



# Integration of an enhanced recovery after surgery program for patients undergoing pituitary surgery

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## Abstract

Evidence-based enhanced recovery after surgery (ERAS) programs aim to improve patient outcomes and shorten hospital stays. The objective of this study is to describe the development, implementation, and evolution of an ERAS protocol to optimize the perioperative management for patients undergoing endoscopic skull base surgery for pituitary tumors. A systematic review of the literature was performed, best practices were discussed with stakeholders, and institutional guidelines were established and implemented. Key performance indicators (KPI) were measured and patient-reported outcome surveys were collected. The ERAS protocol was introduced successfully at our institution. We describe the process of initiation of the program and the perioperative management of our patients. We demonstrated the feasibility of integration of ERAS protocols for pituitary tumors with multidisciplinary engagement, with a particular emphasis on the use of data informatics and metrics to monitor outcomes. We expect that this approach will translate to improved quality of care for these often-complex patients.

## KEYWORDS

Enhanced recovery after surgery, Endoscopic skull base surgery, Pituitary surgery, Outcomes improvement

## INTRODUCTION

In the quest to optimize safe patient outcomes, the role and impact of perioperative management has been a source of significant analysis. Minimizing variability in the delivery of patient management through appropriate utilization of clinical protocols and pathways has been associated with shorter duration of hospital stay, fewer complications, and reduced financial costs to the healthcare system.<sup>1</sup>

Enhanced recovery after surgery (ERAS) programs utilize evidence-based best practices to guide care pathways for a variety of surgical specialties. The concept was first introduced in the field of

colorectal surgery, where it found early success.<sup>2,3</sup> There have since been trials of programs in upper gastrointestinal, pelvic, orthopedic, vascular, head and neck, and neurosurgery with encouraging results.<sup>4-10</sup> The systematic formulation and delivery of ERAS programs ensures all facets of the perioperative care process are planned, anticipated, and addressed for each patient. The programs also facilitate improved understanding among members of the multidisciplinary team by enabling respective clinicians to comfortably predict the next step in management from the other involved specialty teams. Furthermore, ERAS programs have been demonstrated to be drivers of efficiency in health economics; they reduce

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extraneous costs to the healthcare system by minimizing unnecessary peri-operative investigations and shortening length of inpatient hospital stays.<sup>11,12</sup>

Skull base surgery is technically complex and associated with highly variable patient outcomes. The planning and execution of any skull base surgical procedure requires multidisciplinary collaboration, including input from head and neck surgery, neurosurgery, anesthesiology, endocrinology, and nursing specialties, among others. The diversity of stakeholders vested in this patient management paradigm makes the field well-suited to the application of an ERAS program. There are several reports in the literature describing the utility of ERAS protocols for patients undergoing skull base surgery.<sup>13-15</sup>

The objective of this study is to describe the development, implementation, and evolution of an ERAS protocol to optimize the perioperative management for patients undergoing endoscopic skull base surgery for pituitary tumors.

## ERAS DEVELOPMENT PROCESS

The Multidisciplinary Pituitary and Skull Base Center at Memorial Sloan Kettering Cancer Center (MSK) is a tertiary care center that treats patients with both benign and malignant conditions of the skull base. The development of our ERAS protocol for patients with pituitary tumors, involved multiple steps (Figure 1). The goals were to improve outcomes for patients undergoing endoscopic pituitary and

