439.1	430	545.6
Jun 18	863	390.5	398	469.2
Jul 18	864	382.5	381	443.8
Aug 18	900	366.7	403	465.1
Sep 18	825	358.2	333	459.2
Oct 18	1101	346.1	436	430.0
Nov 18	1022	353.4	392	443.5
Dec 18	930	344.5	354	430.7
Jan 19	1032	345.5	397	414.5
Feb 19	932	334.9	365	428.7
Mar 19	887	338.9	343	396.7
Apr 19	1033	323.7	349	408.6
May 19	959	327.9	366	412.6
Jun 19	991	313.1	347	398.7
Jul 19	1018	295.0	362	372.0
Aug 19	999	286.1	335	353.0
Sep 19	1013	286.4	319	386.9
Oct 19	1208	276.5	434	333.8
Nov 19	1151	281.0	320	323.2
Dec 19	1133	280.3	393	319.1

Oral morphine equivalents (OME) on discharge to total hip arthroplasty patients, separated by opioid-naive versus opioid-tolerant patients from January 1, 2018 through December 31, 2019.

65.3 year old (standard deviation (SD) = 10.9) and the mean BMI was 30.7 (SD = 6.3). For TKA patients, there were 34,903 females and 21,942 males. At the time of surgery, the mean age was 66.5 (SD = 9.5) and the mean BMI was 33.2 (SD = 6.6). Further breakdown of demographic data was performed and divided between opioid-naive and opioid-tolerant patients for THA and TKA, respectively (Table 1).

In January 2018, the mean OMEs for THA opioid-naive patients were 530.2 compared to 280.3 in December 2019. For THA opioid-tolerant patients, the mean OMEs began at 684.6 in January 2018, and decreased to 319.1 by December 2019 (Table 2). During this

same period, TKA opioid-naive patients went from an average of 608.5 OMEs per prescription and decreased to 315.4. TKA opioid-tolerant patients went from 756.2 OMEs to an average of 390.5 (Table 3). Between the first and last months of collection, this represented an overall decrease of opioid OMEs for THA by 47.1% for opioid-naive patients and 53.4% for opioid-tolerant patients (Fig. 1). For TKA patients, the OME decrease was 48.3% for opioid-naive patients, and 48.4% for opioid-tolerant patients (Fig. 2).

Time periods were then compared: January 2018 to the introduction of the July 2018 opioid laws, July 2018 until MARCQI POP recommendations in March 2019, and after recommendations from

Table 3

Total Knee Arthroplasty Analysis for Average Opioid Morphine Equivalents.

Date	Number	Average OME for Opioid Naive Patients	Number	Average OME for Opioid Tolerant Patients
Jan 18	1570	608.5	582	756.2
Feb 18	1285	602.6	538	716.3
Mar 18	1324	577.2	552	717.6
Apr 18	1493	544.4	555	680.1
May 18	1523	527.4	594	627.4
Jun 18	1657	451.6	545	536.5
Jul 18	1466	424.3	508	528.4
Aug 18	1498	422.4	553	497.6
Sep 18	1579	420.1	471	509.7
Oct 18	2201	407.7	634	479.4
Nov 18	1938	397.0	540	473.1
Dec 18	1621	421.5	492	492.8
Jan 19	1866	398.3	540	473.9
Feb 19	1679	387.5	405	470.8
Mar 19	1689	388.7	416	489.8
Apr 19	1814	371.1	475	471.9
May 19	1635	374.4	465	442.0
Jun 19	1696	363.4	467	419.4
Jul 19	1677	340.4	436	411.8
Aug 19	1591	334.1	448	391.2
Sep 19	1961	335.1	467	389.7
Oct 19	2302	318.9	589	368.1
Nov 19	1885	320.0	476	372.4
Dec 19	1932	315.4	470	390.5

Oral morphine equivalents (OME) on discharge to total hip arthroplasty patients, separated by opioid-naive versus opioid-tolerant from January 1, 2018 through December 31, 2019.

