

Research Article

23-hour Total Hip Replacement Requiring Only 3.5 Opioid Pills Through 6 Weeks: A Non-selected Prospective Consecutive One Year Cohort

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Background

Many treatment protocols surrounding post-surgical pain management following total hip arthroplasty (THA) rely heavily on opioid medications and conventional formal physical therapy. We hypothesized that an expanded 90-day multimodal protocol could lead to a postoperative opioid-free or significantly reduced-opioid THA recovery with little or no need for formal physical therapy.

Methods

Prospective consecutive patients undergoing THA were enrolled in a 3 month long (6 weeks preoperatively and 6 weeks postoperatively) multimodal protocol including a robust education and optimization program with home-based physical therapy. All patients received a direct anterior approach THA on a Hana table by a single, fellowship-trained surgeon in a community practice. Opioid consumption was recorded at preoperative, postoperative, 3 week and 6 week timepoints.

Results

A total of 207 consecutive patients underwent THA and completed their 6-week follow-up evaluations. Seventy-nine patients (38%) required no opioid pills, 75 (36%) used 1-5 pills, 47 (23%) used 6-10 pills and 6 (3%) used more than ten pills. Overall 97% of patients undergoing DAA THA required 10 pills or less. Of those patients who reported taking at least one opioid pill, 92/128 (72%) took tramadol rather than stronger opioids. Average number of opioids was 3.5 pills per patient. Additionally, at 6 weeks, 95% of patients required no formal physical therapy. The percentage of patients discharged

a I am a board-certified orthopedic surgeon specializing in total hip replacement and total knee replacement. With over 17 years in practice, I have extensive experience in computer navigation and robotic surgery, muscle-sparing techniques like anterior hip replacement, and tourniquet-free knee replacement. My experience and innovation in joint replacement surgery has led me to become the top joint replacement specialist in all of New York State.

I have also developed a new, innovative recovery technique for total knee replacement called the "Therapy-Free Total Knee Replacement." This Therapy-Free protocol decreases pain, saves money, and accelerates recovery, allowing patients to recovery in the comfort of their own homes. This robust program of preoperative patient education and optimization has led to a 2X lower complication rate than the top 200 orthopedic hospitals in the nation.

I currently teach anterior hip replacement and outpatient joint replacement techniques to surgeons in the USA and India. I also spend time educating surgeons and patients about my Therapy-Free, narcotic-free joint replacement method.

I completed my fellowship training at the Cleveland Clinic. I am the founder of the total joint replacement program at St. Elizabeth Medical Center and initiated the Accelerated Outpatient Recovery System for both the hospital and Apex Surgery Center. In my spare time I enjoy hot rods and road racing.

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home the same day was 64% with 94% home by POD #1. Average length of stay was .42 days.

Conclusion

This study confirms that an expanded length multimodal protocol can significantly reduce or eliminate opioid consumption following outpatient DAA THA. It additionally confirms that the majority of patients may do well with a simple home exercise program.

ABBREVIATIONS

OA = osteoarthritis
THA = total hip arthroplasty
DAA = direct anterior approach

INTRODUCTION

The opioid epidemic has been well described and is a national health crisis. Surgical procedures such as joint arthroplasty are arguably one of the more common procedures that expose patients to opioids. More than 50 million surgical procedures are performed each year in the United States, and approximately 40 million patients receive opioids after surgery to manage their postoperative acute pain (Hah et al. 2017). As many as 6.5% of patients that take opioids to manage pain after surgery may become persistent opioid users, representing 2.6 million people (Brummett et al. 2017). Multiple articles have shown that narcotics are over-prescribed (Hannon et al. 2019; Huang and Copp 2019). At many national arthroplasty meetings and in many arthroplasty journals, the number of opioid pills necessary for successful post-operative total hip arthroplasty (THA) appears to range from at least 30-73 oxycodone 5mg pills despite aggressive surgical window multimodal techniques (Hannon et al. 2019; Huang and Copp 2019; Dwyer et al. 2018). A recent retrospective single surgeon study in 2019 suggested that anterior hip replacement patients may only need an initial prescription of twelve tramadol 50mg tablets although 16.8% needed additional oxycodone (Padilla et al. 2019).

