Published in final edited form as:

J Am Coll Surg. 2018 September ; 227(3): 374–381. doi:10.1016/j.jamcollsurg.2018.06.007.

The Spillover Effect of Evidence-Based Opioid Prescribing After Surgery

Ryan Howard, MD¹, Mitchell Alameddine, BS², Michael Klueh, BS², Michael Englesbe, MD³, Chad Brummett, MD⁴, Jennifer Waljee, MD, MS, MPH⁵, Jay Lee, MD¹

¹Department of Surgery, Michigan Medicine, Ann Arbor, MI

²University of Michigan Medical School, Ann Arbor, MI

³Section of Transplant Surgery, Department of Surgery, University of Michigan Health System, Ann Arbor, MI

⁴Department of Anesthesia, University of Michigan Health System, Ann Arbor, MI

⁵Section of Plastic Surgery, Department of Surgery, University of Michigan Health System, Ann Arbor, MI

Abstract

Background: Opioid prescribing after surgery is often excessive, resulting in leftover pills in the community available for diversion. Procedure-specific postoperative prescribing guidelines can reduce excessive prescribing, however it is unclear whether such guidelines influence opioid prescribing for other procedures.

Study Design: A retrospective chart review was conducted for patients undergoing laparoscopic appendectomy, laparoscopic inguinal hernia repair, laparoscopic sleeve gastrectomy, and thyroidectomy/parathyroidectomy between January 1, 2016 and August 31, 2017. Postoperative opioid prescription size (in oral morphine equivalents (OME)) was compared before and after November 1, 2016, when prescribing guidelines were introduced for laparoscopic cholecystectomy. An interrupted time series analysis was conducted to evaluate the effect of this intervention.

Results: A total of 1158 patients were included in the cohort (558 pre-intervention, 600 post-intervention). Opioid prescription size was significantly reduced for laparoscopic sleeve gastrectomy (447.6 ± 74.3 vs. 291.9 ± 104.3 OME, $P < 0.001$), laparoscopic appendectomy (173.7 ± 101.6 vs. 85.8 ± 52.7 OME, $P < 0.001$), laparoscopic inguinal hernia repair (185.0 ± 101.8 vs. 107.9 ± 57.9 OME, $P < 0.001$), and thyroidectomy/parathyroidectomy (81.5 ± 52.8 vs. 42.6 ± 22.5 OME, $P < 0.001$). Interrupted time series analysis revealed that this reduction was attributable to intervention for laparoscopic sleeve gastrectomy (-24.5 ± 5.3 OME, $P = 0.001$), laparoscopic appendectomy (-50.2 ± 28.7 OME, $P = 0.04$), and thyroidectomy/parathyroidectomy (-28.8 ± 9.4 OME, $P = 0.001$). For laparoscopic inguinal hernia repair, the immediate decrease in prescription size was not statistically significant (-38.8 ± 33.1 OME, $P = 0.24$). There was a significant increase

in requests for refills after laparoscopic appendectomy (0.8% vs. 6.6%, $P=0.01$) but not for other procedures.

Conclusion: After implementing evidence-based opioid prescribing recommendations for a single surgical procedure, opioid prescribing decreased for four other surgical procedures. Requests for refills did not increase substantially. This spillover effect demonstrates the potential impact of raising awareness about safe and appropriate opioid prescribing after surgery.

Introduction

Opioid prescribing for acute pain is a common surgical practice. However, variable and excessive prescribing of opioids after surgery is a significant contributor to the current opioid crisis in the United States. Recent studies have demonstrated that opioid prescribing after surgery often results in patients having leftover medication.¹⁻⁵ Up to ninety-two percent of patients report having unused opioids following general surgical procedures, and these excess prescription opioids pose significant risk.⁶ For example, the majority of Americans who misuse prescription opioids get the medication from friends or relatives who have leftover medication.⁷ Given these consequences, surgeons need evidence-based prescribing recommendations to optimize postoperative pain control while minimizing the risks of opioids.