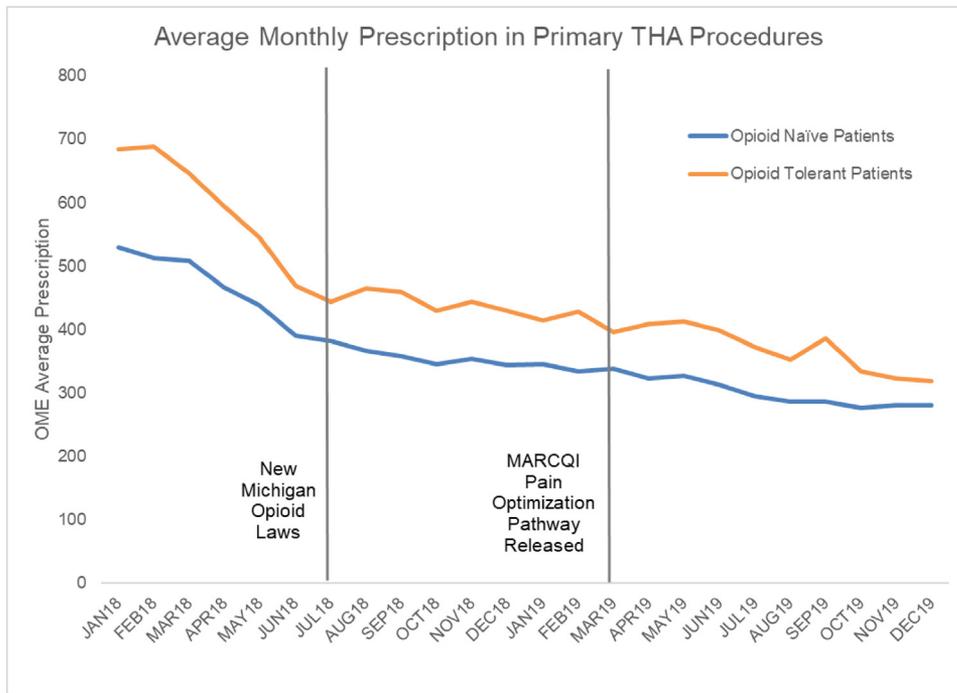


Fig. 1. Oral morphine equivalents (OME) prescribed to total hip arthroplasty patients on discharge for both opioid-naïve and opioid-tolerant patients. This demonstrates a downward trend of opioid prescription over the study period.

March 2019 through December 2019. For these periods, this was further differentiated into groups between THA and TKA, and into opioid-tolerant and opioid-naïve patients for both categories. In all groups across all time periods, there was a statistically significant decrease in OMEs on discharge over time ($P = <.001$) (Table 4).

Data was then differentiated for individual surgeons. After the MARCQI recommendations, there was a decrease in average OMEs

prescribed upon discharge for THA and TKA opioid-naïve patients. Data was placed in a scatter-plot graph with a mean trend line (Figs. 3 and 4) demonstrating the difference pre- and post-recommendations. MARCQI sites were compared to themselves before and after the recommendations for both THA and TKA opioid-naïve patients. Again, this demonstrated a decrease in overall OME prescription on discharge (Figs. 5 and 6).