Prior to this study, in 2016, our clinic developed a new protocol to meet the forecasted demand for outpatient total hip arthroplasty. A robust patient engagement program was created with an emphasis on all phases of the arthroplasty process. The education program helped patients with goal setting and having realistic expectations with appropriate representation of the post-surgery process. A target window of 6 weeks before and 6 weeks after surgery was used to enhance the traditional multimodal pathway. A new, simplified, perioperative home therapy protocol was developed by the author to decrease post-op pain and swelling as previous work by the author showed decreased pain and decreased number of office visits with simplified home therapy versus formal therapy (unpublished data presented at arthroplasty conference). All patients received an anterior approach THA using the Hana table (Mizuho OSI, Union City CA), intraoperative fluoroscopy, and local infiltration analgesia (LIA) with standard bupivacaine in addition to standard multimodal medications to allow for reliable rapid discharge. A corporate research grant was obtained to de-

termine if expansion of the multimodal window to 90 days with a novel protocol could substantially reduce postoperative opioid consumption and formal therapy usage as compared to previously published data with more conventional protocols. The primary intent of this study was to determine the appropriate number of opioid pills to provide patients undergoing THA to allow for satisfactory pain control and recovery. Secondary goals were to: identify postoperative milestones important to patients to provide realistic guidance for recovery, determine if formal therapy was necessary for most patients, and determine what percentage of patients could go home the same day of surgery.

MATERIALS AND METHODS

An IRB-approved, prospective, single surgeon, consecutive patient case series was registered with [clinicaltrials.gov](https://clinicaltrials.gov/ct2/show/study/NCT03790306) (NCT03790306). All patients received written and oral information about the observational study and signed an informed consent document. All data was kept on a confidential platform. A goal of 200 consecutive patients was identified. Patient enrollment began January 18th, 2019 and ended January 9th, 2020. Due to the observational nature of the research protocol, no patients opted out and no elective hip arthroplasty patient was excluded. It is the authors' general practice to limit elective surgery to patients with a BMI of < 40. However, some exceptions were made in cases where patients had made a significant drop in BMI and did not have an extraordinarily large pannus. Hip fracture patients were excluded.

The preoperative protocol consisted of a detailed education booklet, a required education class, insistence on patient coach identification and participation, early laboratory data to allow for patient optimization, and one pre-op therapy visit to explain post-op mobilization and safety issues. The education booklet has nearly every detail that the senior author has been asked about by patients over the past 18 years of practice. This includes nutrition, what to expect, how to make the house safe, what clothes to wear, and what to expect every single day after surgery through 14 days. It has the exact slide deck that is used in the education class with areas to take notes. The inside cover has each patient's individual treatment plan so that every provider that cares for the patient knows what the plan is for the facility stay and 6 weeks postoperatively. It is not the booklet that most surgeons use that typically was developed by the hospital system to cover all different surgeons and approaches. It is specific to the author's individual practice. It is required to be read by both patient and coach. It is required to be available at every preoperative visit in the office, at the preoperative education class and

therapy visit, as well as the decision for surgery visit with the surgeon. It is required to be present for surgery. Every staff member involved with the patient's care is required to read and understand the booklet in order to provide consistent patient messaging. When all patient care providers ask for the book upon arrival, patients and their coaches recognize that they need to thoroughly understand the treatment plan.

Every patient and their coach met with the surgeon to develop a personalized postoperative plan for arrival, surgery, discharge, medications, and recovery. Nearly every patient had a spouse or a child or a sibling as a coach. A few patients asked a good friend or neighbor to help them.

