Preoperative Non-Opioid Analgesia in Total Joint Patients to Decrease Postoperative Pain

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A DNP Project Manuscript
Submitted in Partial Fulfillment of the Requirements for the
Doctor of Nursing Practice Degree

School of Nursing, University of Maryland at Baltimore
May 2022

Abstract

Problem & Purpose: Postoperative pain remains a fundamental concern for adult patients undergoing total joint replacement surgeries. Postoperative pain has negative physiologic effects including increased heart rate and blood pressure, decreased intestinal motility, and decreased immune function. At a small rural medical center, 30% of adult total joint patients undergoing general anesthesia reported a severe postoperative pain score greater than seven on the numeric rating scale. The purpose of this quality improvement project was to implement and evaluate the compliance of administering preoperative non-opioid pain medications (Tylenol, Gabapentin, & Celebrex) in adult total joint replacement patients. *Methods:* The setting of this project was 13 operating rooms with an implementation team consisting of perioperative nurses and anesthesia providers. A protocol form was used to screen eligible patients and non-opioid analgesics were then administered to adults undergoing total joint replacement surgeries. Compliance with administration and documentation of preoperative non-opioid analgesics, postoperative pain scores, and postoperative administration of opioids were tracked via chart audits. *Results:* Chart audits were completed for 48 patients over a 15-week period. On average, 74% of anesthesia providers were compliant with administering preoperative non-opioid medications and 91% of patients denied having severe pain postoperatively. *Conclusions:* Data suggested this was a feasible project with a positive correlation between administering preoperative non-opioid analgesia for patients undergoing total joint replacement surgeries to decrease postoperative pain.

Pain is a known sequela following most surgical procedures with about 80% of patients experiencing acute pain after surgery, and most experiencing moderate-to-severe pain (Baratta et al., 2014). In 2014, there were more than 675,000 surgeries for total knee replacements, total hip replacements, and total shoulder replacements (Goode et al., 2019). A common way to reduce postoperative pain is with opioid pain medications, however this can lead to patients experiencing negative opioid side effects, opioid abuse, and even death in some patients from long-term addiction. Preoperative administration of non-opioid medications including Tylenol, Gabapentin, and Celebrex has been associated with decreased postoperative pain scores, decreased opioid consumption, and shorter length of hospitalization (Memtsoudis et al., 2018; Han et al., 2016; Wan et al., 2019; Fillingham et al., 2020).

At this medical center it was estimated that 30% of adult patients undergoing total joint surgery were experiencing pain greater than 7 out of 10 on the numeric rating scale (NRS) postoperatively. A barrier to addressing postoperative pain at this facility was that no protocol existed for administration of preoperative non-opioid pain medications in this population (see Appendix A for current state process map). Therefore, these patients were often not receiving these medications, which may have contributed to the high postoperative pain scores and opioid consumption. Furthermore, providers often have their own opinions and regular practices regarding perioperative pain management, which are sometimes hard habits to break. The purpose of this quality improvement (QI) project was to implement and evaluate the compliance of administering preoperative non-opioid pain medications (Tylenol, Gabapentin, & Celebrex) in adult total joint replacement patients with the goal of decreasing postoperative pain scores and opioid consumption.

Evidence Review

The American Association of Nurse Anesthetists (AANA) supports the use of Tylenol, Gabapentin, and Celebrex as a part of a preoperative enhanced recovery after surgery (ERAS) protocol (AANA, 2021). A review of recent evidence was completed to determine if the preoperative administration of non-opioid analgesia for total joint replacement procedures reduced postoperative pain and opioid consumption for patients. The review of evidence included four level I studies and one level IV study; all studies were given B ratings for overall quality based on the Newhouse Rating Scale for Quality of the Evidence (2006). See Table 1 for thorough descriptions of the studies' design and settings, populations, interventions, and outcomes. See Table 2 for a synthesis of evidence for all the studies based on the level of evidence and an overall quality rating with explanations.

Han et al. (2013) conducted a meta-analysis of five randomized controlled trials (RCTs) that studied the administration of Gabapentin for managing postoperative pain after total hip arthroplasties (THAs). This level I, B quality study demonstrated that Gabapentin was efficacious in reducing postoperative narcotic requirements and pain scores after THAs. More specifically, Gabapentin significantly reduced postoperative narcotic consumption at 24 hours and significantly reduced pain scores 48 hours postoperatively (Han et al., 2013). Wan et al. (2019) conducted a meta-analysis of five RCTs that studied the administration of Celecoxib (Celebrex) for pain management in arthroscopic joint procedures. This level I, B quality study concluded that Celecoxib administered at 200 mg or 400 mg doses preoperatively decreases postoperative pain in arthroscopic procedures and reduces analgesic consumption in the postoperative period.

Fillingham et al. (2020) conducted a systematic review and meta-analysis of 17 RCTs that studied the administration of IV and/or oral Acetaminophen in total joint arthroplasty

patients. This level I, B quality study demonstrated that both oral and IV Acetaminophen are low-cost and low-risk options to incorporate into multi-modal pain regimens for total joint patients to reduce postoperative pain and opioid consumption. A systematic review of 59 RCTs and one systematic review concluded that paracetamol (Tylenol), COX-2 inhibitors, and intravenous dexamethasone reduces postoperative pain scores when given preoperatively for shoulder surgeries (Toma et al., 2019). This level I, B quality study supports the use of Tylenol and Celebrex in the preoperative phase to reduce postoperative pain scores for this patient population.

