ERAS Protocols for Elective Spine Surgery: A Retrospective Review

Scholarly Pursuit and Thesis

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Abstract

Research Question:

Do adults undergoing elective spine surgery in the two years following the implementation of our new ERAS protocol (July 2018 – March 2020) demonstrate better clinical outcomes compared to patients treated using our original ERAS protocol? Furthermore, do these cohorts differ quantitatively in (1) thirty-day hospital readmission rates, (2) ninety-day postoperative infection rates, and (3) hospital length of stay?

Background, Significance, and Rationale:

The Enhanced Recovery After Surgery (ERAS) program has shown its utility in reducing the hospital length of stay (LOS). ERAS has been established in surgical specialties nationwide, but few studies have been directed at spine surgery. It was only recently that ERAS protocols were outlined for their use in spine surgery. The goal of the study is to evaluate the result of recent changes to the ERAS protocol on patient outcomes.

Materials and Methods:

This retrospective case-control study reviewed electronic medical records of neurosurgical patients at a quaternary referral center for trends and variances. The analysis focused on the recent changes (the addition of a multimodal analgesic regimen (MAR) and preoperative high-carbohydrate drink (HCD) to our ERAS protocol (July 2018- March 2020). Using IBM SPSS version 27, parametric and nonparametric analyses were conducted to assess for differences in infection rates, hospital length of stay (LOS), and readmission rates.

Results:

A between-subjects t-test was utilized to compare the LOS between the BEFORE group and the AFTER group in hours. The BEFORE group ($M = 68.45$, $SD = 58.08$) spent significantly more hours in the hospital than the AFTER group ($M = 62.22$, $SD = 52.36$), $t(3264) = 3.19$, $p < .001$. However, the effect of the difference was small ($d = .18$).

Conclusions:

While many studies have validated the differences between ERAS and non-ERAS cohorts, fewer studies have described modifications of already established ERAS protocols in patients undergoing elective spine surgeries. Changing two components to a complex protocol resulted in a statistically significant reduction in LOS between the BEFORE and AFTER groups. Broad application of these modifications will likely result in better patient satisfaction scores and more prudent utilization of resources.

Research Question

Do adults undergoing elective spine surgery in the two years following the implementation of the new ERAS protocol (July 2018 – March 2020) demonstrate better clinical outcomes, in comparison to patients who were treated using the original ERAS protocol? Furthermore, do these cohorts differ quantitatively in (1) hospital readmission rates, (2) infection rates, and (3) hospital length of stay?

Hypothesis:

We hypothesize that the addition of the preoperative high-carbohydrate drink (HCD) and the multimodal analgesic regimen (MAR) to the ERAS protocol (May 2018) will demonstrate statistically significant differences in hospital readmission rates, hospital length of stay (LOS), and infection rates between the adult cohorts.

Introduction and Significance

The Enhanced Recovery After Surgery (ERAS) protocol has been integral to various surgical specialties since it was first introduced in 2001. Although a term known as 'fast-track' surgery was previously outlined in 1990 [1], the philosophy of ERAS was designed to adhere to quality rather than the speed of recovery. The original concept of an ERAS protocol was centered around several key components: continual fluidity based on active and continuous monitoring, an evidence-based scientific model for care protocols, and a multidisciplinary team working cohesively with the patient as their central focus. [2,3] The original ERAS protocol has since undergone numerous modifications to provide patients and healthcare professionals with a longitudinal, cohesive approach to maximizing the understanding and quality of the patient's journey. [2] Despite its wide application in many surgical fields, its use in elective spine surgeries was limited; [4] with the first ERAS protocol, designed specifically for spinal fusions, was established in 2017 by Wang et al. [5]

The ERAS protocol was initially implemented in 2012 at our quaternary medical facility. Our original ERAS program was developed based on current standards in surgical ERAS research [2] and included four major sections: Preadmission, Preoperative, Intraoperative, and Postoperative guidelines. In addition, this protocol included guidelines for patient education, pre-anesthesia testing, preoperative diet, and medications (intraoperative and postoperative). Further modification of this ERAS protocol was made in May 2018 (Figure 1) with the addition of a preoperative high-carbohydrate drink (HCD) and multimodal analgesic regimen (MAR).

