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Effects of Ohio Opioid Prescribing Policy on Postsurgical Prescriptions Following Sports Procedures

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Background: Prescribed opioid medication after orthopedic sports surgery has been shown to exceed patient requirements. In 2017, as a response to the opioid epidemic, Ohio passed Opioid Prescribing Guidelines (OPG) limiting narcotic prescriptions for acute pain. This study sought to evaluate the effects of the OPG on prescribing behavior of orthopedists following knee arthroscopy (KA), shoulder arthroscopy (SA), and anterior cruciate ligament reconstruction (ACLR). **Methods**: An institutional database was queried to calculate morphine equivalent dose (MED) prescribed at discharge, acute follow-up (<90 days), and chronic follow-up (>90 days) and compare MED pre- and post-OPG. Cases were identified over a 2-year period starting 1 year prior to OPG implementation. Individual surgeon data were tracked to control for inter-surgeon variability. **Results**: A total of 1663 patients were included in the analysis. Demographic variables were similar pre- and post-OPG for each procedure group. With all surgeons included, average discharge MED decreased significantly for all procedures from pre- to post-OPG. Surgeons qualified for individual analysis if they had at least 10 surgeries pre- and post-OPG. Of qualifying providers, 80% of KA, 25% of SA, and 0% of ACLR surgeons reduced discharge MED prescribed post-OPG. MED prescribed during follow-up was largely unaffected by implementation of the OPG. **Conclusion**: Average discharge morphine equivalent dose (MED) prescribed after SA, KA, and ACLR decreased following the implementation of the OPG. The MED reduction effect of the OPG was the greatest in magnitude after SA, and SA was the only surgery that showed MED reductions that persisted during acute follow up. Opioid prescriptions beyond 90 days postoperatively were unchanged by the OPG for all surgeries. Policy that restricts postoperative opioid prescriptions can be an effective, but incomplete method to address the opioid crisis. ***Key Words:*** *opioids, sports, policy*

INTRODUCTION

From 1996 – 2004, political pressure and public policy in the United States encouraged opioid utilization for the treatment of pain without regulation.[1–3] This led to an exponential increase in narcotic prescriptions and contributed to the development of the current opioid crisis. [4,5] In response to rapidly rising mortality rates related to drug overdose, states have begun legislating policy towards the monitoring and reduction of prescription opioids. In 2017, one such piece of legislation was passed in the state of Ohio to limit opioid medications prescribed for acute pain.[6] Known as the Ohio Opioid Prescribing Guidelines (OPG), it stipulated that no more than seven days of opioids may be prescribed, and that the total morphine equivalent dosage (MED) of the prescription cannot exceed an average of 30 MED per day. Appropriate documentation of specific exemptions allows health care providers to prescribe opioids in excess of these limits.[6]

Whale et al.[7] previously analyzed the effect of the OPG on opioid prescribing behavior following total joint arthroplasties. However, the use of opioid prescriptions to manage postoperative pain is also standard practice for orthopedic sports surgeons.[8,9] Orthopedic intervention has been shown to be cost-effective for a multitude of different indications for both knee and shoulder pathologies.[10,11] The frequency of these interventions has been increasingly common over the past 30 years.[8,12,13] Despite widespread knowledge of the opioid epidemic, sports surgeons continue to prescribe opioid quantities that are in excess of what the typical patient requires.[14,15] Thus, the efficacy and clinical effect of the OPG regulations on orthopedic sports surgeons merits objective analysis.

The purpose of this study was to retrospectively analyze the OPG restrictions and their effect on the prescribing patterns of orthopedic sports surgeons. Prescriber behavior was analyzed before and after the initiation of the OPG, following three common sports procedures: knee arthroscopy (KA), shoulder arthroscopy (SA), and anterior cruciate ligament reconstruction (ACLR). We hypothesized that the new guidelines for acute pain management would have a significant effect on the prescribing practices of orthopedic providers by reducing MED prescribed at discharge, at two follow-up time points, and in total.