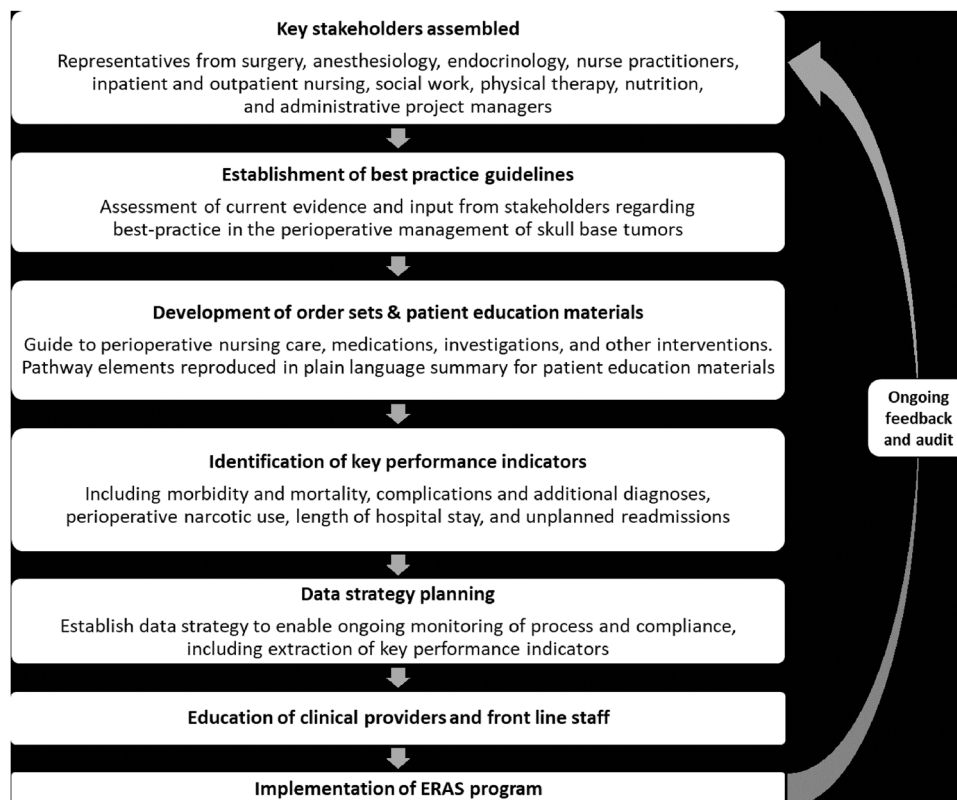
other skull base surgery and to minimize the morbidity related to treatment, which would align with the institutional goals of improving the quality and increasing value of care for patients with skull base tumors.

### Key stakeholders assembled

Key stakeholders were assembled to discuss individual recommendations following conversation with senior leadership ensuring the prioritization of the program. Stakeholders included representatives from neurosurgery, surgery, anesthesiology, endocrinology, inpatient and outpatient nursing, social work, physical therapy, and nutrition; nurse practitioners; and administrative project managers. These discussions allowed identification of the key components of perioperative management and enabled a mutual consensus to be established around the best evidence-based interventions for each component.

### Establishment of best practice guidelines

A systematic review was performed to assess current evidence regarding best practice in the perioperative management of pituitary tumors.<sup>16</sup> This was made available to members of the multidisciplinary team and was carefully considered by stakeholders. In



**FIGURE 1** Diagrammatic representation of the steps involved in establishing a skullbase enhanced recovery after surgery pathway (ERAS = enhanced recovery after surgery)

areas of clinical equipoise, such as the administration of perioperative prophylactic antibiotics, the clinical experience and preferences of the multidisciplinary team were taken into account. There was discussion of the pros and cons of each of these decisions in order to reach a consensus among all team members.

Some management principles were rolled over from other evidence-based ERAS programs at Memorial Sloan Kettering Cancer Center. These included initiatives such as early removal of indwelling urinary catheter, early and frequent mobilization, and avoidance of opioid analgesia.<sup>1,4</sup> Other measures were specific to skull base patients and required special consideration; for example, management of endocrinopathies in the peri-operative period. Daily labs were obtained post-operatively to monitor cortisol and sodium balance. Patients were watched closely for acute endocrine complications, such as hypotensive Addisonian crisis or diabetes insipidus (DI). Monitoring of pituitary function continued after discharge from the hospital, with hormone and electrolyte labs obtained at post-operative clinic visits, and “check-in” phone calls by our nursing team to inquire about symptoms suggestive of DI, rhinorrhea, epistaxis or vision concerns.