In a level IV and B quality study, Memtsoudis et al. (2018) studied the benefit of total hip and knee arthroplasty patients receiving different modes of analgesia preoperatively. Researchers concluded that when patients received multiple modes of analgesia patients displayed fewer adverse effects, decrease in opioid consumption, and had a decreased hospital stay (Memtsoudis et al., 2018). Differences among these studies include different medications being administered in the preoperative period for different types of total joint procedures. However, the overall conclusions demonstrate the benefits of administering preoperative medications for total joint procedures. The evidence review of these five studies supports the preoperative use of Tylenol, Gabapentin, and Celebrex as a multi-modal approach to decrease postoperative pain and opioid consumption in total joint replacement patients.

Theoretical Frameworks

The Theory of Unpleasant Symptoms (TOUS) was used to help decrease postoperative pain and opioid consumption among adult patients undergoing total joint surgery. This theory has three main concepts to help with the understanding of relationships among symptoms and symptom experiences. These concepts include influencing factors (pathology, mental state, and

situational factors), symptoms, and performance (outcome of symptom experience) (Lee et al., 2017). Having a better understanding of the negative effects pain has on the human body and the different factors that influence pain allows for a better understanding of how and why administration of different medications can help combat pain.

The implementation process framework described by Helfrich et al. (2007) focuses on the importance of utilizing several organizational members rather than just one member to implement change. Important aspects of this framework are strong management support, presence of champions, innovation-values fit, and a good implementation climate (Helfrich et al., 2007). This framework was applied to this project and organization because addressing patients' postoperative pain is a critical focus of all healthcare providers. There was strong support from the two chief Certified Registered Nurse Anesthetists (CRNAs), nursing director, and medical director at the site. There were change champions who believed strongly in the project and made it a priority. Lastly, the values of the providers at this site aligned with the project's goals. A combination of all the above led to successful implementation of preoperative administration of non-opioid medications and ultimately decreased postoperative pain scores. The implementation process framework described by Helfrich et al. (2007) was important in leveraging and sustaining the practice change by having strong support from stakeholders. See Figure 1 and Figure 2 for theoretical framework diagrams.

Methods

The QI project took place at a small rural hospital with 13 operating rooms and affected 48 total joint patients during a 15-week period. Inclusion criteria included patients >18 years old undergoing total joint replacement procedures; patients were excluded if they were a trauma patient, on a ventilator, or categorized as an ASA physical status 5. This facility had 19 certified

registered nurse anesthetists (CRNAs), 6 physician anesthesiologists, 18 PACU nurses, and 23 same-day-surgery (SDS) preoperative nurses that worked together to implement the project. To ensure the most vulnerable populations received this intervention, additional time was allotted during preoperative evaluations. Providers and nurses took the extra time and used interpreters if needed to interview patients who were non-English speaking to ensure a complete and accurate medical history was obtained.

A team of stakeholders were mobilized to implement a non-opioid protocol form (see Appendix A) to screen eligible total joint replacement patients to receive preoperative non-opioid analgesia. Team members included the clinical site representative (CSR) CRNA, the two chief CRNAs, nursing director, medical director, CRNA change champions, an orthopedic surgeon, a staff registered nurse (RN), and the preoperative secretary. The preoperative secretary placed the protocol form on all total joint replacement patient charts for anesthesia providers and postoperative nurses to fill out. In the preoperative period, this form served as a reminder to anesthesia providers about giving preoperative non-opioid analgesia. The anesthesia providers filled the form out and documented medication administration in the electronic medical record. Postoperatively, the nurses filled out the patient's pain level and if opioids were given.

There were several structure, process, and outcome measures that were tracked during the implementation of this QI project. Structure measures included educating perioperative RNs and anesthesia providers on the protocol and making the protocol available on patient charts. Process measures included documentation and administration of non-opioid medications in total joint replacement patients. Outcome measures were the incidence of severe postoperative pain as evidence by 7 or greater on the numeric rating scale (NRS) and administration of opioids postoperatively. Strategies and tactics used to for each of these measures included obtaining

formal commitments, providing performance reviews, altering incentive structures, identifying change champions, scheduling meetings with staff, and completing audits and providing feedback.

Chart reviews and audits were performed to collect data on provider compliance with administration and documentation of preoperative non-opioid medications, patients' postoperative pain scores and whether patients received opioids postoperatively. Project data was kept in a secured location in the anesthesia department office to subsequently be electronically stored on a password protected device only accessible by the QI-Project Lead (QI-PL). Minimizing who had access to the collected data helped to ensure confidentiality was maintained and that no security breaches occurred. Lastly, all collected data was destroyed upon completion of the QI project.

Compliance with the QI project was tracked weekly and analyzed via run charts. The median value for anesthesia provider compliance with administering medications and for patients denying postoperative pain was 100%. There were two runs evident in the run chart depicting provider's compliance that demonstrated compliance below the median (see Figure 3). Regarding postoperative pain after total joint replacement surgeries, there was one run evident where percent of patient's denying severe pain fell below the median. There were no shifts or trends seen with the data. Overall, the data between the two run charts shows evidence of positive correlation. In the weeks of low provider compliance with administering preoperative non-opioid pain medications, the percent of patient's denying severe pain were also lower, and vice versa. When compliance fell below 100%, emails and reminders were sent to providers about the project and its goals.

Results

A preoperative protocol was successfully created to ensure total joint replacement patients were screened and given preoperative non-opioid analgesia to address the 30% of these patients reporting severe pain in the recovery room. The first structure measure was the education, 100% of the perioperative nurses and anesthesia providers were educated on the evidence-based implementation of the non-opioid analgesia protocol. Another structure measure was that staff would have access to the protocol, 100% of staff were able to access and utilize the protocol. The preoperative secretary aided in ensuring the protocol was available on the appropriate patient charts. Having the help of the preoperative secretary proved to be a project benefit and a helpful facilitator for this QI project. Other project facilitators included dedicated anesthesia staff, utilization of change champions, an easy-to-use protocol, and weekly staff communication.