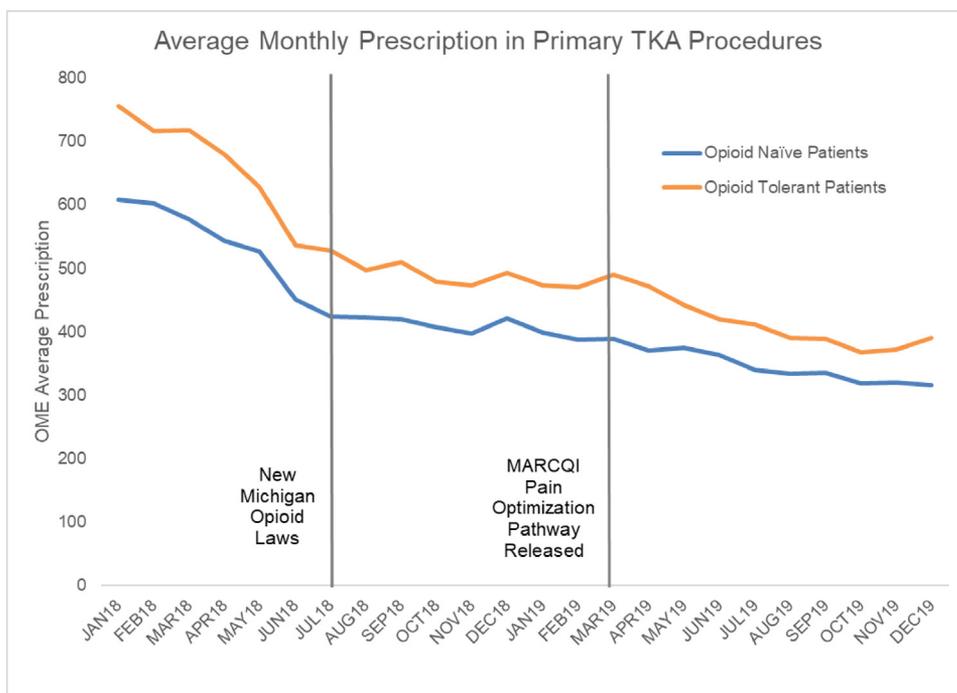


Fig. 2. Oral morphine equivalents (OME) to total knee arthroplasty patients over time comparing for both opioid-naïve and opioid-tolerant patients demonstrating a downward trend of opioid prescription.

Table 4
Statistical Comparisons by Time Period.

Description	Primary THA		Primary TKA	
	Average OME		Average OME	
	Opioid Naive	Opioid Tolerant	Opioid Naive	Opioid Tolerant
Before 7/2018	472.64	606.24	548.84	672.66
7/2018 - 3/2019	351.80	434.88	406.67	490.45
After 3/2019	295.67	366.53	340.02	405.28
P-value	<.0001	<.0001	<.0001	<.0001

Statistical comparisons of oral morphine equivalents (OME) comparing the time periods: 1) prior to July 2018 opioid laws, 2) between opioid laws and MARCQI recommendations, and 3) after MARCQI recommendations. This is further stratified between opioid-naive and opioid-tolerant patients. THA, total hip arthroplasty; TKA, total knee arthroplasty.

Though the MARCQI POP led to a significant decrease in opioid prescribing overall, the average OMEs on discharge remained above the stated goal for THA patients. For opioid-naive THA patients, OMEs on discharge were 16.7% above goal. In contrast, for TKA opioid-naive patients, OME prescriptions were 1.6% below the respective goal.

There was an increase in number of surgeons and sites that were able to meet the POP OME goal for opioid-naive patients. For THA patients, 34.7% of surgeons met OME goals after POP recommendations compared to 15.2% before. This was similarly seen for TKA with 58.3% meeting goal compared to 25.3% before. For individual sites, an increase in compliance to OME goals were seen. For THA patients, 37.7% of sites met goal compared to 9.8% of sites before the POP recommendations. This was also seen at sites for TKA patients, 58.5% of sites compared to 25.3% of sites before.

Discussion

Medical providers in the United States have been battling the growing opioid epidemic. According to CDC data of individuals 12 years and older, 18% of people reported drug use, and of those, 4.3% were of prescription pain relievers. In 2016, prescription opioids

were responsible for 17,087 deaths, or 28% of all drug overdoses. In 2017, 17.4% of the United States population filled at least one opioid prescription, with a trend toward patients of older age [12]. The National Survey on Drug Use and Health (NSDUH) demonstrated that, of people, who abused prescription opioids, 50.5% were obtained from family or friends and 22.1% were obtained from a physician prescription [13].