## Order set creation

The next step was the development of practical items for systematic delivery (order sets) to guide perioperative nursing care, medications, investigations, and other interventions. Instructions also incorporated escalation of the level of care; the most obvious example being the abnormalities in vital signs or symptoms prompting medical review. Specific to the skull base pathway, there were instructions on management of patients who were observed to have an intra-operative cerebrospinal fluid (CSF) leak, including positioning in bed and avoidance of straining. The importance of flexibility in order sets was recognized; they must be able to change and evolve in response to feedback from stakeholders as well as environmental constraints (for example, medication shortages) and patient-specific requirements (for example, medication allergies).

## Development of patient education materials

In addition to the order sets, the stakeholders collaborated to produce patient education materials. The structure of these materials was derived from the components of the agreed ERAS pathway and then adapted into plain language summary for dissemination to patients. They described the expected post-operative course and reiterated important information such as transphenoidal precautions. The patient education materials focused on what is required for functional recovery and safe discharge to home, such as mobility, diet, pain, and new medication management. An example of patient education material is provided in Supplementary Figure A.

## Data strategy & informatics integration

Data strategy was recognized as a key component for the successful introduction and ongoing measurement of the ERAS program. Before integrating data into clinical dashboards for visualization, informatics teams and clinical teams need to decide what the “cohort selection” will be and have selection criteria for who the “ERAS patient” is and how to effectively measure and track that patient. The cohort was selected for the pituitary ERAS program if the surgical current procedural terminology (CPT) code of 62165 was entered when the surgery was scheduled. The non-pituitary, skull base ERAS program captured patients using a variety of other codes including 31299 (unlisted endoscopic approach to the skull base), 61619, 61600, 61601, in the presence of surgery performed in concert by a head and neck surgeon and neurosurgeon. When patients were “enrolled” into the program, there was effective data integration which allows clinical teams to receive feedback via the informatics system to demonstrate outcomes of concern (for example, intraoperative opioid administration).

Key stakeholders worked together with informatics to develop a user dashboard that could provide the necessary clinical information in a clear and concise manner. In order to improve uptake and clinical benefit from the ERAS program, achieving a user-friendly interface was identified as an important objective for the informatics team (Figure 2).

In terms of data strategy, an important consideration was ensuring that our definitions matched those of the data analyst. Not only did this ensure that a consistent definition was being used across all platforms, but it also helped to align our goals with those of the hospital, which helped integrate the program into institutional culture.

## Process & compliance measures

Key performance indicators (KPIs) were identified for ongoing appraisal during implementation of the program. These were intended to provide a measure of the effectiveness of the ERAS process. KPIs included morbidity and mortality, complications and additional diagnoses, length of hospital stay, and unplanned readmissions, and allowed for dynamic assessment of program outcomes. In addition to the outcomes measured, we also measured process compliance; we were interested in assessing how frequently the ERAS components were followed and the trend over time (Figure 3). For example, we can assess the percentage of patients who have undergone total intravenous anesthesia in order to quantify the program's success.