Shared decision making was employed to determine best perioperative practice for each individual patient taking into account their medical history, medications, age, and recent laboratory data. A variety of post-op medications were discussed including acetaminophen 1000mg q8 for 3 weeks (if no liver dysfunction), prednisone 5 mg po daily for 3 weeks (if not insulin-requiring diabetic), celecoxib 100 mg po bid or meloxicam 7.5mg po BID (if no contraindication), gabapentin 300mg q8 prn (if normal GFR), tramadol 50 mg q6 prn or oxycodone 5mg (#10). Each patient used one or more of the aforementioned medications and had their own "patient specific pain plan". This study specifically included one 50mg dose of tramadol as one opioid pill. Several patients had used tapentadol (Nucynta) or hydrocodone in the past and requested this medication instead of tramadol or oxycodone. Patients over 70 years of age were routinely advised against oxycodone unless they had used it in the recent past. Aspirin 81mg po BID was used as DVT prophylaxis for all patients that were not already on anticoagulation for another reason and did not have additional risk factors such as previous DVT or genetic predisposition. All prescriptions were electronically sent prior to surgery. Pre-operative usage of physical therapy to "strengthen the extremity" was discouraged. However, one visit for transfer teaching, safe ambulation post-op, and home preparation was required and in the case of the study, the short performance physical battery was performed.

In the holding area, patients received oral celecoxib (200mg unless contraindicated), oral tranexamic acid (1300mg, author's standard of care for last 4 years), oral gabapentin 300mg, oral acetaminophen (1000mg), and 8mg IV decadron for non-diabetic patients. Patients under 70 with no history of glaucoma or urinary retention issues received a scopolamine patch. Patient expectations for discharge and for strict adherence to written post-op protocol were reinforced. No preoperative opioid was given. Preoperative opioid use within 3 months was identified.

Anesthesia choices included general anesthesia with sevoflurane or spinal anesthesia with lidocaine, chloroprocaine, or bupivacaine. This was based on anesthesiologist and patient preference. The author was unable to control for intraoperative opioids given by anesthesia nor control which anesthesia provider each study patient interacted with.

Every patient had a direct anterior approach (DAA) total hip arthroplasty with anterior capsulectomy utilizing the

Hana table and intra-operative fluoroscopy. Care was taken to correct preoperative deformity to presumed pre-disease state alignment. Differing from the original description and teaching of Dr. Matta, no dislocation maneuver was performed to minimize soft tissue damage. Instead, external rotation of 45 degrees and 5 rotations of traction using the table was used to sublux the head by approximately 2 mm. The neck was then cut in situ and levered anteriorly to allow passage of a corkscrew into the head. The neck was then levered more anteriorly to expose capsular attachments to the neck which were then released. The head was then removed. In this manner, the entire posterior capsular and tendinous attachments below the neck cut were preserved. After acetabular cup placement, the offset, abduction, and anteversion were carefully assessed using fluoroscopy and an Orthogrid analog alignment device. The femur was elevated with the minimum posterolateral release required to free the trochanter and was aided by the femoral elevation arm. Final offset and leg length were evaluated using the same fluoroscopic measuring device. All cases were performed in an inpatient Level 3 hospital or a freestanding ambulatory surgical center (ASC).

Each patient had a periarticular block administered consisting of bupivacaine 30ml of .5% with epinephrine, ketorolac 30mg, saline 10ml, and for those under 70 without an opioid sensitivity, 10 mg of morphine. No liposomal bupivacaine or special block was employed for any patient. Peri-articular injection was placed in the tensor muscle, the undersurface of the rectus and the posterior and medial capsule.

All patients received a press-fit acetabular shell with at least one screw with a highly crosslinked polyethylene. All patients received a press-fit stem. Alignment of the prosthesis was verified using intraoperative fluoroscopy in all cases.

Patients were discharged when tolerating oral food, vital signs were stable, and after passing a therapy safety evaluation. Administration of postoperative oral or intravenous opioids as first line treatment was discouraged in all units. Adherence to this directive was not uniform in the PACU. No intravenous opioids were used after the immediate PACU stay. No specific outpatient risk calculator was used to determine when a patient could go home. Patients were discharged when they had passed therapy (stairs, ADLS, transfers etc), were normotensive, had adequate pain control, had passed a voiding trial, were awake and alert, and did not have vomiting or nausea.