A number of investigators have examined approaches to develop best practice recommendations. Hill et al. evaluated patient-reported opioid consumption following five common surgical procedures and made prescribing recommendations designed to satisfy 80% of patients' opioid requirements.⁸ They observed a 53% reduction in opioid prescription size, with only one new patient requiring a refill. At our institution, we successfully implemented opioid prescribing recommendations based on patient-reported opioid consumption for laparoscopic cholecystectomy and observed a 63% reduction in opioid prescription size.⁹ This represents thousands of excess pills kept out of the community for a single procedure at one institution. While these recommendations were effective for reducing opioid prescribing for laparoscopic cholecystectomy, it is unclear whether or not implementing these recommendations for laparoscopic cholecystectomy had any effect on opioid prescribing for other procedures at our institution. Targeted interventions in other areas of healthcare have been shown to influence provider practice beyond the specific issue they address.¹⁰ Insofar as prescribing recommendations raise awareness about appropriate opioid prescribing in general, that effect may spill over into other surgeries and specialties.

Within this context, we sought to evaluate how implementation of opioid prescribing recommendations for laparoscopic cholecystectomy affected opioid prescribing for other common procedures in which opioid consumption is lower than what is commonly prescribed. We hypothesized that evidence-based recommendations for laparoscopic cholecystectomy would be associated with reductions in opioid prescribing for other surgical procedures.

Methods

Study cohort, data source, and study outcomes

This study was approved by the University of Michigan Institutional Review Board. The need for informed consent was waived for this retrospective analysis of de-identified data. We previously described the development and implementation of evidence-based postoperative opioid prescribing recommendations for laparoscopic cholecystectomy at our institution.⁹ The current study analyzes changes in postoperative opioid prescribing for four different procedures during the same time period. These procedures were laparoscopic appendectomy, laparoscopic inguinal hernia repair, laparoscopic sleeve gastrectomy, and thyroidectomy (including hemi- and total thyroidectomy) and/or parathyroidectomy. These procedures were chosen to provide broad representation across common general surgical procedures for which opioids are commonly overprescribed.¹ A non-laparoscopic procedure was chosen to evaluate the effect on a markedly different procedure during the same time period. We identified patients who underwent the above procedures from January 1, 2016 to August 31, 2017. Patients were excluded from analysis if they experienced a postoperative complication prior to discharge (such as need for reoperation, need for interventional radiologic procedures, or surgical wound complication), or presented to an emergency department within 30 days after surgery. All patient and opioid prescription data were obtained by chart review of the electronic medical record.

Primary outcomes for this study were opioid prescription size at the time of discharge, prescription of acetaminophen or ibuprofen at the time of discharge, and patient requests for refills during the 30 days after surgery. The amount of opioids prescribed at discharge was converted to milligrams of oral morphine equivalents (OME) to adjust for varying potencies between medications.¹¹ For ease of reference, we also calculated the equivalent dose in number of pills of hydrocodone/acetaminophen 5/325 mg ("pills").

Statistical analysis

Patients were divided into four groups based on procedure type: laparoscopic appendectomy, laparoscopic inguinal hernia repair, laparoscopic sleeve gastrectomy, and thyroidectomy/parathyroidectomy. For each group, we calculated the mean opioid prescription size (OME) each month. We then used interrupted time series analysis¹² to compare opioid prescribing before and after implementation of prescribing recommendations for laparoscopic cholecystectomy in November 2016. This is a regression model which tests for the effect of a time-based intervention while controlling for any pre-existing trends prior to intervention.^{13,14} These guidelines were shared with all surgical faculty, staff, and residents via in-person and video presentations at the beginning of November, 2016. The two preceding months (September-October 2016) were excluded from analysis as in our previous study.⁹ This period was during development and logistical implementation of prescribing recommendations and did not reflect either pre-intervention or post-intervention states. This resulted in comparison of eight pre-intervention months (January-August 2016) and ten post-intervention months (November 2016-August 2017).

In addition to the interrupted time series analysis, outcomes were compared for each procedure before and after November 1, 2016. Demographic characteristics including age and sex were compared before and after intervention to test for similarity of groups. Continuous variables were compared using Student's t-test and categorical variables were compared using a Chi-squared test. Opioid prescription size was also compared between residents and surgical staff (physician assistants and nurse practitioners (grouped as PA/NPs)) using ANOVA with least significant difference post-hoc analysis. Two-sided *P* values less than 0.05 were considered statistically significant. All statistical analyses were conducted in SPSS 20.