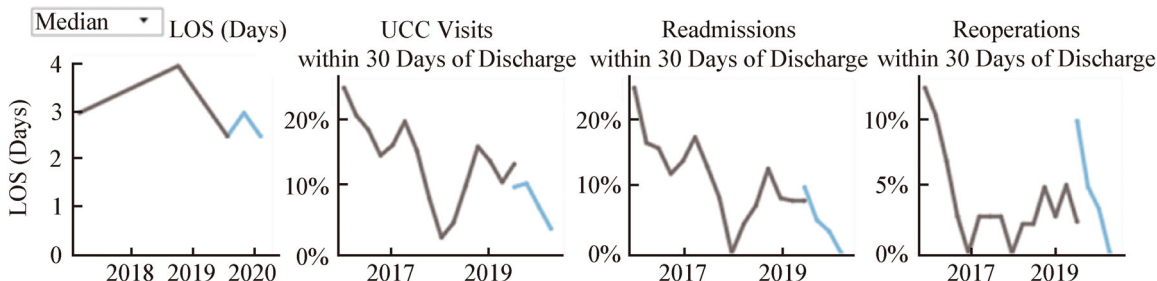
Standardized patient-reported outcome (PRO) questionnaires were agreed upon by all stakeholders to aid in quantification of the patient experience.<sup>17</sup> The Skull Base Inventory (SBI) was used to provide ongoing assessment of patient symptoms over time for patients undergoing pituitary surgery.<sup>17,18</sup> For patients undergoing surgery for a sinonasal malignancy, we used the validated FACE-Q as our PRO platform.<sup>14</sup> Using the data informatics system, the results of PRO questionnaires were integrated into the user interface to allow real-time updates to the clinical record. An example of patient responses in various domains of the SBI is provided in Figure 4.

ERP Program Overview ERP Indicator Compliance ERP Process Measures ERP Patient List ERP Adverse Event Overview



ERP Program Overview

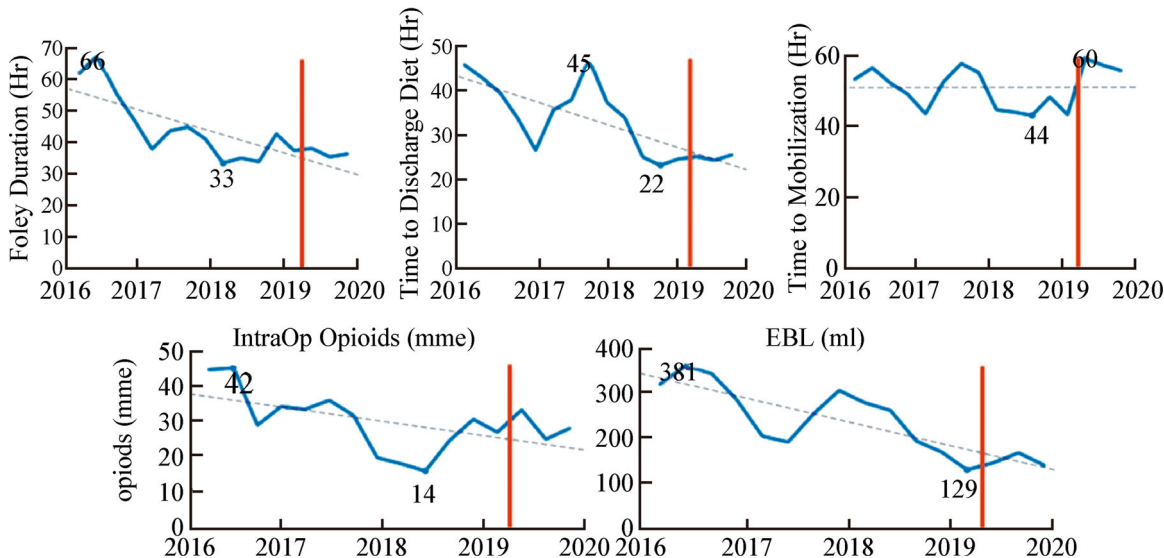
LOS(Days)		%UCC Visits		%Readmissions		%Reoperations	
Pre ERP	ERP	Pre ERP	ERP	Pre ERP	ERP	Pre ERP	ERP
3.0	2.0	14	6	11	3	3.4	2.8



**FIGURE 2** Demonstration of the information technology derived dashboard which tracks performance over time. Metrics are assessed prior to and following initiation of the enhanced recovery after surgery pathway on August 1 2019. This includes all endoscopic skull base procedures. ERP = enhanced recovery program; LOS = length of stay; UCC = urgent care centre