The process changes that occurred included total joint replacement patients receiving medications preoperatively and anesthesia providers documenting administration of non-opioid analgesia. Chart reviews and audits were conducted for a total of 48 total joint replacement patients over a 15-week period. On average, 74% of anesthesia providers were compliant in administering preoperative non-opioid analgesia and subsequently documenting administration of the medications (see Figure 3). There were several weeks where compliance was 100% for administering preoperative non-opioid analgesia, however during weeks 1, 2, 4, 5, 7, 9, and 14 compliance was below 100%. Due to the COVID-19 pandemic, total joint replacement procedures were often delayed or cancelled altogether. Furthermore, certain weeks there were per-diem staff that were not aware of the project and needed to be reminded about the protocol, which decreased compliance during those weeks.

The outcome measures for this QI project were the incidence of patients denying severe postoperative pain (7 or greater on the NRS) in the recovery room and the administration of opioids postoperatively. On average, 91% of patients denied having severe pain postoperatively (see Figure 4).

Descriptive statistics were used to analyze opioid requirements in the recovery room and results showed that only 30% of patients needed opioids for postoperative pain. When there were decreases in provider compliance with administering preoperative analgesia, this correlated with more patients reporting severe pain in the postoperative period, which further supports the goals of the QI project.

Discussion

The results of this project suggest that the implementation of a non-opioid analgesia protocol for total joint replacement patients improves provider compliance with administering preoperative non-opioid analgesia and postoperative pain scores. This project impacted approximately 50 patients who underwent total joint replacement procedures and has the potential to impact more patients. The results of this QI project are consistent with the literature. Multiple studies demonstrated that when preoperative non-opioid analgesia (Tylenol, Gabapentin, and/or Celebrex) was given to total joint replacement patients, postoperative pain scores were reduced when compared to patients who did not receive preoperative medications. Additionally, when preoperative non-opioid analgesia was given to this patient population, opioid consumption postoperatively decreased, similar to this project's results.

There were some variations between anticipated outcomes and observed outcomes. First and foremost, there was a smaller population of patients than was anticipated prior to the start of the QI project. The COVID-19 pandemic strongly effected total joint replacement surgeries being cancelled or postponed because many of them were outpatient procedures and not deemed as urgent. Furthermore, the COVID-19 pandemic had a strong effect on staffing throughout the hospital. On a few different weeks when auditing the data, it was apparent that per-diem staff that were unaware of the hospital protocols in place were the providers caring for total joint replacement patients. This had negative implications for the project because preoperative non-opioid analgesia was not given to eligible total joint replacement patients.

There were several strengths of this project that helped to minimize limitations. Continual education to staff along with regular communication with the CSR and change champions proved essential for the project's success. Being on-site at least once a week allowed staff the opportunity to ask the QI-PL questions about the project and be constantly reminded of the project and its goals. This QI project demonstrated it is feasible to implement a preoperative non-opioid analgesia protocol in this patient population to improve provider compliance and improve postoperative pain scores.

Conclusion

The utilization of a protocol is a feasible intervention to improve provider compliance with administration of non-opioid analgesia to decrease severe pain postoperatively. The outcomes of this QI project have worthy implications for patient outcomes and the quality of health care moving forward. Postoperative pain is always a concern for patients undergoing surgery, so any efforts or interventions that can combat this issue should be taken into consideration when patient care plans are carefully constructed.

To ensure spread and sustainability, staff should continue to be educated on the positive results of the project and administration of non-opioid analgesia should be documented in the electronic medical record. To further aid in sustainability, the protocol was made to be simple and easy-to-use to be integrated into the site's workflow. Implications for further practice include the continued utilization of the preoperative non-opioid analgesia protocol and to incorporate education of the project into new staff onboarding processes. Additional implications include making the preoperative administration of non-opioid analgesia a normal standard of practice at this hospital for total joint replacement procedures. Future QI projects could be completed to expand on this project for other patient populations that experience severe postoperative pain at this hospital.

References

American Association of Nurse Anesthetists (AANA). (2021). *Enhanced recovery after surgery*. https://www.aana.com/practice/clinical-practice-resources/enhanced-recovery-after-surgery

Baratta, J. L., Schwenk, E. S., & Viscusi, E. R. (2014). Clinical consequences of inadequate pain relief: barriers to optimal pain management. *Plastic and reconstructive surgery*, *134*(4S-2), 15S-21S.

Fillingham, Y. A., Hannon, C. P., Erens, G. A., Mullen, K., Casambre, F., Visvabharathy, V., Hamilton, W. G., & Della Valle, C. J. (2020). The efficacy and safety of acetaminophen in total joint arthroplasty: Systematic review and direct meta-analysis. *The Journal of Arthroplasty*, *35*(10), 2715-2729. https://doi.org/10.1016/j.arth.2020.05.037

Goode, V. M., Morgan, B., Muckler, V. C., Cary, M. P., Jr, Zdeb, C. E., & Zychowicz, M. (2019). Multimodal Pain Management for Major Joint Replacement Surgery. *Orthopedic nursing*, *38*(2), 150–156. https://doi.org/10.1097/NOR.0000000000000525

Han, C., Li, X. D., Jiang, H. Q., Ma, J. X., & Ma, X. L. (2016). The use of gabapentin in the management of postoperative pain after total hip arthroplasty: A meta-analysis of randomised controlled trials. *Journal of Orthopaedic Surgery and Research*, *11*(1), 1-7. https://doi.org/10.1186/s13018-016-0412-z

Helfrich, C.D., Weiner, B.J., McKinney, M.M. & Minasian. L. (2007). Determinants of implementation effectiveness adapting a framework for complex innovations. *Medical Care Research and Review, 64*(3), 279-303 doi: 10.1177/1077558707299887

Lee, S. E., Vincent, C., & Finnegan, L. (2017). An analysis and evaluation of the theory of unpleasant symptoms. *Advances in Nursing Science*, *40*(1), E16-E39.