METHODS

All study protocols were reviewed and approved by the university's Institutional Review Board. Data were retrospectively obtained from a single hospital network that included five hospitals, similar to a previously published protocol.[7] Briefly, Structured Query Language (SQL) programming was used to extract data directly from the network's electronic medical records (EMR; Hyperspace 2018; Epic Systems Corporation). Cohorts were defined by surgery performed within 1-year date ranges surrounding August 31, 2017, the date the OPG went into effect. The pre-OPG cohort was defined as surgeries that occurred from September 1, 2016 to August 31, 2017, and likewise, the post-OPG cohort was defined as surgeries that occurred from September 1, 2017 to August 31 2018. An institutional Open Surgical Procedure code was used to document every surgery performed within the 5-hospital system. This code was used to identify outpatient surgeries that were coded as Shoulder Arthroscopy (SA), Knee Arthroscopy (KA), and ACL Reconstruction (ACLR). KA was separate from ACLR due to the expected increased pain after ACLR compared to KA. A total of 1963 surgeries were retrospectively identified.

Exclusion criteria included: age less than 18 years, any procedure found to have incomplete data, surgical diagnosis of septic arthritis, surgical diagnosis of degenerative knee pathology, revision ACL reconstruction, or any inpatient stay after surgery. The primary operative surgeon was de-identified and assigned a unique identifier. Surgeon ID was included in pooled analyses to control for variability of prescribing patterns between providers. Surgeons with <10 procedures in either the pre-OPG or post-OPG time periods were excluded from analysis of individual surgeon behaviors but were retained in the pooled opioid prescription analysis (see statistical analysis details below). The above method of identifying and analyzing surgical data within this hospital system has been tested and shown to be accurate.[7]

Patient-level variables were collected, including age, sex, BMI, and Charlson Comorbidity Index (CCI). The primary outcomes were oral MED prescribed at discharge and follow-up. All opioids were converted to oral MED using the conversion formula provided by the Ohio Board of Pharmacy.[16] Follow-up duration was split into 90-day follow-up (acute) and greater than 90 days follow-up (chronic). Total MED prescriptions for a given surgery were defined as discharge MED + acute MED + chronic MED. Only opioid prescriptions written by orthopedic surgeons, residents, or advance practice practitioners within the hospital system were included in the analysis. The exclusion of non-orthopedic providers was performed to maximize data accuracy and allow for tighter control of inter-prescriber variability, although it may not have captured the full scope of each patient's complete access to opioid prescriptions during the study period.

Statistical Analysis

Each sports surgery group was analyzed separately, but the same analysis methods were used for each. All statistical analysis was performed in SAS 9.4 (SAS Institute, Cary, NC) with significance set to α=0.05. For each surgical procedure, patient characteristics were compared between the pre- and post-OPG cohorts using Wilcoxon-Mann-Whitney tests for continuous and ordinal variables, and chi-square tests for frequency distributions. We calculated effect size using Cohen's *d* for continuous data, Cramer's V for frequency data, and following Grissom and Kim for ordinal data.[17] Common language effect size (CL; also called probability of superiority) was calculated for each comparison.[18]

For each surgical procedure, pooled MED data from all surgeons were analyzed for pre- to post-OPG differences. Analysis of covariance (ANCOVA), controlling for surgeon ID, was used to test for differences in MED pre- and post-OPG means and standard deviations (SD) at all time points. This approach controlled for possible effects of randomness and effects of variation in surgeon prescribing habits, workflow, and case load in response to the OPG implementation. Sub-analyses included examining only those patients with greater than 0 MEDs prescribed during the follow-up time points, and the percentage of patients that received any opioid prescription during each follow-up period was also assessed.

Individual prescriber patterns were also compared between time periods within qualifying surgeons (≥10 observations of the relevant procedure in both the pre- and post-OPG time periods). Due to sample size, only discharge prescriptions were used for prescriber-specific analysis. Changes in individual prescriber MED levels were analyzed using Wilcoxon-Mann-Whitney tests, Cohen's *d*, and CL. Changes in individual prescriber prescription variability were also qualitatively assessed by comparing coefficients of variation (CV) pre- and post-OPG.