ERP Process Measures

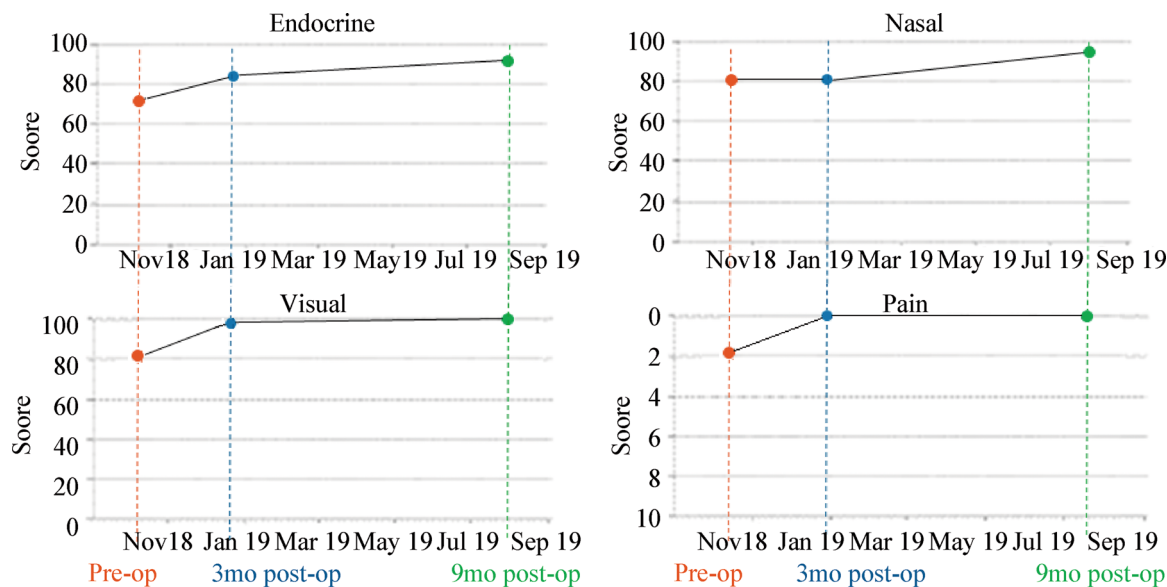


**FIGURE 3** Demonstration of multiple enhanced recovery after surgery process measures over time. The red line demonstrates initiation of the program. ERP = enhanced recovery program; EBL = estimated blood loss

The data management team developed a plan for ongoing assessment of compliance of the ERAS program. Variations in compliance are audited in order to identify the root cause. Adjustments to the protocol will be made as necessary. This highlights the dynamic nature of the protocol and the need for flexibility in implementation.

**Education of clinical providers and front-line staff**

Front-line staff members were educated regarding the rationale and specifics of ERAS prior to implementation. They were given an opportunity to ask questions and provide feedback. These face-to-face sessions were led by nursing leadership for nurses in the post-



**FIGURE 4** Example of Skull Base Inventory scores over time across the domains of endocrine, nasal, visual, and pain for a patient on the enhanced recovery after surgery pathway. The patient had bitemporal hemianopia secondary to a pituitary macroadenoma and underwent endoscopic transsphenoidal resection with improvement in vision, energy level, and nasal congestion

anesthesia care unit and the neurosurgical unit. This feedback contributed to the ongoing audit of the program, and recommendations were incorporated into the model in a dynamic fashion.

## Implementation of program

Every effort was made for the program to be implemented on a determined “roll out” date. This involved obtaining “buy-in” from all stakeholders in agreeing to and completing agreed upon patient inclusion criteria, care management items, order sets, patient education materials, data to be collected, and PROs.

## Feedback & auditing

The ERAS program was implemented under careful observation by all key stakeholders and was focused on including a system to measure compliance and an auditing system to measure feedback. Patients were considered on the pathway when they called the Multidisciplinary Pituitary and Skull Base Tumor Center phone number; their enrollment was formalized as soon as they were scheduled for skull base surgery with specific CPT codes. Perioperative orders were cross-checked in real time by multiple team members to ensure that all aspects of patient care had been addressed. Both pre-operatively and post-hospital discharge, patients were asked to complete a PRO questionnaire.