Memtsoudis, S. G., Poeran, J., Zubizarreta, N., Cozowicz, C., Mörwald, E. E., Mariano, E. R., & Mazumdar, M. (2018). Association of multimodal pain management strategies with perioperative outcomes and resource utilization: a population-based study. *Anesthesiology*, *128*(5), 891-902.

Newhouse, R. (2006). Examining the source for evidence-based nursing practice. Journal of Nursing Administration, 36(7/8), 337340.

Wan, R., Li, P., & Jiang, H. (2019). The efficacy of celecoxib for pain management of arthroscopy: A meta-analysis of randomized controlled trials. *Medicine*, *98*(49), 1–6. https://doi.org/10.1097/md.0000000000017808

Tables

Table 1

Evidence Review Table

Citation: Han, C., Li, X. D., Jiang, H. Q., Ma, J. X., & Ma, X. L. (2016). The use of gabapentin in the management of postoperative pain after total hip arthroplasty: A meta-analysis of randomised controlled trials. *Journal of Orthopaedic Surgery and Research*, *11*(1), 1-7. https://doi.org/10.1186/s13018-016-0412-z					Level I
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
"The aim of this work was to investigate the effect of gabapentin and make a better understanding of the efficacy and safety of gabapentin in the management of postoperative pain after total hip arthroplasty (THA)"	Meta-analysis of randomized controlled trials (RCTs)	**Sampling Technique/Search Strategy:** A search was conducted using the following databases: MEDLINE, PubMed, EMBASE, and Cochrane Central Register of Controlled Trials (CENTRAL). The following keywords were used: "pain management, postoperative pain, total hip arthroplasties, total hip replacement, and gabapentin". The search was limited to RCTs conducted in humans, English publication, and dated up to December 2015. Two reviewers independently performed eligibility assessments and disagreements were resolved by consensus. **# Eligible:** 11 potentially eligible studies were identified. After excluding six studies, five studies were left meeting eligibility criteria. These studies were published between 2009 and 2015; each study had between 20 and 300 patients. **# Accepted:** 5 RCTs with 573 patients **# Control:** 304 patients **# Intervention:** 269 patients **Power analysis:** Not reported **Group Homogeneity:** Heterogeneity was estimated depending on the value of P and I^2 using the standard chi-square test. P <0.10 and I^2 >50% were defined as	**Control:** Placebo **Intervention:** Gabapentin **Intervention fidelity (describe the protocol):** Two trials gave Gabapentin 600 mg 2 hours preoperatively and Gabapentin 600 mg postoperatively in the recovery room; two trials gave Gabapentin 600 mg 2 hours preoperatively; and one trial gave Gabapentin 800 mg 2 hours preoperatively.	**DV:** Postoperative narcotic requirements and pain scores **Measurement tool (reliability), time, procedure:** Postoperative narcotic requirements were measured at 24 hours and 48 hours postoperatively. Pain scores were measured utilizing the visual analogue scale (VAS) at 24 hours and 48 hours postoperatively (at rest and with movement).	**Statistical Procedures(s):** Data was analyzed using the RevMan 5.3 (The Cochrane Collaboration, Oxford, UK). The fixed-effects model was used for data analysis when no significant heterogeneity was found. Results were expressed as the standardized mean difference, with 95% confidence intervals (CIs) for continuous outcomes such as narcotic consumption and pain scores. Differences in means were considered significant if P <0.05. All RCTs included had a low risk for bias according to the Cochrane collaboration's tool. **Results:** Gabapentin significantly reduced postoperative narcotic consumption at 24 hours (P = 0.007) and significantly reduced VAS

		having significant heterogeneity. Statistically similar baseline characteristics were observed between the control and intervention groups.			scores at 48 hours (P = 0.004).
Citation: Toma, O., Persoons, B., Pogatzki-Zahn, E., Van de Velde, M., & Joshi, G. P. (2019). Prospect guideline for rotator cuff repair surgery: Systematic review and procedure-specific postoperative pain management recommendations. *Anaesthesia*, *74*(10), 1320-1331. https://doi.org/10.1111/anae.14796					Level I
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
"The aim of this systematic review was to evaluate the available literature on the effects of analgesic and surgical interventions on pain after rotator cuff repair"	Systematic review of RCTs	**Sampling Technique:** The following electronic databases were searched: MEDLINE, Embase, PubMed, and Cochrane Databases. Search strategies involved looking for RCTs published between 1 January 2006 and 15 April 2019. Search terms included "pain" OR "analgesia OR "anaesthesia" OR "visual analogue scale (VAS)" OR "peripheral nerve" OR "peripheral block" OR "interscalene block" OR "brachial plexus anaesthesia" OR "supraclavicular block" OR "nonsteroidal anti-inflammatory agent" OR "paracetamol" OR "gabapentin" OR "pregabalin" OR "clonidine" OR "opiate" OR "ketamine" OR "corticosteroid" OR "intra articular drug administration" OR "cryotherapy" AND "rotator cuff repair" OR "arthroscopic rotator cuff repair" OR "rotator cuff surgery". # **Eligible:** 322 eligible studies identified # **Accepted:** 59 RCTs and one systematic review met inclusion criteria # **Control:** Not reported # **Intervention:** Not reported **Power analysis:** Not reported **Group Homogeneity:** Heterogeneity in study designs was present.	**Control:** Placebo **Intervention:** Multi-modal pain medications given in the preoperative, intraoperative, and postoperative phase. Modes of analgesia included: paracetamol, cyclo-oxygenase-2 (COX-2) inhibitors, IV dexamethasone, gabapentin, regional analgesia techniques, perineural adjuncts (opioids, glucocorticoids, or α-2-adrenoceptor agonists), arthroscopic surgical technique, and transcutaneous electrical nerve stimulation (TENS). **Intervention fidelity (describe the protocol):** Not available for the RCTs included in the systematic review	**DV:** Postoperative pain scores and analgesic requirements. **Measurement tool (reliability), time, procedure:** Pain intensity scores were defined as a change of more than 10 mm on the VAS or numerical rating scale (NRS).	**Statistical Procedures(s):** Recommendations were made according to the procedure-specific postoperative pain management (PROSPECT) methodology. Grading of A-D was assigned to each of the studies to categorize the overall level of evidence. Proposed recommendations were sent to the PROSPECT Working Group for review and publication. The effectiveness of each intervention for each outcome was evaluated qualitatively by assessing the number of studies showing a significant difference between control and interventions groups (P <0.05). Risk of bias was not discussed. **Results:** Combinations of Paracetamol (Acetaminophen) and a nonsteroidal anti-