Evidence has shown that it is often not the orthopedic provider prescribing the majority of opioids consumed by patients. Namba et al. reviewed 35,565 TKA and 17,430 THA patients to identify who prescribed opioids preoperatively and postoperatively. They found that primary care and internal medicine providers were the highest prescribers both before and after the surgery. Specifically, in the year before TKA, orthopedic surgeons prescribed only 9% of the opioids, 47% in the 90 days after surgery and only 14% in the year that followed. Similarly, in the year before THA, orthopedic surgeons prescribed 14% of the opioids, 40% in the 90 days after surgery and only 14% in the year to follow [14]. Markel et al. demonstrated similar findings in a review of 367 patients undergoing TJA. Using the Michigan Automated Prescription System (MAPS), only 23% of the opiate prescriptions were written by orthopedic surgeons. In patients identified as chronic opiate users,

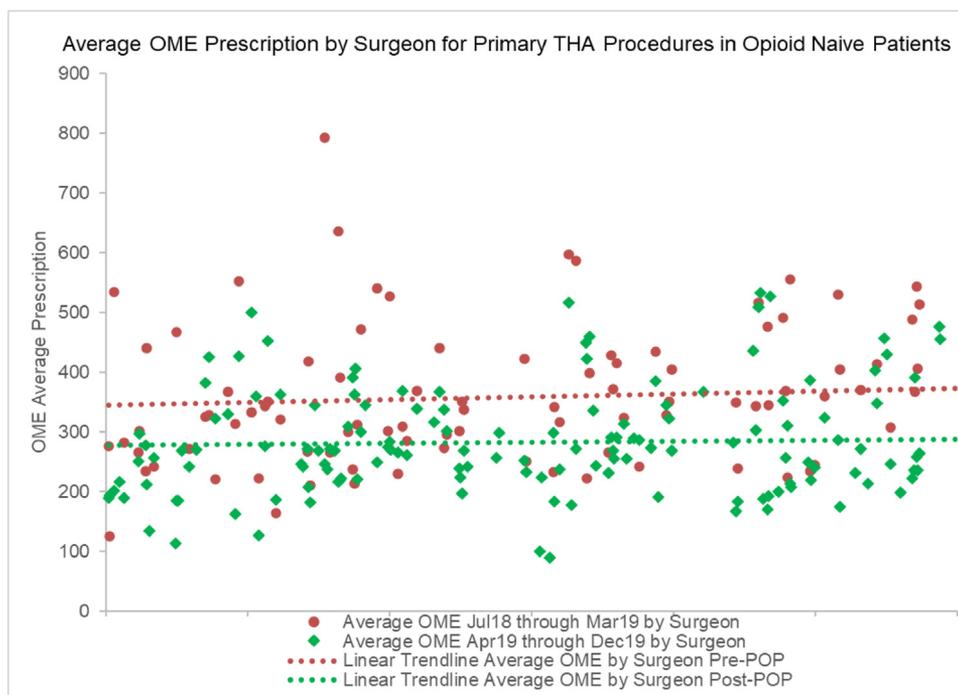


Fig. 3. Oral morphine equivalents prescribed to total hip arthroplasty patients that were opioid-naive, comparing surgeon specific prescription before and after MARCQI POP.