Compliance with pre-determined metrics is audited and fed back to clinicians. For example, the clinician dashboard displays the percentage of patients that meet criteria such as indwelling urinary catheter removal on post-operative day 1 (process) and urinary tract infection or length of stay (outcome). Auditing these data means

engaging with patient-facing team members to determine the barriers to achieving desired process and outcome measures.

The development and implementation of the skull base ERAS program took a combined total of twelve months.

## ERAS CARE PATHWAY

The above process outlines the steps taken to develop and implement the ERAS program at our institution. Here we describe the patient journey to illustrate how the program translates into clinical care.

### Pre-operative

Prior to the first clinic visit, the patient is contacted by the nurse coordinator to obtain the patient's medical history, identify and import outside hospital data, and determine the need for pre-operative consultations. Each patient has both magnetic resonance imaging (MRI) of the brain and computed tomography (CT) of the sinuses arranged, if they have not already been performed. Laboratory studies including complete blood count, comprehensive metabolic panel, and a “pituitary panel” (cortisol, corticotropin, prolactin, thyrotropin, thyroxine, insulin-like growth factor 1, growth hormone, testosterone, follicle-stimulating hormone, luteinizing hormone) are ordered.

At the first clinic visit, the patient meets with the neurosurgeon, otolaryngologist, and neuroendocrinologist. The purpose of this consultation is to confirm or provide diagnosis and discuss treatment options. If surgery is indicated, the surgical plan is reviewed—including the approach, reconstructive plan, and need for

intraoperative MRI. If non-surgical management is an option, medical therapies are discussed with the patient. If the consensus decision is to proceed with surgery, the neuroendocrinologist develops a perioperative hormonal management plan. A consultation is scheduled with the ophthalmologist if the tumor is extending beyond the sella or if the patient self-reports visual changes.

Throughout the clinic process, the patient is supported by the skull base nurse, who provides the patient with verbal and written educational materials. The patient is encouraged to ask questions throughout the process. The Skull Base Inventory PRO questionnaires is triggered and released through the patient's portal following the clinic visit when a diagnosis or common procedural terminology code is entered into the chart. At the conclusion of the clinic, the entire skull base team meets to discuss the management plan as part of the Multidisciplinary Skull Base Tumor Conference. Patients with challenging diagnoses or disease course are referred for a more comprehensive discussion at the Multidisciplinary Pituitary and Skull Base Tumor Board, held bimonthly.

Following the first clinic visit, the patient is referred to the anaesthetic pre-admission clinic for pre-surgical testing and further medical workup as required. Patients older than 65 years of age are referred to the Geriatric service for clearance. Patients with Cushing's disease and acromegaly are flagged in the clinic to alert the provider on the day of surgery due to their high risk for difficulty with bag masking and intubation as well as risk for obstructive sleep apnea.<sup>19,20</sup> Following completion of the anesthesiology workup, the patient is cleared to proceed to surgery.

## Operative

Surgery is performed in a room with intra-operative MRI capabilities. Intra-operative image guidance uses both pre-operative MRI and CT. Prophylactic broad-spectrum intravenous antibiotics (vancomycin, metronidazole, and ceftazidime) with CSF coverage are given prior to anesthetic induction and continued for 48 hours post operatively.

A thorough discussion of the surgical technique is beyond the scope of this manuscript. In short, a rescue flap is preserved bilaterally for smaller tumors and a nasoseptal flap is raised for large tumors that extend into the suprasellar space. The resection proceeds with the assistance of intra-operative image guidance. Intra-operative MRI is used in select cases. Following resection, the tumor bed is carefully inspected for evidence of a CSF leak. If a high-flow leak is identified, the rescue flap is secondarily converted to a nasoseptal flap. Non-absorbable nasal packing is placed for 48 hours in all patients with high-flow leaks. Doyle splints are used in all others who have undergone nasoseptal flaps. Lumbar drains are not used routinely.