					inflammatory drug (NSAID) or a COX-2-specific inhibitor are recommended preoperatively for patients undergoing rotator cuff repairs.
Citation: Wan, R., Li, P., & Jiang, H. (2019). The efficacy of celecoxib for pain management of arthroscopy: A meta-analysis of randomized controlled trials. *Medicine*, *98*(49), 1–6. https://doi.org/10.1097/md.0000000000017808					Level I
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
"We conducted a systematic review and meta-analysis to assess if celecoxib before the surgery decreases postoperative pain intensity of arthroscopy"	Meta-analysis of RCTs	**Sampling Technique:** Two investigators searched the following electronic databases: PubMed, Embase, Web of science, EBSCO, and Cochrane library databases. The following keywords were used: celecoxib and arthroscopy. Reference lists of screened full-text studies were also used to identify other potential trials. Inclusion criteria included: patients undergoing arthroscopy, celecoxib versus placebo intervention, and RCTs. **# Eligible:** 7 full-text articles were assessed for eligibility. 2 were excluded because there was no placebo as the control. **# Accepted:** 5 RCTs were included in the meta-analysis with 548 total participants. **# Control:** 272 patients **# Intervention:** 276 patients **Power analysis:** Not reported **Group Homogeneity:** Heterogeneity is reported using the I^2 statistic, and I^2 >50% indicates significant heterogeneity. When this is present, researchers searched for potential sources via omitting one study in turn for the meta-analysis or performing subgroup analysis.	**Control:** Placebo **Intervention:** Celecoxib (200 mg or 400 mg doses) **Intervention fidelity (describe the protocol):** Four studies administered Celecoxib 400 mg 1-2 hours preoperatively, while one study administered Celecoxib 200 mg 1 hour preoperatively.	**DV:** Primary outcome was pain scores. Secondary outcomes included analgesic consumption, first time of analgesic requirement, adverse events, nausea, and vomiting (N/V). **Measurement tool (reliability), time, procedure:** VAS scores were used to evaluate pain intensity at 2-6 hours and 24 hours postoperatively. Secondary outcome measurement tools and procedures were not discussed.	**Statistical Procedures(s):** Statistical analyses performed using the Review Manager Version 5.3 (The Cochrane Collaboration, Software Update, Oxford, UK). Outcome data was analyzed with the random-effects model and compared to the control group. **Results:** Celecoxib administered preoperatively resulted in significantly lower pain scores at 2-6 hours and 24 hours after surgery (P <0.0001). Celecoxib administered preoperatively resulted in reduced analgesic consumption (P = 0.03) and decreased adverse events (P = 0.001), but did not exhibit obvious effect on first time for analgesic

					requirement or impact N/V.
Citation: Fillingham, Y. A., Hannon, C. P., Erens, G. A., Mullen, K., Casambre, F., Visvabharathy, V., Hamilton, W. G., & Della Valle, C. J. (2020). The efficacy and safety of acetaminophen in total joint arthroplasty: Systematic review and direct meta-analysis. *The Journal of Arthroplasty*, *35*(10), 2715-2729. https://doi.org/10.1016/j.arth.2020.05.037					Level I
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
"The purpose of this study is to systematically review and evaluate the evidence on the use of acetaminophen in the management of postoperative pain following total joint arthroplasty (TJA)"	Systematic review and direct meta-analysis of RCTs	**Sampling Technique:** The following electronic databases were searched: MEDLINE, EMBASE, and the Cochrane Central Register of Controlled Trials. Bibliographies of relevant systematic reviews were manually searched for additional references. Two clinicians reviewed titles and abstracts for relevant articles, and then reviewed full-text articles. Any articles that were excluded were then reviewed by another pair of clinicians for inclusion. Inclusion criteria included: English language, human subjects, primary total hip arthroplasty (THA) or total knee arthroplasty (TKA) procedure, comparative design including the use of acetaminophen for at least one treatment group, and quantitative patient-reported outcome data. # **Eligible:** 77 eligible studies identified # **Accepted:** 17 studies met inclusion criteria # **Control/# Intervention:** Not reported **Power analysis:** Not reported **Group Homogeneity:** Low heterogeneity was present based on I^2 testing.	**Control:** Placebo **Intervention:** IV or oral acetaminophen administered during the perioperative phase **Intervention fidelity (describe the protocol):** Not available for the RCTs included in the systematic review	**DV:** Postoperative pain and opioid consumption **Measurement tool (reliability), time, procedure:** Postoperative pain scores were measured between 24 and 48 hours following surgery using the VAS or the NRS.	**Statistical Procedures(s):** Meta-analysis was completed using STATA 12.1 software. If a study had an increased quantitative heterogeneity coefficient, it was removed from the meta-analysis. If a meta-analysis was not possible due to inconsistencies in reporting of outcomes, a qualitative review of outcomes was reported. The quality of articles was appraised based on GRADE methodology for assessing possible risk of bias. A 95% CI was used to calculate statistical significance. **Results:** IV acetaminophen demonstrated lower postoperative pain scores between 24 and 48 hours following surgery and a reduced 24-hour postoperative opioid consumption. No significant difference