Once discharged, patients followed a home therapy protocol consisting of 40 min ice and elevation, and 8 minutes of 2 simple exercises to be performed hourly from 7 am to 9pm for 2 weeks. The only two exercises required were short walk and ankle pumps. Each patient was expected to walk a short distance such as to the bathroom and back or to the kitchen and back and perform a minimum of 10 ankle pumps every hour while awake to decrease DVT risk. No SCD units were used in the home setting. No mobile messaging system or digital patient engagement platform was used. The handbook provided day by day instructions for

the first 14 days as well as detailed expectations for three weeks and six weeks after surgery.

No specific anterior hip precautions were used. We do not recommend martial arts, skiing, or extreme yoga positions for 3 months. Otherwise, patients may do as they wish. Every patient was weight-bearing as tolerated progressing from a walker after POD #2 when comfortable and secure. The single SNF patient was followed through until discharge and all opioids were tallied. This patient did have daily formal therapy intervention.

In office follow up was performed at 10-14 days, three weeks and six weeks. Radiographic implant evaluation was performed at 3 weeks after surgery and compared to the immediate postoperative radiograph to ensure adequacy of alignment.

POSTOPERATIVE OUTCOME MEASURES

Pre and Post-op HOOS JR scores and patient compliance with the protocol and total opioid pill count usage (and type of narcotic pill) was documented. VAS pain scores ranging from 0 (no pain) to 10 (worst pain imaginable) were documented POD #1-3, two weeks, three weeks, and six weeks. A single research coordinator obtained the data and tracked and verified opioid usage against the NYS ISTOP database. This database was used to confirm that no patient received more narcotic pills from another prescriber. At each data collection point, the patient counted remaining opioid pills and referred to their personal opioid diary in the handbook to ensure an accurate tally.

Total pill counts were chosen as the data point to obtain as virtually no patients and few community arthroplasty surgeons use MME or oMMED on a daily basis.

The patient's date of return to driving was documented as well as cessation of assistive device use. Each patient had a preoperative as well as 3 and 6 week postoperative Short Physical Performance Battery (SPPB). Lastly, readmission and adverse events were noted.

RESULTS

DISPOSITION OF STUDY SUBJECTS

A total of 208 consecutive subjects undergoing total hip arthroplasty were consented and included in this cohort. One patient was unable to be reached postoperatively. No others were excluded, declined, or subsequently removed from this observational study. Female patients predominated (116/207, 56%), the average age was 68.7 (RANGE 31-91) and the average body mass index was 31.2kg/m (RANGE 17.9-42.1). Most patients were ASA category 2 (38.2%) or category 3 (60.4%), Pre-operative opioid use was seen in 30/207 patients (14.5%). Patients were counseled to wean off narcotics totally for 6 weeks preoperatively under the guidance of their prescribing provider. Twenty-four patients (11.6%) had a preoperative diagnosis of anxiety or depression at the time of THA. One hundred ninety-two patients had the hospital as the site of surgery and 15 patients had THA in the ASC setting.

Patient outcome measures were in line with expected results for an elective primary THA population. The mean HOOS Jr score increased from 49.5 (8.1-92.3) at baseline to 92.1 (61.8-100) at 6 weeks.

OPIOID USE

Seventy-nine patients (38%) required no opioid pills throughout the entire episode of care. Another 75 patients (36%) required 1-5 pills, 47 (23%) required 6-10 pills and 6 (3%) required more than ten pills. Thus, 97% of the patients in this study required 10 pills or less. Of note, patients reporting taking at least one opioid pill (128), 92 (72%) took tramadol and 36 (28%) used oxycodone or tapentadol. This pill total includes oral opioids given in hospital prior to discharge. The average number of opioid pills per patient was 3.5 pills.

Four of the six patients who required greater than ten opioid pills reported using opioids in the preceding 3 months, compared to 2/177 who were not using opioids at baseline but required more than 10 opioid pills ($p=0.0045$). Opioid naive patients (those who had never taken narcotics pre-operatively) only had a 1.1% (2/177) likelihood of using greater than 10 pills.