## Perioperative anesthesia considerations

In addition to standard American Society of Anesthesiologists (ASA) monitors, arterial line placement is recommended to assist with blood pressure management and fluid/resuscitation. Bispectral index (BIS)

monitoring is also recommended, especially when utilizing total intravenous anesthesia (TIVA). Additionally, two large-bore intravenous lines should be placed prior to the start of surgery. The safety and success of transsphenoidal pituitary surgery is dependent upon adequate surgical field visibility. The combination of a richly-vascularized sinonasal mucosa and a confined surgical space can cause even minimal bleeding to compromise surgical field visibility.<sup>21</sup> This incurs increased surgical risk, longer operating times and greater blood loss.<sup>22</sup> Therefore, minimizing bleeding in order to ensure adequate field visibility is a primary goal of endoscopic skull base surgery.

A variety of techniques including surgical site injections of local anesthesia, topical decongestants, "head up" positioning, and controlled hypotension have been implemented to reduce surgical site bleeding.<sup>23,24</sup> Additionally, a growing body of evidence supports the use of TIVA as an important means to minimize bleeding and optimize surgical field visibility.<sup>25,26</sup> The benefits of TIVA over inhalational anesthesia (IA) in this regard are explained primarily by the distinct physiological mechanisms by which these two classes of drugs lower mean arterial blood pressure (MAP). While a reduction in MAP can be accomplished by decreasing either cardiac output (CO) or systemic vascular resistance (SVR), interventions that reduce the former are more effective in reducing surgical field bleeding than the latter. The application of TIVA, specifically a regimen consisting of propofol and remifentanyl, decreases MAP by reducing cardiac output. Conversely, inhalational anesthetics decrease MAP primarily by reducing SVR. This leads to vasodilation causing an increase in sinonasal blood flow and a bloodier surgical field.<sup>25-27</sup>

The ability of TIVA to confer superior surgical field visibility has led to its recommended use in transsphenoidal pituitary surgery at MSKCC. Our TIVA regimen typically consists of a combination of propofol (100-175 mcg/kg/min) and remifentanyl (0.05-0.20 mcg/kg/min) with dose titration as needed. As mentioned, BIS monitoring is recommended in any case utilizing TIVA. The benefit of lower MAPs to aid surgical field visibility needs to be carefully balanced with the maintenance of adequate cerebral and coronary blood flow. Therefore, intraoperative blood pressure goals need to be tailored to each individual patient based on medical comorbidities and risk for end-organ damage. Communication between surgical and anesthesia teams regarding appropriate intraoperative blood pressure parameters is crucial.

While rapid emergence is desirable to enable early neurologic examination, care must be taken to avoid coughing and straining which can contribute to post-operative CSF leak and venous bleeding. Performing a deep endotracheal extubation is also inappropriate as airway obstruction is common and application of positive pressure can disrupt surgical repair and hemostasis. Smooth emergence from anesthesia can be facilitated with the use of short-acting opioid agonists (fentanyl and remifentanyl). Additionally, intraoperative administration of intravenous acetaminophen (15 mg/kg with a maximum single dose of 1,000 mg) is recommended for analgesia.

## Post-operative

The patient recovers in a general post-anesthesia recovery unit for the first 2–3 hours then proceeds to a specialized neurosurgical unit. The patient is initially positioned flat in bed and up to 30 degrees until the morning of post-operative day number in the setting of high flow CSF leak. In the absence of high flow leak, there are no limitations on bed position. Neurological and visual checks are performed every hour during post-operative day (POD) 0 for 8 hours, then extended to every 2 hours for 8 hours and then extended to every 4 hours thereafter. The patient is carefully monitored for hypotension that may indicate Addisonian crisis.