RESULTS

A final combined cohort of N=1663 outpatient orthopedic sports surgeries were included in the final sample (KA: N=519, SA: N=1033, ACLR: N=111). Of the KA cases, 494 (95%) had a surgical diagnosis of meniscal injury with the remaining 25 patients having diagnoses related to cartilage pathology. Indications for SA were more variable, with rotator cuff repair (60%) making up the majority of the surgical diagnoses, followed by labral pathology (15%), impingement (10%) and instability (5%). The diagnosis of pain made up the remainder of surgical diagnoses for the SA group (10%).

Sample size, demographics, and comorbidities comparing each surgery group pre- and post-OPG are presented in **Table 1.** Surgery cohorts were comparable in terms of demographics and comorbidities both pre- and post-OPG. Of note, the ACLR procedure had a substantially smaller sample size when compared to KA and SA, which limited subgroup analyses.

Postoperative MED Prescribed

MEDs prescribed at discharge were significantly reduced after OPG implementation for all surgeries studied (pre-OPG mean±SD vs. post-OPG mean±SD: KA: 262.0±12.1 vs. 188.4±11.4, *P*<0.01; SA: 566.4±12.2 vs. 314.50±10.4, *P*<0.01; ACLR: 573.4±34.7 vs. 428.5±35, *P*<0.01)

	Variable	Pre-OPG	Post-OPG	P[b]	ES[c]	CL[c]
Knee Arthroscopy	*Sample (N)*	244	275			
	Age (y)	14.4 ± 54.5	54.0 ± 13.9	0.61	0.04	0.51
	Sex (%F)	57%	49%	0.11	0.07	0.52
	BMI ($k\cdot m^{-2}$)	32.4 ± 7.5	33.1 ± 8.0	0.52	0.09	0.53
	CCI	2 (0-3)	1 (0-2)	0.08	0.16	0.54
Shoulder Arthroscopy	*Sample (N)*	438	595			
	Age (y)	53.5 ± 15.8	53.6 ± 14.7	0.74	<0.01	0.50
	Sex (%F)	40%	30.5 ± 14.7	0.41	0.03	0.51
	BMI ($k\cdot m^{-2}$)	30.0 ± 6.4	43%	0.07	0.08	0.52
	CCI	1 (0-3)	1 (0-3)	0.73	0.05	0.51
ACL Reconstruction	*Sample (N)*	57	54			
	Age (y)	27.4 ± 9.7	30.3 ± 9.9	0.11	0.30	0.58
	Sex (%F)	53%	46%	0.57	0.06	0.52
	BMI ($k\cdot m^{-2}$)	27.6 ± 5.5	28.8 ± 7.3	0.62	0.19	0.55
	CCI	0 (0-0)	0 (0-0)	0.76	<0.01	0.50

Table 1. Sample Characteristics for Knee Arthroscopy, Shoulder Arthroscopy, and ACL Reconstruction Patients*. (a. presented values are mean ± SD for ratio data [age, BMI], median ± IQR for interval data [CCI], and frequencies for the nominal variable sex; b. P-values: Wilcoxon-Mann-Whitney tests [continuous data] or chi-square tests [nominal data]; c. effect size estimates [ES]: continuous data = Cohen's d, frequency data = Cramer's V, CL: common language effect size)*

However, SA was the only procedure group to show statistically significant reductions in MED prescribed during acute follow-up (pre-OPG: 242.1±19.7 vs. post-OPG: 186.1±16.8, *P*=0.03). Likewise, SA showed reductions in total MED per procedure after implementation of the OPG (pre-OPG: 863.8±32.4 vs. post-OPG: 543.6±27.7, *P*<0.01) [**Figure 1**]. No other statistically significant differences were found for MED prescribed after KA, SA, or ACLR during acute or chronic follow up (for each, *P*≥0.10). Similarly, no statistically significant differences were found when the frequency of patients receiving opioid prescriptions during follow up periods was compared pre- and post-OPG (for each, *P*≥0.09) [**Figure 2**].