HOME BASED AND FORMAL PHYSICAL THERAPY RESULTS

All patients saw a physical therapist in the hospital or the ASC for instruction on their home program prior to discharge. At six weeks post-operatively, 8 (3.9%) patients required outpatient physical therapy services, one (0.5%) patient had required home based physical therapy and one (0.5%) had been discharged to inpatient rehab from the hospital. Overall, 197 of 207 patients (95.2%) did not require any formal therapy from discharge through 6 weeks post-op.

SPPB scores improved from 8/12 pre-operatively to 11/12 at six week follow up.

SPPB score by category (0 being worst score, 4 being best score):

ASSISTIVE DEVICE USE

Proportion of assistive device usage is provided in Table 3.

RETURN TO WORK AND DRIVING

Return to work and return to driving proportions are displayed in Table 4. One hundred thirty-one of 207 (63%) subjects were retired and, therefore, had no work to return to.

LENGTH OF STAY

A total of 132/207 patients (64%) were discharged home the same day of surgery and 30% the next morning. Only 1/207 (0.48%) was admitted to a rehabilitation unit, and 0/207 (0%) were readmitted within the 6 week study collection period. Overall average length of stay was 0.42 days for the entire cohort.

ADVERSE EVENTS—NON READMISSIONS

Two patients were seen and treated non-operatively for postoperative hematoma, two patients were treated non-operatively with oral antibiotics for superficial wound erythema within the 6 weeks postoperative follow-up which was the end of study follow-up. One patient reported muscle weakness limiting mobility and function (treated by homecare physical therapy) which resolved by the first follow-up visit. No deep venous thromboses (DVT), pulmonary embolisms (PE), myocardial infarctions (MI), strokes, dislocations, or deaths within the 6 week follow-up period.

ADVERSE EVENTS—READMISSIONS WITHIN 6 WEEKS POST OP

No readmissions within the 6 week study period of the consecutive 207 patients. One patient treated for skin erythema/suture abscess ultimately readmitted 8 weeks post-op with deep MRSA infection requiring explantation and antibiotic spacer placement. This was outside the 6 week follow-up period but was included here for complete data transparency.

DISCUSSION

The primary intent of this study was to determine the appropriate number of opioid pills to provide patients undergoing THA to allow for satisfactory pain control and recovery. Secondary goals were to: identify postoperative milestones important to patients to provide realistic guidance for recovery, determine if formal therapy was necessary for most patients, and determine what percentage of patients could go home the same day of surgery.

Huang et al recently published a prospective study in which they identified an average number of opioid pills needed for hip and knee replacement (Huang and Copp 2019). They found that with their current protocol, the average opioid-naïve THA patient needs 30 hydrocodone 10mg tablets postoperatively. These patients underwent posterior approach THA. Hannon et al published that the initial prescription for opioids should be thirty oxycodone 5mg pills compared to larger prescriptions (Hannon et al. 2019). When reviewing that protocol, it appears that patients used tramadol 100mg q8 hours in addition to the prescription of either 30 and 90 oxycodone. It appears that the median number of tramadol used was 60 tablets in addition to OxyIR although it is not entirely clear. The study did not clearly differentiate between THA and TKA and did not differentiate the type of THA approach. Lastly, Dwyer et al showed that the average total opioid pill usage was 73 pills for THA (oxycodone 5mg or stronger) (Dwyer et al. 2018). No mention of hip approach was readily apparent.

By comparison, our data using DAA on a Hana table in conjunction with an expanded multimodal protocol showed that 97% of patients required 10 total opioid pills or less through 6 weeks after surgery. This includes all doses given prior to discharge as well as all doses at home. Seventy-two

percent of those patients who used narcotics only used tramadol. This cohort did not exclude previous opioid users or patients with a history of anxiety or depression. We believe this to be one of the lowest published opioid usages for THA in the United States and validates Padilla's work (Padilla et al. 2019).