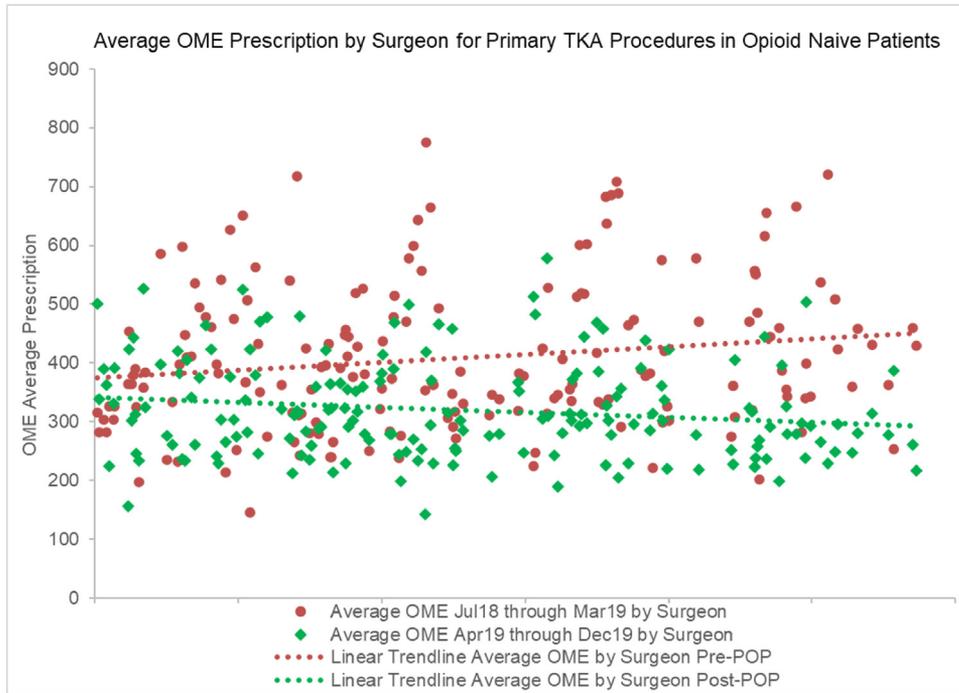


Fig. 4. Oral morphine equivalents prescribed to total knee arthroplasty patients that were opioid-naive, comparing surgeon specific prescription before and after MARCQI POP.

only 15% of prescriptions were written by orthopedic surgeons [15].

Preoperative opioid use has been associated with worse pain control and function postoperatively in TJA [16–20]. Preoperative use has demonstrated more inpatient complications requiring longer length of stay, and a higher risk for opioid use over 3 months

after TJA [21]. Pivec et al. reported that chronic preoperative opioid use resulted in higher total opioid use after THA, longer length of stay and lower Harris hip scores [16]. Smith et al demonstrated that preoperative opioid use in TKA was associated with less pain relief and lower WOMAC pain scores postoperatively [17,22]. Ben-Ari et al. reported a higher rate of revision after TKA in veterans with

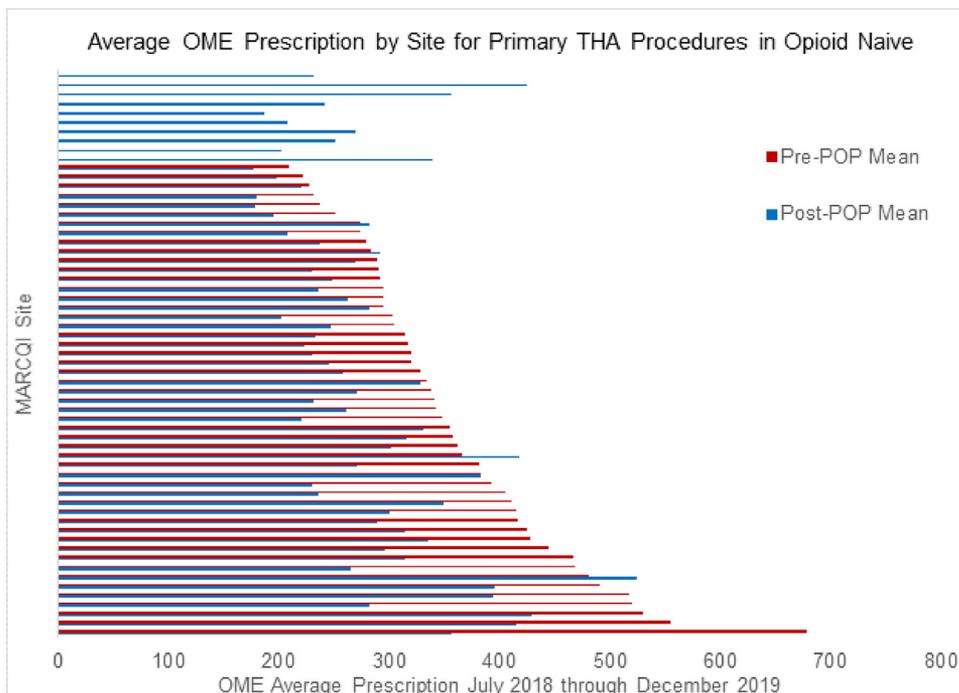


Fig. 5. Oral morphine equivalents (OME) prescribed to total hip arthroplasty opioid-naive patients as compared by site prior to initiation of POP and after the recommendations. Overall there is a reduction in OME prescribing for most sites and of note, some of the sites did not have data prior to the initiation of this program.