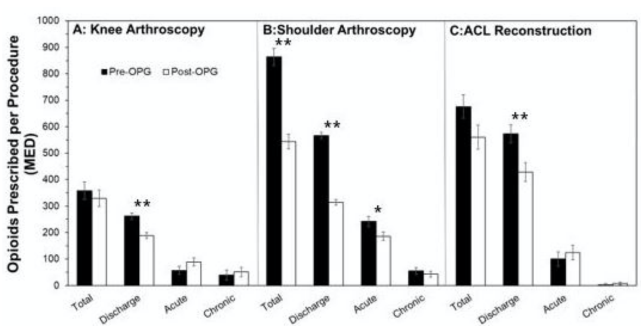

Figure 1. Pre-OPG and Post- OPG Opioid Prescriptions (MED) Across All Patients and All Prescribers (*bar represent means adjusted for prescriber (ANCOVA), and whiskers represent standard errors*)

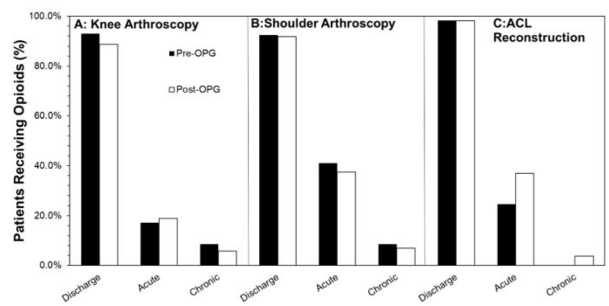

Figure 2. Percentage of Patients Receiving any Opioid Prescription (*black bars represent pre-OPG and white bars represent post-OPG patients.)*

Finally, subgroup analysis of only those patients receiving an opioid prescription during each follow-up period found no significant differences in MED prescribed per patient from pre- to post-OPG (for each, *P*≥0.07). These findings of non-significance included knee arthroscopy patients receiving follow-up prescriptions, despite increases in adjusted mean MED of 37% at acute follow-up (*P*=0.17) and 148% at chronic follow-up (*P*=0.07) [**Figure 3**].

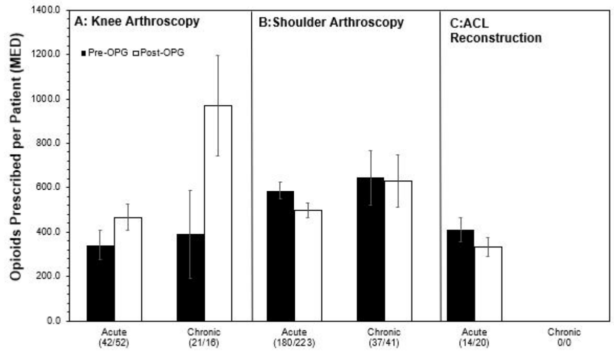

Figure 3. Sub-Analysis of Only Patients Who Received Opioid Prescriptions. *Black bars represent Pre-OPG and white bars represent Post-OPG patients. Asterisks indicate that the Post-OPG adjusted mean is significantly lower than the Pre-OPG adjusted mean (*P<0.05;**P<0.01).*

Individual Surgeon Analysis

Eight unique surgeons met the sample size criteria for individual analysis for one or more of the procedures. Assigned surgeon IDs are consistent across procedures for the following results and related figures. In all, these analyses included five surgeons performing KA, four surgeons performing SA, and two surgeons performing ACLR [**Table 2**].

Table 2. Number of procedures by surgeon[a]

Surgeon ID	N_{KNEE}	$N_{SHOULDER}$	N_{ACL}	N_{TOTAL}
S1	---	381	---	381
S2	50	223	33	306
S3	---	241	---	241
S4	79	69	---	148
S5	68	---	---	68
S6	66	---	---	66
S7	65	---	---	65
S8	---	---	33	33

a. Includes only surgeons eligible for individual analysis for one or more procedures. See text for eligibility criteria.