Results

Study cohort

A total of 1,250 patients underwent one of the above listed procedures between January 2016 and August 2017. Ninety-two patients were evaluated at an emergency department for a post-operative problem unrelated to pain control or experienced a postoperative complication prior to discharge, leaving 1,158 patients for analysis (Table 1). No data were collected regarding preoperative opioid use, so this was a mixed cohort of opioid-naïve patients and patients already using opioids. Within this cohort, 558 patients underwent surgery prior to intervention and 600 patients after intervention. The size of each group before and after intervention was 135 vs. 126 patients for laparoscopic sleeve gastrectomy, 131 vs. 122 patients for laparoscopic appendectomy, 59 vs. 108 patients for laparoscopic inguinal hernia repair, and 233 vs 244 patients for thyroidectomy/parathyroidectomy. Demographic characteristics were similar before and after intervention for each group. There were no significant differences in age, sex, or length of stay before and after intervention, except for age in laparoscopic inguinal hernia repair, which decreased from 59.3 ± 14.7 years to 52.8 ± 16.8 years ($P < 0.01$). Prescriptions were written by 115 residents and 24 PA/NPs overall.

Opioid prescriptions

Prior to the intervention, postoperative opioid prescriptions were most common after laparoscopic sleeve gastrectomy (99.3%), followed by laparoscopic inguinal hernia repair (94.9%), laparoscopic appendectomy (93.9%), and thyroidectomy/parathyroidectomy (89.3%) respectively. Prescription size was highest following laparoscopic sleeve gastrectomy (447.6 ± 73.4 OMEs, 90 ± 15 pills), followed by laparoscopic inguinal hernia repair (185.0 ± 101.8 OMEs, 37 ± 20 pills), laparoscopic appendectomy (173.7 ± 101.6 OMEs, 35 ± 20 pills), and thyroidectomy/parathyroidectomy (81.5 ± 52.8 OMEs, 16 ± 11 pills) respectively.

After November 2016, postoperative opioid prescription size was significantly reduced for all four procedures (Figure 1). Specifically, mean prescription size was reduced to 291.9 ± 104.3 OMEs (58 ± 21 pills) for laparoscopic sleeve gastrectomy, 107.9 ± 57.9 mg (22 ± 12 pills) for laparoscopic inguinal hernia repair, 85.8 ± 52.7 mg (17 ± 11 pills) for laparoscopic appendectomy, and 42.6 ± 22.5 (9 ± 4.5 pills) mg for thyroidectomy/parathyroidectomy, ($P < 0.001$ for all procedures). There was no significant change in the

percentage of patients who received opioid prescriptions following these procedures. Prescriptions for acetaminophen and ibuprofen were significantly increased for laparoscopic sleeve gastrectomy (34.1% vs 48.4%, $P=0.02$) and laparoscopic inguinal hernia repair (38.0% vs. 13.6%, $P=0.001$), but not for laparoscopic appendectomy (64.8% vs. 54.2%, $P=0.09$) or thyroidectomy/parathyroidectomy (75.1% vs. 75.8%, $P=0.86$). Requests for refills did not increase following laparoscopic sleeve gastrectomy (5.2% vs. 7.9%, $P=0.37$), laparoscopic inguinal hernia repair (1.7% vs. 5.6%, $P=0.23$), or thyroidectomy/parathyroidectomy (2.1% vs. 2.0%, $P=0.94$). However, they did increase significantly following laparoscopic appendectomy (0.8% vs. 6.6%, $P=0.01$).

Interrupted time series analysis reveals that the immediate decrease in postoperative opioid prescription size in after November, 2016 was statistically significant for laparoscopic sleeve gastrectomy ($P=0.001$), laparoscopic appendectomy ($P=0.04$), and thyroidectomy/parathyroidectomy ($P=0.001$) (Figure 2). For laparoscopic inguinal hernia repair, there was already a statistically significant trend in decreased prescription size (-6.3 ± 2.6 mg/month, $P=0.02$), and the immediate decrease in prescription size after November, 2016 was not statistically significant ($P=0.24$).