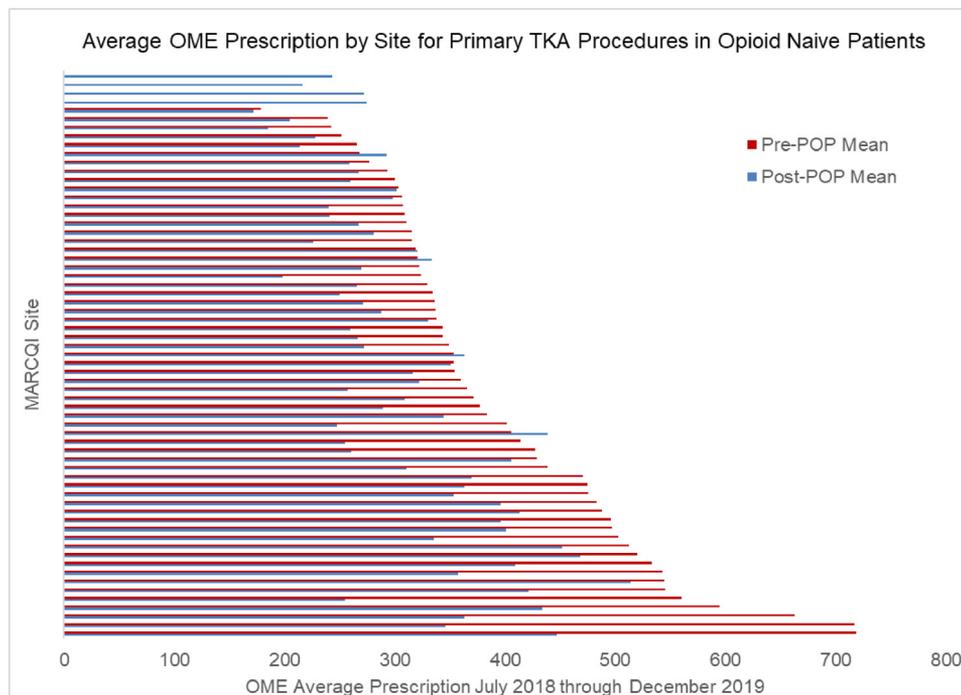


Fig. 6. Oral morphine equivalents (OME) prescribed to total knee arthroplasty opioid-naive patients as compared by site prior to initiation of POP and after the recommendation. Overall there is a reduction in OME prescribing for most sites and of note, some of the sites did not have data prior to the initiation of this program.

a history of long term opioid use compared to those without [18]. Similarly, Bedard et al. found preoperative opioid use was associated with increased risk of early revision TKA [23]. Weick et al. reported an increased risk of early revision and 30-day readmission in TJA patients who were taking preoperative opioids [24]. Zywiell et al. showed lower knee society scores, higher complication rate and increased revision rate for patients on chronic opioids before TKA [19]. Nguyen et al. showed that even with chronic opioid use, successful weaning before TJA can significantly improve clinical outcomes postoperatively [20]. In our study, there were 9124 opioid-tolerant THA patients and 12,218 opioid-tolerant TKA patients, comprising 28.6% and 23.0% of patients, respectively.