The question then becomes: what portions of our protocol lead to a minimum 6-fold decrease in opioid pill usage? We believe the following factors are responsible: education and patient engagement beginning six weeks preoperatively, perioperative multimodal medications, specific THA approach, post-operative multimodal medications, and a specific post-op home based therapy protocol in combination with robust education and clear post-operative goal-setting.

Multiple authors have shown that an organized preoperative educational format with a dedicated "joint coach" can have significant impact on patient outcomes and satisfaction (Stevenson, Neuwirth, and Sheth 2018; Gaffney et al. 2017). We believe that many surgeons overlook this component opting instead for the lure of a quick "new perioperative cocktail fix". Education and strong patient engagement are the cornerstone of preoperative anxiety prevention and we stress its importance. In this study, every patient received a highly detailed handbook which guided them through the exact steps of the author's pre-operative, intraoperative and postoperative protocol.

At annual meetings and in multiple journals, surgeons continue to debate about what is the right secret recipe in the periarticular cocktail as well as the pre-surgery medication admixture (Stevenson, Neuwirth, and Sheth 2018). Liposomal bupivacaine at one point appeared to be a possible panacea for this issue. Research studies have advocated for and against its inclusion in multi-modal pathways (Domb et al. 2014; Beachler et al. 2017). Prior to this study, we trialed this medication but were unable to achieve meaningful opioid reduction. Our study cocktail which includes standard bupivacaine appears to provide reasonable pain relief through 18 hours post-op.

The surgical approaches for THA can be categorized as anterior (with and without a table), anterolateral, direct lateral, posterior, and superior. Each approach has its own potential benefits and pitfalls. Few studies document the appropriate number of narcotics needed during the postoperative phase. Of those studies, there appears to be a significant need for opioids as described earlier.

Our goal was to document the number of pills necessary with a specific protocol; which in this case included a DA approach using a specialized table and anterior capsulectomy. The systematic review with meta-analysis by Miller et al concluded that anterior approach had less pain and reported less narcotic usage as compared to posterior approach (Miller et al. 2018). Miller et al went on to document studies showing lower C-reactive protein levels and less soft tissue damage (Miller et al. 2018). Brismar et al noted that DAA required less early opioid use than the direct lateral approach (Brismar et al. 2018). Seah et al showed lower opioid consumption in the early post-operative period with DAA versus direct lateral and posterior approach (Seah et

al. 2019). Padilla et al. recently noted that DAA THA with a novel opioid sparing protocol can lead to low opioid usage and equal patient satisfaction as to more traditional approaches to pain management (Padilla et al. 2019). The opioid sparing arm received an initial prescription of 12 tramadol. Limitations of that study were the exclusion of previous narcotic users, single surgeon site, and lack of statewide opioid use verification. Overall, however, it confirms that initial ultra-low narcotic prescriptions provide similar relief and patient satisfaction compared to a larger initial prescription protocol.

Just as Huang et al described in 2019, we sought to prospectively document the total opioid pill usage in a consecutive cohort. We believe that a multi-center study looking at THA approach that documents opioid use should be undertaken and also suggest that anterior hip approach be classified as with or without a table and clear documentation of capsulotomy versus capsulectomy. Just as noted by Miller et al, it is the author's supposition that DAA with a table leads to lower inflammation and pain due to less soft tissue disruption. The extremely low opioid usage data in this study certainly helps show that a multi-center study is warranted.

It has been reported that formal physical therapy after total hip replacement may not be needed (Austin et al. 2017). We believe that aggressive formal post-op therapy may result in higher pain scores and increased opioid usage and delayed improvement in ADL due to increased swelling from current therapy protocols. We suggest that further study comparing different post-op therapy protocols be undertaken. In this study, 95% of patients did not need any formal therapy to achieve satisfactory pain relief and return of ADLs. This has significant implications on the post-discharge spend for insurers as well as decreasing patient co-pays. It also reduces the risk of number of potential coronavirus exposures but allowing patients to convalesce at home.