There were significant differences in opioid prescribing by provider level (Table 3). PA/NPs prescribed significantly less after intervention for all procedures. Residents prescribed significantly less after intervention for all procedures except laparoscopic sleeve gastrectomy (350.0 ± 138.9 vs. 234.4 ± 85.5 OMEs, $P=0.065$). Prior to intervention, residents prescribed more than PA/NPs following thyroidectomy (104.6 ± 63.7 vs. 68.7 ± 38.1 OMEs, $P<0.001$) and PA/NPs prescribed more than residents following laparoscopic sleeve gastrectomy (457.3 ± 50.3 vs. 350.0 ± 138.9 OMEs, $P<0.001$). After intervention, residents prescribed more than PA/NPs following laparoscopic inguinal hernia repair and thyroidectomy (53.3 ± 25.1 vs. 37.7 ± 15.9 OMEs, $P<0.001$).

Discussion

Following implementation of evidence-based postoperative opioid prescribing recommendations for laparoscopic cholecystectomy at our institution, there was a significant spillover effect that resulted in significantly smaller opioid prescriptions after four other surgical procedures. We observed a direct impact of this intervention beyond pre-existing trends in prescribing practices for laparoscopic sleeve gastrectomy, laparoscopic appendectomy, and thyroidectomy/parathyroidectomy. Despite this reduction in prescribing, patients requested more refills after only one procedure (laparoscopic appendectomy). Prescriptions for non-opioid analgesics also increased significantly in two procedures. Subtracting post-intervention prescription size for all procedures from the predicted prescription size had no change occurred reveals that roughly 10,000 pills were prevented from entering the community over 10 months for these four procedures.

Reduction of excess opioids available for diversion is a critical part of addressing the current opioid crisis. Excess pills pose a significant risk to the communities in which patients live, with the majority of Americans who use prescription opioids non-medically obtaining the medication from a friend or relative.^{7,15} In our own work in opioid reclamation within

Michigan communities, we have noted that having excess opioids after surgery is one of the most common reasons for having unused prescription opioids at home. Postoperative opioid prescriptions also pose a risk to the patients themselves, with 5-10% of opioid-naïve patients transitioning to chronic opioid use after surgery.¹⁶⁻¹⁸

The current study provides evidence that interventions designed to reduce excessive opioid prescription after surgery will likely have an impact on opioid prescribing beyond the specific procedures they address. We observed that around the time of the intervention for laparoscopic cholecystectomy, prescribing practices markedly changed in four other unrelated procedures. While recommendations were made for laparoscopic cholecystectomy, none were made for the four procedures described here. Providers adjusted their prescribing habits without using a formal dataset about patients' opioid usage after surgery and reduced prescription size between 35-51%. This phenomenon can be seen in other fields. For example, after the Food and Drug Administration issued a public health advisory about the risk of selective serotonin reuptake inhibitors (SSRIs) in pediatric patients with depression, SSRI prescriptions for adult patients also decreased significantly.¹⁹ Similarly, after legislative changes removed the requirement for HIV pretest counseling in an effort to increase the rate of providers offering HIV testing to patients, providers were also more likely to offer testing for hepatitis C virus as well.¹⁰

Despite the lack of data about postoperative opioid usage, requests for refills increased for only one procedure. In addition, all procedures saw a significant reduction in prescription size regardless of baseline prescriptions size. Prior to intervention, opioid prescriptions following laparoscopic sleeve gastrectomy were over five times larger than prescriptions following thyroidectomy/parathyroidectomy (equivalent to roughly 90 pills vs. 16 pills), however prescriptions were dramatically reduced after both procedures. This reduction in excessive prescribing is an important step in optimizing postoperative opioid prescribing. It also offers an insight into how local trends can drive practice change among surgeons in the absence of data. The increase in requests for refills following laparoscopic appendectomy also illustrates the importance of integrating patient-reported data to accurately tailor opioid prescribing after surgery. Further investigation is needed to ensure that these changes did not have a negative effect on patient-reported outcomes such as pain score.