					regarding postoperative pain scores or opioid consumption when comparing IV versus oral acetaminophen was noted.
Citation: Memtsoudis, S. G., Poeran, J., Zubizarreta, N., Cozowicz, C., Mörwald, E. E., Mariano, E. R., & Mazumdar, M. (2018). Association of multimodal pain management strategies with perioperative outcomes and resource utilization: A population-based study. *Anesthesiology*, *128*(5), 891–902. https://doi.org/10.1097/aln.0000000000002132					Level IV
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
"Aimed to determine how the number and type of analgesic modes is associated with reduced opioid prescription, complications, and resource utilization"	Retrospective cross-sectional cohort study	**Sampling Technique:** Data was extracted from the Premier Perspective database that contained detailed patient-specific information. Patients with International Classification of Diseases, Ninth Revision (ICD-9) procedure codes for primary hip or knee arthroplasty from 2006 to 2016 were included. **# Eligible:** 1,814,048 records were looked at for eligibility **# Accepted:** 1,540,462 records were ultimately accepted (total hip arthroplasties N=512,393 and total knee arthroplasties N=1,028,069) **# Control/# Intervention:** Not reported **Power analysis:** Not reported **Group Homogeneity:** Not reported	**Control/Intervention:** Use of multimodal analgesia categorized into four groups: opioids only, and 1, 2, or more than 2 additional modes (Modes of analgesia included: use of peripheral nerve block (PNB), acetaminophen, steroids, gabapentin/pregabalin, ketamine, NSAIDs, or COX-2 inhibitors) **Intervention fidelity (describe the protocol):** Review of patient databases to evaluate patients who had opioids only, and 1, 2, or more than 2 additional modes of analgesia.	**DV:** Perioperative opioid prescription, cost/length of hospitalization, opioid-related adverse effects (respiratory, gastrointestinal, genitourinary, and central nervous systems complications) **Measurement tool (reliability), time, procedure:** Opioid prescription was measured using charges for opioids and was expressed in oral morphine equivalents (calculated using the Lexicomp "opioid agonist conversion" and the GlobalRPH "opioid analgesic converter"). Time of measurement was day 0 (includes intraoperative), day 1,	**Statistical Procedures(s):** Chi-square test for categorical data and the Kruskal-Wallis test for continuous variables. Multilevel, multivariable regression models measured association between number of analgesic modes and predefined outcomes. Multilevel (or mixed-effects) models account for the correlation of patients within hospitals and fix separate regression lines for each hospital. **Results:** Patients who underwent hip and knee arthroplasties were less likely to require patient-controlled analgesia (PCAs), were less likely to require opioid prescriptions, and had shorter length of hospitalization when they received multimodal

				and after postoperative day 1. Cost of hospitalization was adjusted for inflation and expressed in 2016 U.S. dollars. Reliability not reported.	analgesia versus opioids only (P <0.001). Less complications were evident with increasing number of analgesic modes (P <0.05).

Table 2
Evidence Synthesis Table

Evidence Based Practice Question (PICO): In adult total joint patients undergoing general anesthesia, does the preoperative administration of Tylenol, Gabapentin, and Celebrex compared to no administration decrease postoperative pain scores?			
Level of Evidence	**# of Studies**	**Summary of Findings**	**Overall Quality**
I	**4**	Han et al. (2013) conducted a meta-analysis consisting of five RCTs that studied the administration of gabapentin in the management of postoperative pain after THA. Researchers concluded that gabapentin was efficacious in the reduction of postoperative narcotic requirements and VAS scores after THA. More specifically, gabapentin significantly reduced postoperative narcotic requirements at 24 hours after surgery and significantly reduced VAS scores at 48 hours after surgery.	B, a thorough literature search was conducted. Each of the included RCTs had a placebo group and an intervention group, therefore control was present. The results were reasonably consistent with definitive conclusions drawn; however, heterogeneity was present among the studies. A power analysis was not reported to determine sufficient sample size.
		Toma et al. (2019) conducted a systematic review of 59 RCTs and one systematic review that studied different modes of analgesia given during the preoperative, intraoperative, and postoperative phases for rotator cuff repair surgeries. Postoperative pain scores were improved when paracetamol, COX-2 inhibitors, and intravenous dexamethasone were given preoperatively.	B, a thorough literature search was conducted. Some of the studies included had a control group, but some did not. No power analysis was reported, and heterogeneity was present among the studies. However, results were reasonably consistent with definitive conclusions.
		Wan et al. (2019) conducted a meta-analysis consisting of five RCTs that studied the administration of celecoxib for pain management in arthroscopic procedures. Researchers concluded that celecoxib administered at 200 mg	B, a thorough literature search was conducted. Each of the included RCTs had a placebo group and an intervention group. The results were consistent with reasonably definitive conclusions drawn. A power analysis was not reported to determine sufficient sample size.