A possible negative to lack of formal therapy intervention is the time it takes for patients to cease using assistive devices. It is possible that formal therapy and education by a therapist may shorten the time needed to progress from walker to cane to independence.

There has been much interest in outpatient total joint arthroplasty versus the more traditional inpatient stay in recent years. This study shows that using this protocol, our site was able to reliably discharge 94% of "unselected" patients home within 23 hours with a very low complication rate through 6 weeks and without readmission. Additionally, 64 % can be discharged home from a hospital or ASC the same day without a special risk calculator without readmission.

Limitations of the study include the fact that this is a single surgeon series, it lacks a contemporary comparison group, and is admittedly primarily descriptive in nature. We believe that the "real world" aspect of this data can provide significant value to the surgeon who practices outside of the academic setting. This requires significant investment and dedication on the part of the surgeon to implement changes to the protocol from the moment that each patient

decides to move forward with arthroplasty to 6 weeks following surgery. Further research on this paradigm including prospective, multi-center comparison studies is warranted to determine the generalizability of the results.

We chose total pill count over documenting MME unlike other studies. The practicing orthopedist doesn't routinely deal in MME and it makes many articles hard to interpret in real-world scenarios. MME and oMEDD table validity have also been called into question in recent years (Fudin, Cleary, and Schatman 2016). We suggest that AAHKS review the usefulness of oMEDD and MME to its delegates in light of the controversy surrounding its validity and the difficulty applying it to real world practice.

Some of our pain management colleagues have suggested that any opioid given during the preoperative, intra-operative, or postoperative phase may lead to central opioid sensitization (Rivat and Ballantyne 2016). They have suggested that this may lead to increased opioid use after discharge. We did not control for this variable. We recommend that future studies address this issue to determine if central opioid sensitization leads to greater postoperative opioid usage.

In summary, this study demonstrated that an expanded multimodal outpatient protocol can be implemented in a high volume, non-academic community surgical setting and lead to an ultra-low opioid usage after THA. Further modifications and improvements to this protocol should help our field progress toward the goal of ultimately making THA recovery opioid free.

The following chart is provided in response to reviewers' desire to see a comprehensive algorithm.

Areas to focus on:

1. Create a highly organized, personalized education engagement platform that starts 6 weeks pre-op and extends 6 weeks post-op. There are several companies that can help organize this. This is the most important step and also the most time-consuming. It will also be the best thing that has happened to your practice. (25%)
2. Optimize laboratory data through your office (don't rely on clearance physician). (2%) Albumin levels, diabetes control, anemia correction, renal optimization, etc.
3. Educate on dangers of opioids. (5%)
4. Require coach participation and personalize the total joint education class to your specific protocol. (2%)
5. Discourage pre-op therapy EXCEPT for education on how to control post-op swelling and how to perform ADLs safely and prevent DVT. Review the literature on prehabilitation. Consider how you personally feel after a 60-minute workout and then consider your 84 year old THA patient doing that with an arthritic hip. Review data on nociceptor upregulation. (12%)
6. Train all personnel involved in patient's outcome to say the same message and understand the pathway.
7. Have at least 4 education visits (in addition to booklet) for each patient pre-op as patients do not retain all of the information in a single visit. (initial decision to consider surgery, education class, one pre-op ther-