Of the five surgeons performing KA, four (S2, S5-S7) exhibited substantial, significant prescription MED reductions at discharge post-OPG [**Figure 4**]. Percent reductions ranged from 15.8% to 25.4% (for each, *P*≤0.01) with moderate effect sizes (Cohen's *d* range: 0.25 to 0.54; CL range: 0.57-0.66). The remaining KA surgeon exhibited no change in prescribed MED post-OPG (3.3% increase; *P*=0.41). Regarding SA, only one of the four surgeons (S1) exhibited a substantial, significant reduction in prescribed opioids of 59.0% [**Figure 5**], with a large effect size (*P*<0.01; Cohen's *d*: 2.23; CL: 0.94). The other three surgeons performing SA exhibited negligible reductions of 0.2% to 2.4% (for each, *P*≥0.41). Neither ACLR surgeon demonstrated any meaningful change in prescribed MED at discharge post-OPG (S8: 3.9% increase, *P*=0.44; S2: 2.0% decrease, *P*=0.43) [**Figure 6**].

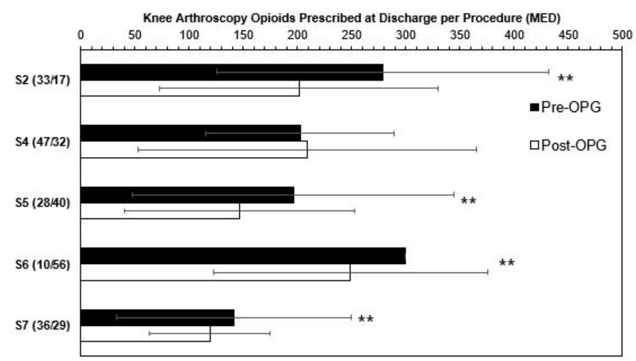

Figure 4. Mean Pre-OPG and Post-OPG Discharge MEDs for Each Surgeon Performing Knee Arthroscopy. *Black bars are for Pre-OPG patients, white bars are for Post-OPG patients. Asterisks indicate that the Post-OPG mean is significantly lower than the Pre-OPG mean (*P<0.05;**P<0.01).*

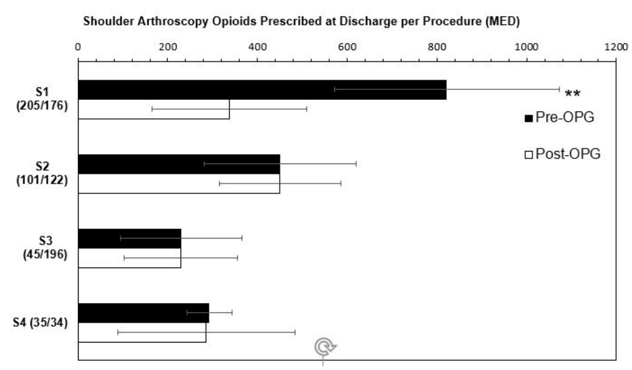

Figure 5. Mean Pre-OPG and Post-OPG Discharge MEDS for Each Surgeon Performing Shoulder Arthroscopy. *Asterisks indicate that the Post-OPG mean is significantly lower than the Pre-OPG mean (*P<0.01;**P<0.01).*

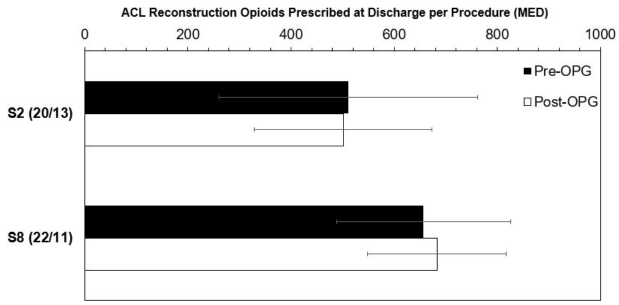

Figure 6. Mean Pre-OPG and Post-OPG discharge MEDs for Each Surgeon Performing ACL reconstruction. *Black bars are for Pre-OPG patients, white bars are for Post-OPG patients. Asterisks indicate that the Post-OPG mean is significantly lower than the Pre-OPG mean (*P<0.05;**P<0.01).*

Finally, there were no consistent patterns of change in prescription variability from pre- to post-OPG, as determined by percent changes in CV, ranging from -29% to +52%. Within KA, three surgeons increased the variability of their prescriptions, whereas two decreased. In SA, two increased and two decreased, while in ACLR one increased and the other decreased prescription variability. Of the two surgeons qualifying under more than one procedure, one (S4) became consistently more variable following the start of the OPG (+32% in KA, and +52% in SA), whereas the other (S2) showed marginally more variability in KA prescriptions (+9%), but slightly less variability for SA (-7%) and ACLR (-8%).