Qualitative data are needed to understand what motivated these changes in prescribing during this time. In a related study, we performed a qualitative assessment of surgical oncology providers,²⁰ who received an intervention similar to the one implemented for laparoscopic cholecystectomy.⁹ Social influences and goals were identified as key determinants of prescribing behavior, while education and guidelines were identified as likely to change behavior.²⁰ The findings of our study suggest these interventions may also be effective for other procedures outside surgical oncology. One possibility is that this intervention prompted providers to begin asking their patients how much medication they used after surgery and used this informal data to inform their opioid prescribing. It is also possible that the prescribing recommendations for laparoscopic cholecystectomy served as an anchor by which providers began to adjust prescribing for other procedures. Based on how much more or less painful providers perceived other procedures in comparison to laparoscopic cholecystectomy, they may have adjusted prescribing up or down accordingly.

Changes in prescribing may also reflect increasing awareness of the opioid epidemic itself. For example, this increased awareness may be what drove the decreased prescribing in hernia repair prior to any intervention.

This study also suggests potential unintended consequences when designing interventions to address excessive opioid prescribing. As we saw, an intervention targeted at a single surgical procedure had a significant effect on other, unrelated procedures. In one case, this resulted in prescriptions that were likely insufficient to adequately manage postoperative pain as evidenced by an increase in requests for refills after laparoscopic appendectomy. Additionally, we observed different prescribing practices between different levels of provider. Future opioid prescribing recommendations should be clear which procedure they address and should be communicated with all provider levels.

Appropriate opioid prescription size is only one element in safely and effectively treating patients' pain after surgery. Appropriate patient education also plays a role in optimizing postoperative pain management. This should begin before surgery, by setting proper expectations. Patients should be informed that they can expect to have pain after surgery and that this is normal.²¹ When data such as average opioid use following surgery are known, they can be shared with patients. For example, at our own institution, using data generated from the study of laparoscopic cholecystectomy, we now routinely inform patients how many tablets of opioid medication the average patient uses after that procedure. This is a powerful way to set patient expectations, and may in fact serve as a mental anchor for postoperative opioid use. Patients should also be advised to use non-opioid analgesics, such as acetaminophen and ibuprofen, to manage their pain, and that opioids are for breakthrough pain. The use of multimodal analgesia is also critical to this effort. Postoperative pain management should include the use of adjuvant pain medication such as acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDs), and anticonvulsants.²² Additionally, non-pharmacologic therapies such as the use of heat and/or cold, as well as focused breathing have a role in postoperative pain management. As interventions are developed to address appropriate opioid prescribing after surgery, they should take into account these modalities. Lastly, patients should be told how to properly dispose of leftover opioids. A novel tool in the state of Michigan is an online map, where patients can search for licensed disposal sites located in or near their zip code.²³

This work has several limitations. First, this study analyzed prescribing habits and changes at only a single institution. These results may not be generalizable to institutions where prescribing practice differs significantly. Moreover, it's possible that the pre-intervention state at our institution uniquely overprescribed, and was only brought into a normal range of prescribing in the post-intervention state. However, multiple studies demonstrate that opioid overprescribing after surgery is a common phenomenon across institutions, specialties, and procedures.^{2,6,8,9} In addition, unlike our previous study,⁹ we did not collect patient-reported opioid usage or pain scores after surgery for these procedures. Lastly, this study did not survey providers about why their prescribing habits changed during this time period. These last two limitations are planned to be addressed in work that is currently underway.

Conclusion

After implementing evidence-based opioid prescribing recommendations for a single surgical procedure, opioid prescribing decreased for other surgical procedures without increasing the need for opioid refills. This spillover effect demonstrates the potential impact of raising awareness about safe and appropriate opioid prescribing after surgery.