Nutrition is a significant independent, modifiable risk factor for unplanned re-admission within 30 days of discharge. [6] Blood glucose balance is critical as drops in blood glucose result in lower energy and a decreased recovery capability. Additionally, a multi-modal analgesia approach was outlined to better modulate the post-surgical stress response than any single drug or modality. [7] With the addition of an HCD (the night before and 3 hours preoperatively) and a MAR, our old ERAS protocol was modified to reflect these two adoptions.

There have been ample studies evaluating the benefits of an ERAS protocol versus the control, non-ERAS protocol; however, there is a paucity of evaluating changes made to already established ERAS protocols. Our research serves as a preliminary study to evaluate changes made to an existing ERAS protocol and how those changes affect several endpoints. Only very recently has the need for a unified ERAS protocol in neurosurgery been formally discussed. We believe this framework can additionally serves as a starting point for a unified ERAS protocol for elective spine surgeries, and perhaps expanded to all of neurological surgery in the near future.

Materials and Methods

All patients (between ages 16-90) undergoing elective spine surgery at a quaternary medical referral center (Texas Health Harris Methodist) between June 2016 – 2018 (BEFORE) and August 2018 to August 2020 (AFTER) were included in the study. Surgeries in July 2018 were excluded to provide our clinical team with ample time to adapt to this new ERAS protocol [8] implemented on July 1, 2018 (see Fig. 1). Patients undergoing nonelective spinal surgery and those with incomplete data fields were excluded from the study.

To evaluate the impact of the modifications to our ERAS protocol (addition of MAR and preoperative HCD) in patients undergoing elective spine surgery, three outcome measures were assessed: (1) thirty-day hospital readmission rates, (2) ninety-day postoperative infection rates, and (3) hospital length of stay in hours (LOS).

The electronic medical records for all patients who underwent elective spine surgery both twenty months before and after the implementation of our new ERAS protocol were retrospectively reviewed. Our new ERAS sample period was limited to the period between July 2018 and March 2020 due to the decrease in elective surgery volume because of the COVID-19 pandemic. These patients were demographically matched in each group.

All patient information was deidentified and aggregated into a database, separating the patients by cohort (old vs. new). Data collected included patient demographics and independent variables: ninety-day postoperative infection rate, LOS, and thirty-day readmission rate. To mitigate confounding variables for each type of surgical procedure, the average length of stay was identified as a true zero, and a non-zero integer indicated days below or beyond the average length of stay for any given patient.

IBM SPSS was used for statistical analysis of the data. A between-subjects t-test was conducted to compare the BEFORE group to the AFTER group on LOS, while a chi-square test of independence was used to test for a relationship between ERAS status and readmission rate and ERAS status and SSI; since this data was nominal and dichotomous.

Figure 1: Current ERAS Protocol - THFW

TEXAS HEALTH HARRIS METHODIST HOSPITAL FORT WORTH
ELECTIVE SPINE SURGERY ERAS PROTOCOL

PREOPERATIVE PHASE

Education in Surgical Clinic:

1. Define Expectations – ERAS Guide
    a. Daily exercise
    b. Smoking cessation
    c. Healthy diet
    d. Reduction/elimination of alcohol
    e. Incentive spirometer education
    f. Carbohydrate drink education
2. Attend spine surgery pre-op education class
3. Define orthotic needs
4. Define discharge plan
5. Label the patient "*ERAS PROTOCOL*" when scheduling

Pre-anesthesia Testing

1. CHG wipes or CHG liquid and education on use.
2. Carbohydrate drink education
3. Encourage hydration 2 days prior to surgery
4. Dietary consultation for BMI > 30
5. Complete ODI functional assessment tool
6. Labs: CBC, BMP, PCR MRSA, HgA1c (if diabetic)

One day prior to surgery:

1. No solid food 8 hours prior to surgery.
2. 100 gm clear carbohydrate drink before midnight.
3. Clear liquids up to 2 hours prior to surgery.

DAY OF SURGERY

Pre-Op
Diet Orders:

1. 50 gm clear carbohydrate drink 3 hours prior to surgery
2. No solid food 8 hours before surgery.
3. Clear liquids up to 2 hours prior to surgery.