- apy evaluation taught by a therapist that endorses your plan, and decision for surgery visit with the surgeon). (2%)
8. Create a patient specific pain management plan WITH the patient so there is clear buy-in pre-operatively. (2%)
 9. Only prescribe 10 opioid pills as initial prescription. We now strongly encourage tramadol unless there is a clear objection/contraindication. (5%)
 10. Optimize non-narcotic meds for post-op pain and swelling per each patient's unique medical history. Some reviewers seem to believe that the post-operative oral prednisone may be the magic bullet while others are concerned about infection. It is our opinion that it is just one small piece of the puzzle. (all non-narcotic meds = 5%)
 11. Do not use pre-op opioids or intrathecal opioids or new high potency opioid derivatives post-op.
 12. Use tranexamic acid for every patient pre-op and post-op and use 81mg aspirin for DVT prophylaxis in every patient that does not have a clear contraindication. (2%)
 13. Consider the evidence for matching or partially matching the patient's native hip alignment and whether that may have some effect on post-op pain. (2%)
 14. Consider the evidence both published and anecdotal of decreased pain with the anterior approach. Understand that there are biases on both sides on the equation. I personally have been involved with surgery and aftercare of over six thousand posterior, lateral, and anterior approaches with and without a table. It is my personal opinion that a DAA with a table and fluoroscopy provides the most consistent, reproducible results with the least amount of soft tissue trauma and post-op pain. The best person to ask is your x-ray technician. They can tell at the first 2 week post-operative visit which approach a patient had just by observing the gait pattern on the way to the x-ray suite. (25%)
 15. Do not use a drain.
 16. Train PACU staff and discharge staff to consider non-narcotic options while patients are in-facility.
 17. Have facility therapy staff teach same messaging and understand and encourage home therapy protocol.
 18. As with any other stress to a bone, such as a fracture, do not recommend strengthening and high levels of weight-bearing activity. Instead focus on swelling reduction through ice and elevation (40min/hour) in conjunction with DVT prophylaxis.
 19. Buy a separate "emergency phone" that is carried by the operative surgeon or his/her PA in order for patients to have rapid access to a knowledgeable team member. Patients do not call that often in our experience, but greatly appreciate easy access and quality answers to questions. (2%)
 20. Make sure that the patient understands that they are "on track". Every surgeon has performed hundreds if not thousands of this procedure. For the patient, this surgery is n of 1. Consider a post-op text messaging system in conjunction with a detailed post-op recovery book (in process now but was not used for this study). Patients are less anxious with daily and weekly reminders of what "normal" should feel like. (2%)
 21. Make sure your staff and the patients know that refills on opioids are generally discouraged. (2%)
 22. Consider how each of these areas help create value in a bundle and review the 42-day 0% readmission rate with this protocol.
 23. If your team has numbers and outcomes that meet or exceed this study no matter the approach, please contact the author so a site visit may be arranged.
 24. Be personally responsible for making a patient permanently addicted to opioids. You are the prescriber of the post-op opioids. Even 10 pills is essentially a 24 hour prescription which has a reported 6% risk of chronic opioid addiction.
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Table 1. Average best and worst pain scores.

Time Frame	Average BEST pain score	Average WORST pain score
POD 1	0.29	5.7
POD 2	0.23	5.6
POD 3	0.15	5.4
POD 10-14	0.02	4.2
3 week	0.07	3.2
6 week	0.01	2.1

VAS pain scores range from 0 (no pain) to 10 (worst pain imaginable).

Table 2. Short Physical Performance Battery (SPPB) measures.

	Pre op Balance	Pre op Gait	Pre op Chair Rise	6 week Balance	6 week gait speed	6 week Chair rise
Mean	3.5	2.96	1.56	3.95	3.89	3.17
Standard Deviation	1.08	1.12	1.36	0.31	0.45	1.31

SPPB measures range from 0 (worst performance) to 4 (best performance).

Table 3. Assistive device use before and after surgery.

Assistive Device	Pre-op Usage	10-14 day	3 week post op	6 week post op
None	146/207 (71%)	32/207 (15%)	105/207 (51%)	179/207 (86%)
Any type of cane	51/207 (24%)	131/207 (63.5%)	84/207 (41%)	23/207 (11%)
Any type of walker or crutches	7/207 (3%)	41/207 (20%)	18/207 (9%)	5/207 (2.4%)
Wheelchair	3/207 (1.4%)	0/207 (0%)	0/207 (0%)	0/207 (0%)

Table 4. Return to work and return to driving post-operative percentages.

	2 Weeks	3 Weeks	6 Weeks
Return to work	14.47%	31.58%	53.95%
76/207 worked pre op			
Return to driving	41.38%	71.98%	90.64%
203/207 drove pre op			



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