Hospital for Special Surgery
Analysis Plan

GENERAL INFORMATION

1. **Name:** Jiabin Liu
2. **E-mail:** liuji@hss.edu
3. **Phone: 2152908341**
4. **Supervisor information:** Jiabin Liu

Project title: Enhanced Recovery After Surgery Component Utilization Among Various Racial Populations

5. **IRB approval obtained?** Yes (IRB #2017-0169)
6. **Primary choice of journal for manuscript:**
   Anesthesiology

DESCRIPTION OF RESEARCH

7. **Background and rationale for study:** *(explain in max. 200 words the background and specific rationale for your study; what is currently lacking and what is your study going to add to the current literature; use max 5 references)*

Racial disparities in care and outcomes have been drawing extensive attention in recent years. Such disparities in care have been described in various surgical specialties, such as colorectal [1], cardiac [2], and other settings [3]. The existence of such disparities has been associated with worse surgical outcomes amongst minority groups [4].

One proposed intervention to reduce the risk for disparate care is the establishment of protocolized care approaches such as Enhanced Recovery After Surgery (ERAS) protocols. [5] Interdisciplinary, standardized protocols aimed at hastening recovery, optimizing patient outcomes and minimizing complications after surgery. These protocols typically involve preoperative education, optimization of pain management, early mobilization, and various other components.

To date, there is a paucity of data to show how ERAS has been implemented across patient groups of different racial backgrounds, and specifically if they can improve disparities and thus outcomes among orthopedic patients, such as lower extremity total joint arthroplasty (TJA).

References:

1. Schneider EB, Haider A, Sheer AJ, Hambridge HL, Chang DC, Segal JB, Wu AW, Lidor AO: Differential association of race with treatment and outcomes in Medicare patients undergoing diverticulitis surgery. Arch Surg 2011; 146: 1272-6
2. Cooper WA, Thourani VH, Guyton RA, Kilgo P, Lattouf OM, Chen EP, Morris CD, Vega JD, Vassiliades TA, Jr., Puskas JD: Racial disparity persists after on-pump and off-pump coronary artery bypass grafting. Circulation 2009; 120: S59-64
3. Marques IC, Wahl TS, Chu DI: Enhanced Recovery After Surgery and Surgical Disparities. Surg Clin North Am 2018; 98: 1223-1232
4. Varadhan KK, Neal KR, Dejong CH, Fearon KC, Ljungqvist O, Lobo DN: The enhanced recovery after surgery (ERAS) pathway for patients undergoing major elective open colorectal surgery: a meta-analysis of randomized controlled trials. Clin Nutr 2010; 29: 434-40
5. Riepen DW, Gelvez D, Collett GA, Nakonezny P, Estrera KA, Huo MH: Standardized total knee arthroplasty pathway improves outcomes in minority patients. Am J Manag Care 2021; 27: e152-e156

8. **Specific Aims:** *(what are your study's specific aims; try to be as specific as possible and make a distinction between primary and secondary aims)*

Primary: Is racial disparity exist in the use of ESRA (we defined the use of more than 80% of ERAS components as "high ERAS" use).

Secondary: Does use of ESRA decreased disparities in perioperative outcome.

9. Hypotheses: *(add separate hypotheses for each of your specific aims; if it is not clear from your background text then add here too why you hypothesize a specific outcome)*

We hypothesize that among lower extremity total joint arthroplasty patients, ERAS utilization increased over time amongst all racial groups, and that such standardized ERAS care protocols resulted in reduction of racial disparities and improved outcomes.

10. Population: *(specify your target population and be as specific as possible in regards to, e.g. ICD-9 procedure or diagnosis codes, age range, etc.; if possible provide references for any specific ICD-9/10 codes used;* ***clearly state inclusion and exclusion criteria****)*

Patients undergoing inpatient elective (hip and knee) TJA surgery were identified. Knee TJA was defined based on International Classification of Diseases 9th Revision (ICD-9) procedure code 81.54 or 10th Revision (ICD-10) procedure codes 0SRC0xx, 0SRD0xx. Hip TJA was defined based on ICD-9 procedures codes 81.51 or ICD-10 procedure codes 0SR90xx, 0SRB0xx.

11. Timeframe: *(specify the time frame of the study and any justifications if necessary)*

January 2006 through December 2021

12. Intervention: *(specify the intervention or main effect of interest and how it is* ***categorized*** *and how it is* ***defined****; also state if there are any secondary effects of interest)*

The main 'exposure' of interest was race categorized as Asian, Black, White, or Other.