DISCUSSION

Ohio, like numerous other states, [19–22] recently initiated new legislation in response to the opioid epidemic. In the present study, analysis of 1,663 primary, outpatient sports surgeries demonstrated that implementation of the OPG was related to a statistically significant decrease of MED prescribed at discharge for all studied procedures. In the case of SA, the reduction in MED prescribed per procedure after OPG implementation persisted during acute follow-up and resulted in a statistically significant drop in the total MED prescribed per procedure. This same effect was not observed for KA or ACLR. Importantly, the OPG also had no significant effect on opioid prescribing metrics beyond 90 days follow-up for any of the procedures.

The opioid epidemic that the United States is facing today is complex, with high rates of chronic opioid use and drug overdose mortalities.[23] Several recent studies have presented data illustrating the propensity for restrictive policy to decrease opioids prescribed after common orthopedic surgeries. A theoretical benefit of these restrictions on acute opioid prescriptions is a downstream reduction in chronic use. However, none of these studies present data beyond 90 days of follow-up.[24–26] Our results show that chronic opioid use did not decrease as a result of the Ohio OPG in the postoperative orthopedic sports patient population. The OPG had no measurable effect on MED prescribed per procedure, percentage of patients receiving opioids nor the MED prescribed per patient beyond 90 days postoperatively. This is not to say that the OPG is without substantial benefits, which include decreased discharge MED across surgeries and decreased total MED after SA. Opioids prescribed in excess of a patient's requirements have been shown to have the potential to lead to misuse of excess opioids by the patient or others in the population.[27] Reduction in prescribed opioids at discharge to a more appropriate level could reduce the broader potential for recreational use and abuse.

Our results in Ohio are similar to those that have been published on data from another state, Rhode Island, showing that policy can effectively reduce opioids prescribed at discharge after orthopedic procedures.[24,25] Even without a reduction in chronic use, ideally, this reduction in MED at discharge is large enough in magnitude to reduce total MED prescribed. However, the present study found that a reduction in total MED prescribed over the entire follow up course was only seen for SA. No change in total MED prescribed after KA and ACLR was observed. Several reasons may explain why the total MED decrease was only found in the SA cohort. Other studies have shown SA patients to require higher MED postoperatively compared to KA patients (300 MED versus 200 MED respectively),[9,15] and a similar pattern was observed in the present study's data. Restrictions on opioids may have a larger effect on surgeries that are more painful which, thus, have overall higher *a priori* levels of opioid prescription. At the same time, procedures such as KA that are less opioid-heavy to begin with, may have less room for decrease, and thus less apparent prescriber response to state guidelines.

Individual provider analysis demonstrated heterogeneity between orthopedic surgeons regarding each surgeon's response to the OPG restrictions. Four of the five qualifying surgeons in the KA procedure cohorts had statistically significant reductions in MED prescribed at discharge. This was in stark contrast to SA procedures, where only a single surgeon out of the qualifying four demonstrated a decrease; this SA surgeon's decrease in MED prescriptions post-OPG was the largest in magnitude for any surgeon in any of the analyzed procedures (Cohen's *d*: 2.23; CL: 0.94). Surgeon heterogeneity in MED reductions from pre- to post-OPG alone is an interesting finding in our study, but our data also showed wide disparities in terms of how variable each surgeon's prescriptions were from patient to patient. Although not the primary outcome of the study, we found that some prescribers increased their patient-to-patient variability from pre- to post-OPG while others saw this variability decrease. It is possible that the OPG prompted some surgeons to adjust narcotic prescription dosing on a patient-by-patient basis (increased variability) while others adjusted narcotic prescriptions more broadly to comply with the OPG restrictions (decreased variability). Reasons for this heterogeneity can only be speculated upon, as this was not the primary goal of this study; however, this finding should guide further research into individual prescriber response to narcotic prescriber policy and restrictions. Understanding surgeon response to restrictions could help guide the creation of more effective policy in the future.