		or 400 mg doses before surgery decreases postoperative pain of arthroscopy. Fillingham et al. (2020) conducted a systematic review and meta-analysis of 17 RCTs that studied the administration of IV and/or oral acetaminophen in TJA patients. Results demonstrated that IV acetaminophen reduces postoperative pain and opioid consumption following THA and TKA surgeries. Although results were inconsistent when comparing oral acetaminophen and the placebo, five RCTs demonstrated no significant difference when comparing IV to oral acetaminophen in regard to postoperative pain control and opioid consumption. Authors concluded both oral and IV acetaminophen are low-cost and low-risk options to incorporate in multi-modal pain regimens for TJA patients.	B, a thorough literature search was conducted. Each of the included RCTs had an intervention group and a placebo group, and five RCTs compared IV versus oral acetaminophen. Results were consistent between the RCTs and reasonably definitive conclusions were drawn. Limitations of the study was discussed; however, no power analysis was reported.
IV	**1**	Memtsoudis et al. (2018) conducted a retrospective cross-sectional cohort study on total hip and knee arthroplasty patients receiving different modes of analgesia. Results demonstrated that when patients received multiple analgesic modes they displayed fewer adverse effects, decrease in opioid prescription, and a decrease in hospital stay.	B, Reasonably consistent results with fairly definitive conclusions. Large sample size, however, no power analysis was reported. Reasonably consistent recommendations and conclusions were made at the end of the study.

Figures

Figure 1
Theory of Unpleasant Symptoms Diagram (Lenz et al., 1997)

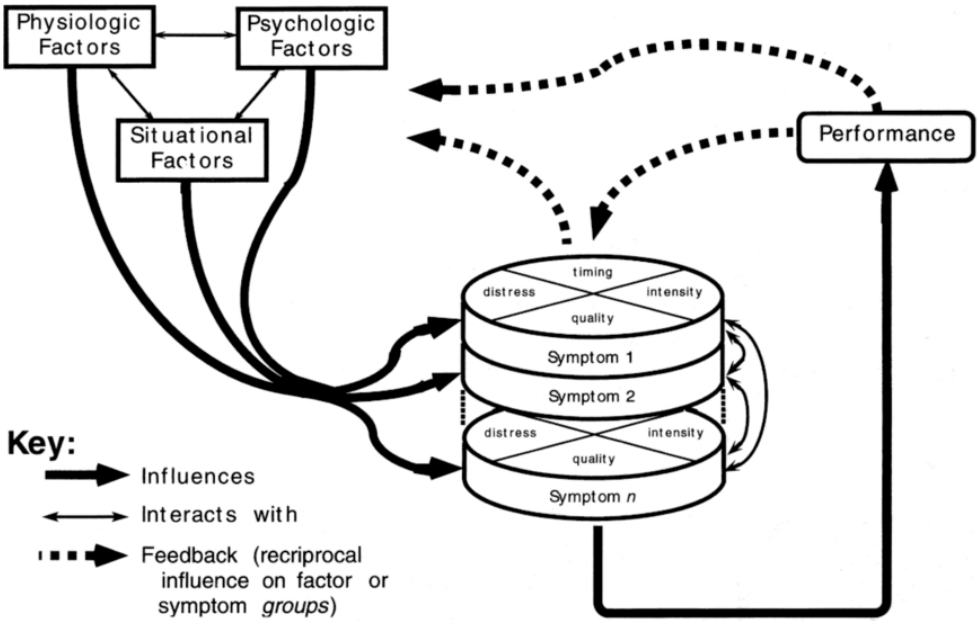


Figure 2
Complex Innovation Implementation Framework (Helfrich et al., 2007).