13. Comparison: *(specify the comparison group)*

Asian vs White; Black vs White; Other races vs White

14. Outcome(s): *(specify primary and secondary outcomes and how they are defined; if necessary add references)*

ERAS use was defined by 8 components commonly used in such protocols, identified using billing and CPT codes as previously described [6]: (1) use of multimodal anesthesia (including peripheral

nerve block, non-steroidal anti-inflammatory drugs, cyclooxygenase-2 inhibitors, paracetamol/ acetaminophen, gabapentin/pregabalin, or ketamine) on the day of surgery or postoperative day 1, (2) use of tranexamic acid on the day of surgery or postoperative day 1, (3) use of antiemetics on the day of surgery or postoperative day 1, (4) use of steroids on the day of surgery, (5) physical therapy on the day of surgery or postoperative day 1, (6) avoidance of urinary catheters, (7) avoidance of patient-controlled analgesia, and (8) avoidance of wound drains. A binary outcome variable was generated based on if a patient received more than 80% of ERAS components.

Secondary outcome variables include any major complication defined by ICD-9/10 codes (including acute renal failure, delirium, myocardial infarction, pulmonary embolism, respiratory failure, stroke, or in-hospital mortality; Appendix 2), in-hospital mortality, and prolonged length of stay (LOS > 3days).

Reference:
6. Memtsoudis SG, Poeran J, Zubizarreta N, Cozowicz C, Morwald EE, Mariano ER, Mazumdar M: Association of Multimodal Pain Management Strategies with Perioperative Outcomes and Resource Utilization: A Population-based Study. Anesthesiology 2018; 128: 891-902

15. Covariates of interest: *(list **ALL** other variables of interest that may be available in your data source and provide a rationale for each variable and how it will be categorized; add references if necessary)*

Patient-level variables included age, sex (male, female), insurance type (commercial, Medicaid, Medicare, uninsured, other), and Elixhauser Comorbidity index (categorized as 0, 1, 2, 3+). Healthcare-level variables included hospital location (urban, rural), hospital size (<300, 300–499, ≥500 beds), hospital teaching status, procedure type (hip/knee TJA), and year of procedure.

DATA / ANALYSIS

16. Database to be used:
Premier Healthcare claims database (Premier Healthcare Solutions, Inc., Charlotte, NC; 2006-2021)

17. Sample size: *(provide any justifications for the sample size needed; do you expect a strong effect? Is the outcome of interest common? etc.)*
NA

18. Analyses requested: (provide empty tables and figures in an Excel file as you envision them in your manuscript, this will clarify the analyses needed; be as specific as possible in this section and try to describe the analyses needed based on each table/figure you think you need)

We first assessed (unadjusted) trends in 'high ERAS' use by racial subgroups. Descriptive analysis of all study variables was stratified by race. Categorical variables were presented as counts and percentages, and continuous variables were presented as median and interquartile ranges (IQR).

Mixed-effects models were applied to compare associations between race and the use of more than 80% of ERAS components, i.e., 'high ERAS'. We then subsequently modeled the association between race and 'high ERAS' and the outcomes of any major complication, in-hospital mortality and prolonged LOS. We next modeled all covariates to estimate effects for each race groups. Finally, we applied an

interaction term between race and ERAS to assess whether the association between ERAS and outcomes was any different across racial subgroups, i.e., to assess whether ERAS protocols exerted a stronger effect in non-White versus White subgroups, assuming higher odds of complications for non-White groups that would require a stronger impact of ERAS protocols to reduce potential racial disparities in outcomes. Models were adjusted for all available covariates. A random intercept term that varies at the level of each hospital was included in the model, accounting for the cluster effect of patients within hospitals as they are likely to experience similar care. Odds ratios (OR) and 95% CIs were reported. A p-value <0.05 was used as the cutoff for statistical significance. Analyses were performed with SAS version 9.4 (SAS Institute, Cary, NC).

19. Limitations of study: *(specify any known limitations of the proposed study)*

First, this is a retrospective cohort study. Our study is limited by the quality of existing database and by the available details. Socio-economic and geographic information could not be extracted for further analysis. Second, we defined ERAS based on our group's previous publication (xxx). ERAS pathways vary across different institutions at different time, and our approach is unlikely to appreciate these differences.