References

1. Hill MV, McMahon ML, Stucke RS, Barth RJ Jr. Wide Variation and Excessive Dosage of Opioid Prescriptions for Common General Surgical Procedures. *Annals of surgery*. 2016.
2. Bartels K, Mayes LM, Dingmann C, Bullard KJ, Hopfer CJ, Binswanger IA. Opioid Use and Storage Patterns by Patients after Hospital Discharge following Surgery. *PLoS One*. 2016;11(1):e0147972. [PubMed: 26824844]
3. Bates C, Laciak R, Southwick A, Bishoff J. Overprescription of postoperative narcotics: a look at postoperative pain medication delivery, consumption and disposal in urological practice. *J Urol*. 2011;185(2):551–555. [PubMed: 21168869]
4. Rodgers J, Cunningham K, Fitzgerald K, Finnerty E. Opioid consumption following outpatient upper extremity surgery. *J Hand Surg Am*. 2012;37(4):645–650. [PubMed: 22410178]
5. As-Sanie S, Till SR, Mowers EL, et al. Opioid Prescribing Patterns, Patient Use, and Postoperative Pain After Hysterectomy for Benign Indications. *Obstet Gynecol*. 2017.
6. Bicket MC, Long JJ, Pronovost PJ, Alexander GC, Wu CL. Prescription Opioid Analgesics Commonly Unused After Surgery: A Systematic Review. *JAMA Surg*. 2017.
7. Substance Abuse and Mental Health Services Administration: Results from the 2008 National Survey on Drug Use and Health: National Findings. Rockville, Maryland: Office of Applied Studies, NSDUH Series H-36, HHS Publication No. SMA 09-4434. 2009.
8. Hill MV, Stucke RS, McMahon ML, Beeman JL, Barth RJ Jr. An Educational Intervention Decreases Opioid Prescribing After General Surgical Operations. *Ann Surg*. 2017.
9. Howard R, Waljee J, Brummett C, Englesbe M, Lee J. Reduction in Opioid Prescribing Through Evidence-Based Prescribing Guidelines. *JAMA Surg*. 2018;153(3):285–287. [PubMed: 29214318]
10. Frimpong JA, D'Aunno T, HELLERINGER S, Metsch LR. Spillover effects of HIV testing policies: changes in HIV testing guidelines and HCV testing practices in drug treatment programs in the United States. *BMC public health*. 2016;16:666. [PubMed: 27473519]
11. Gammaitoni AR, Fine P, Alvarez N, McPherson ML, Bergmark S. Clinical application of opioid equianalgesic data. *Clin J Pain*. 2003;19(5):286–297. [PubMed: 12966254]
12. Lopez Bernal J, Cummins S, Gasparrini A. Interrupted time series regression for the evaluation of public health interventions: a tutorial. *International journal of epidemiology*. 2016.
13. Brunette MF, Gunn W, Alvarez H, et al. A pre-post pilot study of a brief, web-based intervention to engage disadvantaged smokers into cessation treatment. *Addict Sci Clin Pract*. 2015;10:3. [PubMed: 25638283]
14. Wagner AK, Soumerai SB, Zhang F, Ross-Degnan D. Segmented regression analysis of interrupted time series studies in medication use research. *Journal of clinical pharmacy and therapeutics*. 2002;27(4):299–309. [PubMed: 12174032]
15. Lipari RN, Hughes A. How People Obtain the Prescription Pain Relievers They Misuse The CBHSQ Report. Rockville (MD)2013.
16. Brummett CM, Waljee JF, Goesling J, et al. New Persistent Opioid Use After Minor and Major Surgical Procedures in US Adults. *JAMA Surg*. 2017;152(6):e170504. [PubMed: 28403427]
17. Harbaugh CM, Lee JS, Hu HM, et al. Persistent Opioid Use Among Pediatric Patients After Surgery. *Pediatrics*. 2017.
18. Lee JS, Hu HM, Edelman AL, et al. New Persistent Opioid Use Among Patients With Cancer After Curative-Intent Surgery. *Journal of clinical oncology : official journal of the American Society of Clinical Oncology*. 2017;JCO2017741363.

19. Busch SH, Frank RG, Leslie DL, et al. Antidepressants and suicide risk: how did specific information in FDA safety warnings affect treatment patterns? *Psychiatric services*. 2010;61(1):11–16. [PubMed: 20044412]
20. Lee JS, Parashar V, Miller JB, et al. Opioid Prescribing After Curative-Intent Surgery: A Qualitative Study Using the Theoretical Domains Framework. *Ann Surg Oncol*. 2018.
21. Gawande AA. It's Time to Adopt Electronic Prescriptions for Opioids. *Annals of surgery*. 2017;265(4):693–694. [PubMed: 28067675]
22. Wick EC, Grant MC, Wu CL. Postoperative Multimodal Analgesia Pain Management With Nonopioid Analgesics and Techniques: A Review. *JAMA Surg*. 2017;152(7):691–697. [PubMed: 28564673]
23. Opioid Disposal Map. <http://michigan-open.org/takebackmap/>. Accessed December 18, 2017.