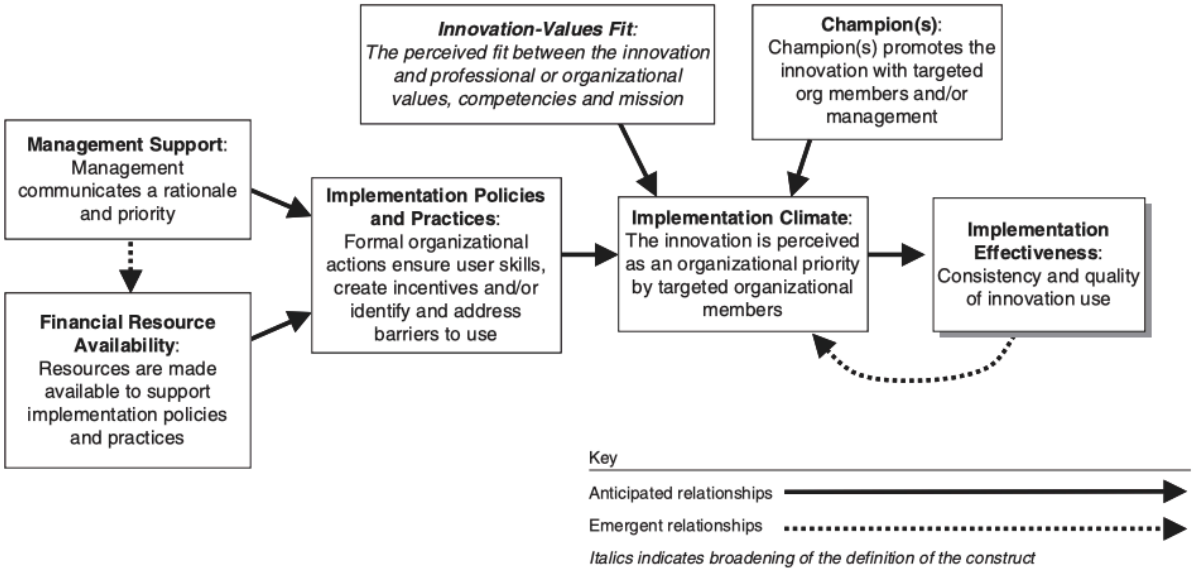


Figure 3

Run Chart for Preoperative Administration of Non-Opioid Pain Medications

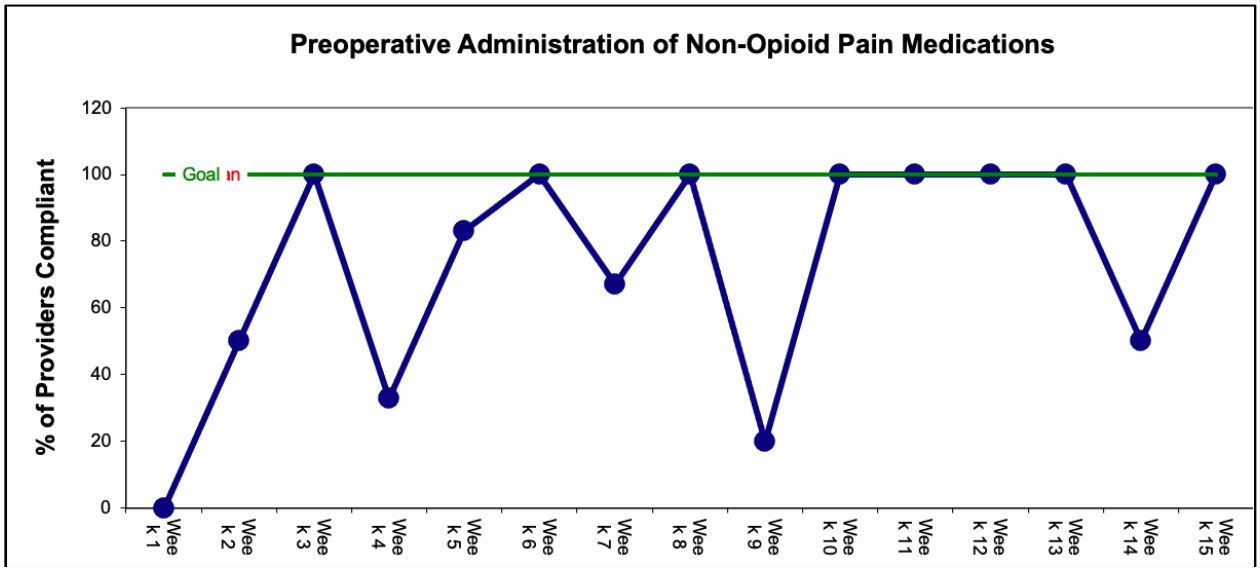
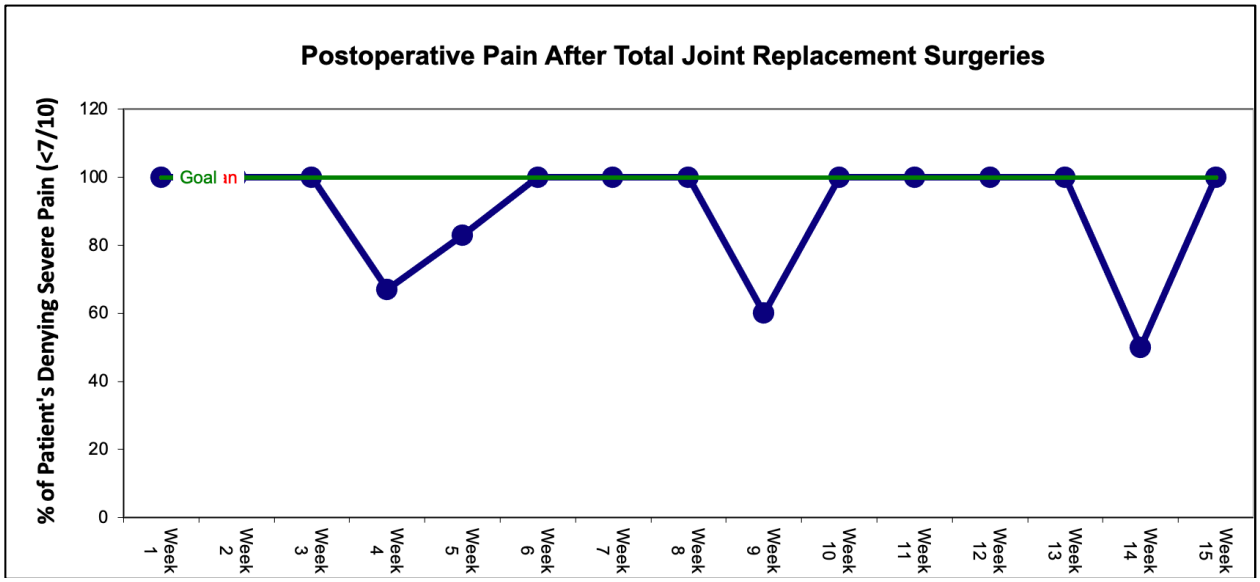


Figure 4

Run Chart for Postoperative Pain After Total Joint Replacement Surgeries



Appendix A

Non-Opioid Protocol			
PREOPERATIVE – Anesthesia Provider			
Is the patient undergoing a total joint replacement surgery?	YES	or	NO
Did the patient receive 300-600 mg Gabapentin?	YES	or	NO
Did the patient receive 1,000 mg Tylenol?	YES	or	NO
Did the patient receive 200-400 mg Celebrex?	YES	or	NO
Reasons why patient did not receive one or more of the following medications: **Allergy** **Contraindication** **Patient already taking medication** **Other:** _____			
POSTOPERATIVE – PACU RNs			
What was the patient's postoperative pain score on the numerical rating scale (NRS)? 0 1 2 3 4 5 6 7 8 9 10			
Did the patient receive opioid pain medication postoperatively?	YES	or	NO

Appendix B

Process Map of Current State