The heterogeneity between different surgeons' responses discussed above highlights the importance of controlling for prescriber when assessing the effects of opioid policy. This prescriber heterogeneity was seen after a similar analysis of opioid prescribing habits after total joint arthroplasty.[7] To our knowledge, this paper is the first to control for prescriber heterogeneity when analyzing the effects of opioid policy on opioid prescriptions after orthopedic sports surgeries.

LIMITATIONS

A limitation of this analysis is that it did not include an evaluation of changes in workflow, local anesthesia, and other oral analgesics pre- and post-OPG implementation. The authors acknowledge that these factors and others could affect why a particular surgeon's practice was or was not changed by the OPG.

Another significant limitation of the study is the inability to account for opioid prescriptions outside the hospital system available. Patients may have obtained opioids outside the available EMR, including illegally. Additionally, our methods did not assess for patient history of opioid use. Sample size limitations were also encountered with subgroup analyses and limited our conclusions. Despite having over 1,500 total patients, some subgroups had fewer than 25 patients for analysis. In some of those cases, even large differences were not statistically significant, which may indicate these analyses being underpowered [e.g., see **Figure 3A** and results pertaining to follow-up MED in KA patients]. Finally, this study showed reduction in pain medication without assessing patient pain levels or patient-reported outcome measures. Thus, no conclusions can be made about the effects of the OPG on adequacy of pain control, or on patient satisfaction after the orthopedic sports procedures. Although there was a reduction in discharge opioids prescribed, there may have been a corresponding increase in patient calls and clinic visits. These variables would be better addressed with a prospective study measuring the effects of opioid policy such as the OPG.

IMPLICATIONS

Our results illustrate that statewide policy like the OPG can play a role in reducing opioids prescribed after some orthopedic procedures, but the magnitude of the effect is perhaps more dependent on the prescribing practices of the surgeon prior to legislation enactment. The study was designed so that the results can be applied on an individual prescriber basis, across healthcare systems and on a policy level. As postoperative recovery in orthopedic sports patients moves away for pharmacology, the need for a multidisciplinary approach including therapists and athletic trainers increases. Restrictions like the OPG may decrease opioid burden while increasing the opportunity for alternatives including biofeedback techniques, electrophysiology and other therapy techniques to maximize patient recovery and return to play. Therefore, the results illustrate the importance for a multidisciplinary approach to orthopedic sports surgery including addressing pain control alternatives, surgeon/patient education and drug monitoring programs.

FUTURE RESEARCH

There remains significant room for improvement in how we address the opioid crisis without sacrificing patient care and pain control. As discussed above, comparing patient reported pain outcome scores after common orthopedic surgeries would help understand how restrictions directly affect patient symptoms. Also, studies analyzing policy effect on healthcare costs, patient return to sport, and healthcare systems would allow for analysis of any unintended consequences of policy such as the OPG. The opioid crisis cannot be addressed with a single policy, but, rather, will require a collaborative effort between disciplines including physicians, patients, healthcare systems and policy makers. Research is needed to understand how to improve upon current policies and create new interventions within and across disciplines.

CONCLUSION

In conclusion, the 2017 Ohio Opioid Prescribing Guidelines (OPG) led to a clinically substantial and statistically significant drop in morphine equivalent dose (MED) prescribed at discharge after shoulder arthroscopy, knee arthroscopy, and ACL reconstruction. This reduction was substantial enough after shoulder arthroscopy to show a total reduction in MED prescribed in the six months following the procedure. Conversely, chronic opioid prescriptions were shown to be largely unaffected by the OPG. Heterogeneity in individual surgeon responses to the OPG after each surgery was substantial. Overall, legislation like the OPG can be an effective but incomplete method to address the role of orthopedic pain relief prescriptions in the opioid crisis.

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