Medications:

1. Ofirmev 1 gm x 1
2. Gabapentin 600 mg po
3. Midazolam 1-2 mg age adjusted for elderly per Anesthesia
4. Consider scopolamine patch

5. DVT prophylaxis - SCDs
6. Abx as ordered by surgeon

Intra-Op – GENERAL SPINE CASES

1. Cefazolin 2 g IV
    a. Recommendation: 2 gm if < 120 kg, 3 gm if > 120 kg
    b. re-dose every 6 hours
2. PCN Allergy
    a. Clindamycin 900 mg IV, re-dose every 6 hours
3. Dexamethasone 4 mg IV after induction.
4. Ketamine bolus 0.25 – 0.5 mg/kg at induction and every 4 hours
5. Consider judicious fluid administration when deemed euvolemic.
6. Maintain normothermia
    a. Forced air body warmers
    b. Low flow anesthesia
    c. Fluid warmer
    d. Other warming and heat conservation methods
7. Minimize tubes, lines, and drains
    a. Arterial lines or central lines not required unless specific indication
    b. No Foley catheters for ACDFs, discectomies, or surgeries anticipated to last less than 2 hours.
8. Utilize Lung Protective ventilation strategies
9. Maintain normoglycemia
10. Zofran 4 mg at end of surgery (30 min prior to closure)
11. Consider wound infiltrate with local anesthetic for all posterior spine approaches
12. Valium 2.5 – 10 mg IV or Robaxin 500-750 IV

Intra-Op – SPECIAL CONSIDERATIONS FOR COMPLEX SPINE CASES

1. Ketamine infusion of 4 mcg/kg/min
2. Lidocaine infusion: 1.5 mg/kg bolus, 2 mg/kg/hr infusion, continue up to 8 hours post-op.
3. Tranexamic acid 1 gm bolus and infusion dosing of 100 mg/min.
4. Methadone IV 0.05 – 0.10 mg/kg
5. Consider placing central line if indicated for fluid resuscitation or blood products.

    Complex Spine Definition
        1. Surgery for correction of deformity (scoliosis, kyphosis, flat-back syndrome).
        2. Surgery anticipated to last 6 or more hours.

POSTOPERATIVE

Medications

1. IV Fluids per surgeon and weight discretion
2. Pain Management per surgeon discretion
3. Minimize IV narcotics

   a. Tylenol IV 1gm every 6 hours x 4 doses
   b. Consider Toradol 15 mg IV q6h x 3 doses for non-fusions
4. Neurontin 300mg TID x 3 days
5. Zofran 4 mg IV every 4 hours as needed
6. 2 L oxygen via nasal cannula x 6 hours
7. Laxative of choice post op.

Nursing Orders

1. Regular diet POD #0
2. Oral hydration
3. Chewing gum/mints
4. Incentive spirometer use and education.
5. Nutrition consult for BMI>30
6. DC Foley by 7am POD #1
7. Smoking cessation education for active tobacco users
8. Diabetic Resource RN consults for HgA1c 8.5 or greater, otherwise diabetic education per nursing staff.

Unless otherwise directed

1. OOB on POD # 0
2. Ambulate in hallways with assistance TID starting POD # 1
3. OOB for all meals starting POD #1
4. Discharge Planning by CTM
5. Verify follow up appointment with surgeon

Results

The patients' ages ranged from 16 to 91 years, with an average age of 60. In addition, 1788 of the patients were females (53%), and 1582 were males (47%). Regarding race, the sample was pretty homogeneous, consisting of 2918 white patients (87%), 332 black patients (10%), and 120 patients with other races (3%).

A total of 3370 participants were included in the study—1901 in the BEFORE group (Controls) and 1469 in the AFTER group (Cases). The annual surgical volume at our facility was equivocal between 2016 and 2020. Whereas 110 patients were readmitted (within thirty days from surgery) in the BEFORE group, only 83 patients were readmitted in the AFTER group. Likewise, 18 patients had a postoperative surgical site infection (SSI) in the BEFORE group, while only 12 patients had an SSI in the AFTER group.

As readmission status and infection rate are nominal and dichotomously measured, chi-square tests of independence were computed to determine if there is a relationship between ERAS status and readmission rates and ERAS status and infection rates. Neither analysis was significant, $X^2 = .029$, $p = .866$ and $X^2 = .159$, $p = .69$, respectively.