Figure 1 –.
Mean (SEM) Opioid Prescription Size Before and After Intervention

Figure 2 –.
Mean (SEM) Opioid Prescription Size Over Time, Before and After Intervention

Table 1 –

Patient Characteristics and Prescribing Before and After Intervention.

Laparoscopic Sleeve Gastrectomy	Pre-Intervention (135)	Post-Intervention (126)	P
Age (mean (SD), years)	45.7 (11.7)	46.1 (10.8)	0.77
Sex (% female)	80.7	76.2	0.37
Length of stay (mean (SD), days)	2.1 (0.5)	2.0 (0.5)	0.36
Prescription (%)	99.3	99.2	0.96
Prescription size (mean (SD), OME)	447.6 (74.3)	291.9 (104.3)	<0.001
Acetaminophen/Ibuprofen (%)	34.1	48.4	0.02
Request for refill (%)	5.2	7.9	0.37
Laparoscopic Appendectomy	Pre-Intervention (131)	Post-Intervention (122)	P
Age (mean (SD), years)	38.3 (15.1)	36.9 (14.5)	0.46
Sex (% female)	51.9	49.2	0.67
Length of stay (mean (SD), days)	0.6 (1.6)	0.5 (1.8)	0.74
Prescription (%)	93.9	88.5	0.13
Prescription size (mean (SD), OME)	173.7 (101.6)	85.8 (52.7)	<0.001
Acetaminophen/Ibuprofen (%)	54.2	64.8	0.09
Request for refill (%)	0.8	6.6	0.01
Laparoscopic Inguinal Hernia Repair	Pre-Intervention (59)	Post-Intervention (108)	P
Age (mean (SD), years)	59.3 (14.7)	52.8 (16.8)	0.01
Sex (% female)	10.2	11.1	0.85
Length of stay (mean (SD), days)	0.1 (0.3)	0.1 (0.3)	0.95
Prescription (%)	94.9	97.2	0.44
Prescription size (mean (SD), OME)	185.0 (101.8)	107.9 (57.9)	<0.001
Acetaminophen/Ibuprofen (%)	13.6	38.0	0.001
Request for refill (%)	1.7	5.6	0.23
Thyroidectomy/ Parathyroidectomy	Pre-Intervention (233)	Post-Intervention (244)	P
Age (mean (SD), years)	51.4 (16.0)	50.4 (16.4)	0.53
Sex (% female)	76.4	76.2	0.97
Length of stay (mean (SD), days)	0.9 (0.4)	0.9 (0.5)	0.68
Prescription (%)	89.3	87.3	0.50
Prescription size (mean (SD), OME)	81.5 (52.8)	42.6 (22.5)	<0.001
Acetaminophen/Ibuprofen (%)	75.1	75.8	0.86
Request for refill (%)	2.1	2.0	0.94

Table 2 –

Differences Between Resident and PA/NP Prescribing Before and After Intervention

Laparoscopic Sleeve Gastrectomy	N (Pre/Post)	Pre-Intervention	Post-Intervention	P
Resident	8 / 8	350.0 (138.9) *	234.4 (85.5)	0.065
PA/NP	126 / 116	457.3 (50.3)	295.6 (101.8)	<0.001
Laparoscopic Appendectomy		Pre-Intervention	Post-Intervention	P
Resident	48 / 54	167.5 (91.3)	96.3 (45.3)	<0.001
PA/NP	75 / 53	196.3 (95.0)	98.6 (45.6)	<0.001
Laparoscopic Inguinal Hernia Repair		Pre-Intervention	Post-Intervention	P
Resident	53 / 99	190.8 (95.0)	112.4 (57.5) *	<0.001
PA/NP	3 / 5	266.7 (57.7)	60 (37.9)	0.001
Thyroidectomy/ Parathyroidectomy		Pre-Intervention (233)	Post-Intervention (244)	P
Resident	84 / 95	104.6 (63.7) *	53.3 (25.1) *	<0.001
PA/NP	144 / 140	68.7 (38.1)	37.7 (15.9)	<0.001

* = statistically significant difference in prescription size between residents and PA/NPs