Despite traditional attempts to curb opioid utilization, over-prescription remains common. In a study of outpatient elective upper extremity surgeries, patients on an average had 66% of their opioid prescriptions remaining [25]. Howard et al. performed a population study in Michigan across health systems in 2392 patients with postoperative opioids. Patients on an average used 30% of their opioid prescriptions. More importantly, the higher number of opioids that were prescribed showed a statistically significant increase in opioid consumption [26]. We found that in opioid-tolerant patients undergoing TJA, 28.6% of THA and 23% of TKA patients had higher levels of opioid consumption across all time periods. At the end of the collection period, their requirement on discharge was 13.8% and 23.8% higher than opioid-naive patients for THA and TKA respectively. Though still higher than their opioid-naive counterparts, the MARCQI initiative demonstrated decreased opioid prescription in this population, potentially limiting the risk of over-prescription.

Once prescribed opioids, there is a risk for patients to have a sustained opioid use after arthroplasty. Sun et al. demonstrated that the odds ratio of chronic opioid use after TKA patients was 5.10, with chronic opioid use for nonsurgical patients of 0.136% compared to 1.41% of TKA patients [27]. Another database study of opioid-naive patients found that orthopedics was responsible for

8.8% of sustained opioid use [28]. Goesling et al. demonstrated that after TJA, opioid-naive patients were using opioids at six months postoperatively in 8.2% of TKAs and 4.3% of THAs [29]. In addition, those who take opioids preoperatively are more likely to continue to take them postoperatively [30,31]. Chronic opioid use after the first year was higher in chronic users (THA 47% vs 10%) (TKA 62% vs 13%) [32]. Opioid-naive patients are at risk for sustained opioid use, but they tend to fill fewer medications and be less likely for sustained narcotic use. A database analysis of 69,368 patients after TJA found that opioid-naive patients were less likely to fill prescriptions and filled fewer pills (THA 73 vs 126 pills, TKA 86 vs 126 pills). This was consistent in our findings. The mean OMEs on discharge being 280.3 vs 319.1 for THA patients and 315.4 versus 390.5 for TKA patients at the end of the study period [32].

Some institutions have begun combatting this issue by limiting prescriptions of opioids closer to the number required after observation and feedback, therefore eliminating large excesses of opioids, without increases in the number of refills needed [33,34]. A randomized-control trial of 304 patients undergoing TJA were divided into groups that would get either 30 or 90 tablets of oxycodone, and they demonstrated that prescription of lower number of oxycodone was associated with decreased opioid consumption, decreased unused tablets, and no differences in pain scores or reported outcomes between the two groups [35]. However, this can have its difficulties and breakthrough pain can occur. In one study of 802 patients after TJA, 33% required additional narcotic rescue for breakthrough pain, with patients at the highest risk having preoperative narcotic use [21].

In March 2019, the POP was released by MARCQI setting guidelines for opioid prescription after arthroplasty, including limitations on quantities at discharge. Since these were introduced, there has been a consistent downward trend in the quantity of opioid prescriptions after arthroplasty. However, this recommendation alone did not account for the change. MARCQI's quality initiative included many facets. As previously discussed, distributed reports and

collaborative meetings created a platform for open discussion to get providers together to create a best-practice model. This demonstrates the magnitude of influence a registry can have at integrating providers and health-care systems toward a common goal.

There are several limitations to this study. The data was collected using a large state-wide registry and although it was specifically abstracted by MARCQI nurses there are inherent limitations to registry-level data. While the POP recommendations were given at a set time-point and tracked before and after being released, there were additional factors that may have influenced opioid prescribing patterns, including legislative changes at the State level. We attempted to account for these changes by identifying those time-points, but there may be unrecognized effects. Furthermore, it is difficult to quantify the impact of general awareness and education on opioid addiction as well as the impact of the media and reporting on this issue. This paper does not address short or long-term clinical outcomes as they relate to changes in the opioid prescribing and further research is required to better understand the impact of these recommendations.

Conclusion

The MARCQI POP program was successful in drastically reducing opioid prescriptions by providing evidence-based pain protocols with set OME limits. The MARCQI recommendations were not only effective, but also have been sustainable, thus demonstrating the importance of quality initiative feedback and analysis to positively affect prescribing behavior. Simple education and quality reporting can have a significant impact on physician behavior. Further studies will need to be performed to correlate the decreased opioid prescriptions and any potential adverse patient outcomes.

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