A between-subjects t-test was conducted to compare the BEFORE group to the AFTER group on length of stay in hours. Results showed a statistically significant difference between the groups. The BEFORE group ($M = 68.45$, $SD = 58.08$) spent significantly more hours in the hospital than the AFTER group ($M = 62.22$, $SD = 52.36$), $t(3264) = 3.19$, $p < .001$. The effect of the difference was small ($d = .18$).

Discussion and Innovation

The Enhanced Recovery After Surgery (ERAS) protocol has been a focal point of surgical research since its formal implementation and guidelines were established in 2001. However, until recently, no guidelines have been specific to neurosurgery or spine surgery. Nevertheless, the safety and efficacy of ERAS have been demonstrated; in a five-year, diverse population study Staartjes et al. found that ERAS was safe and effective for posterior and anterior lumbar fusions and did not increase readmission rates, with an increase in the proportion of early discharges. Adverse events and LOS were also decreased, with increased subjective patient scores and better clinical outcomes. [7] Similarly, Elsarrag et al. [9] found that ERAS protocols applied to spine surgeries reduce LOS, accelerate return to normal functions, minimize pain, and reduce associated financial costs.

While many studies have validated the differences between ERAS and non-ERAS cohorts, fewer studies have described modifications of already established ERAS protocols in patients undergoing elective spine surgeries. A better understanding of the impact of these changes will allow for more effective improvements and standardization of ERAS protocol in patients undergoing elective spine surgery. These modifications may then be generalizable to the neurosurgical patient population at large.

While both of the changes to our ERAS protocol modifications were supported individually, it is still important to verify that changes are having a positive impact. We showed that by adding MAR and HCD we showed a statistically significant reduction in the LOS in the AFTER group. This can have benefits for patient recovery, satisfaction, utilization of scarce resources, and reduction in hospital costs. Beyond this, our results further pave the way for a universal ERAS protocol for all of neurological surgeries in the future as well as promoting a culture of evaluating changes made to established programs and protocols to further validate outside results each quaternary facility.

A significant limitation of the study is that patient records and outcomes were reviewed only from one quaternary facility, in addition to the inherited detriments of a retrospective analysis.

Future Directions

Our work further validates how individually verified changes, such as multimodal analgesic regimens and optimal nutritional status preoperatively, can work synergistically to give patients the best possible outcome. There exists a paucity of research in the field of neurosurgery comparing changes to currently implemented ERAS protocols. While our work is promising, it is significantly limited in being restrictive to one quaternary facility at the moment. We intend to expand this work to more facilities in the area and hope to encourage others to do the same at their institutions. As an adjunct to our current research, we intend to further delineate between elective spine surgeries and the subtypes of surgeries taking place and look for any significant trends or correlations within the subtypes and our three variables.

After much work is done to test for statistically significant changes at multiple locations, we can further devise a project to analyze for variances and trends both between and within the varying quaternary facilities as well as further description statistics about surgery types and their effect on hospital length of stay, surgical site infections, and readmission rates amongst other variables.

This work should serve as one of the initial steps to devise a specialty-wide ERAS protocol to be adopted for elective spine surgery and should apply to elective neurosurgeries across many demographics and regions. With a continual emphasis on one of the cornerstones of ERAS being continual improvement and evolvement as new evidence-based medicine is explored and standards shift through time, we will rely on the work of many others in the field to create the best possible protocol for our patients, with the added benefits associated with reducing scarce resources and limiting hospital expenditures.

Conclusions

ERAS has been a pinnacle development in the field of surgery, beginning first in the field of general surgery, and has evolved from the original premise of fast-track surgery. The standardized protocol of ERAS has been slow to be adopted in the field of neurosurgery and few, if any, standardized protocols specialty-wide have been developed. Furthermore, a paucity of research exists that has evaluated and analyzed modifications to already implemented ERAS protocols in the field of neurosurgery.

Changing two components to a complex protocol at our quaternary facility resulted in a statistically significant reduction in LOS between the BEFORE and AFTER groups. Broad application of these modifications will likely result in better patient satisfaction scores and more prudent utilization of resources.

Compliance

While our final data was deidentified for anonymity we first obtained Internal Review Board (IRB) approval through the Texas Health Resources (THR) IRB review board; specifically, the Harris Methodist Fort Worth, TX branch under Study #: STU-2021-0324. This was then verified and approved by the Anne Burnett Marion School of Medicine at TCU.

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Contributions

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