The patient receives regular IV or PO acetaminophen as needed for pain; opioid analgesia is avoided whenever possible but the patient may receive 5 mg of oxycodone as needed for moderate or severe pain. Prophylactic intravenous antibiotics (ceftazidime, metronidazole, and vancomycin) are continued for 48 hours at which point they are converted to oral antibiotics (amoxicillin/clavulanate) for an additional 2 weeks.

The patient receives blood and urine electrolyte assessment every 6 hours for 24 hours and then daily if needed. Most patients do not receive intra-operative steroids unless they are already on a steroid regimen pre-operatively. We therefore obtain AM serum cortisol levels for 2 consecutive days post-operatively to ensure adequate levels. Serum cortisol < 9 mcg/dl is managed with oral hydrocortisone. Patients with Cushing's disease undergo daily serum cortisol assessment. Glucose is assessed prior to meals and bedtime and treated with sliding scale insulin as needed. Patients are written for enoxaparin for DVT prophylaxis and PPI for GI prophylaxis. If no intra-operative MRI has been performed, then an MRI is arranged for POD 1.

Neuroendocrinology is consulted on all acromegaly and Cushing patients and on others when indicated to assist with diagnosis and treatment of perioperative endocrinopathy.

For functional recovery, early mobilization is an important component of the ERAS program. If there was no high flow CSF leak intraoperatively, the patient is encouraged to sit out of bed at 6 hours post-operatively. The indwelling urinary catheter is removed on POD 1 to facilitate mobilization. The patient sits in a chair throughout the day and is encouraged to mobilize every 6 hours. Physical therapy is consulted as required.

Discharge planning begins pre-operatively during the patient education period and continues throughout the process. We aim to discharge patients on POD 2 if they are medically stable and able to mobilize independently and self-manage their medications.

## Post-discharge

The patient is provided with the contact details of the neurosurgical unit and the skull base nurse upon discharge. They attend the skull base outpatient clinic 1-week post-discharge for removal of Doyle splints and nasal debridement. Plasma sodium, AM cortisol and a set of pituitary hormone levels are checked to assess for post-operative

sodium water balance concerns (DI, SIADH) and for hypopituitarism. The patient is asked to complete a PRO questionnaire at this visit and each subsequent clinic visit. The questionnaire can be completed either via the online patient portal or in person via an electronic platform in the clinic.

The patient returns 2 weeks post-operatively to discuss surgical pathology and a follow-up treatment plan. The nose is again debrided, and laboratory studies are checked. A third post-operative visit takes place at 4 weeks, and thereafter as needed. Follow-up imaging is performed 3 months post-surgery and then as agreed upon thereafter. Patients with hypopituitarism or secretory adenomas are also seen by the neuro-endocrinologist and often followed long-term.

## DISCUSSION

There is a growing body of evidence supporting the integration of ERAS programs into a range of surgical fields. Kehlet et al.<sup>2,3</sup> initially reported on ERAS protocols in colorectal surgery and found the use of “fast-track” protocols to be associated with fewer complications, more rapid recovery, and earlier return to work. These findings have been extrapolated to other fields of surgery, and over the past 5 years there have been a number of studies examining their role in the field of head and neck surgery, with mounting evidence to support their use.<sup>1,4,28–31</sup> The number of studies in the field of neurosurgery is more limited, although studies report ERAS protocols in patients undergoing craniotomies.<sup>5,32,33</sup>

This paper adds to the small number of skull base ERAS protocols in the published literature. Both Pan et al.<sup>14</sup> and Hughes et al.<sup>13</sup> showed a shorter length of stay after implementing an ERAS protocol, while Thomas et al.<sup>15</sup> reported that their protocol was associated with a low rate of complications and readmissions. Our primary goal in developing this protocol was to reduce the morbidity of surgery and optimize post-operative care. We focused on a number of factors that we believed would help achieve this goal, all of which were guided by our review of the literature. These factors included limiting the use of intraoperative opioids, avoiding unnecessary tests and interventions, clarifying care pathways to reduce ambiguity for the health care team, and improving pre-operative patient education and awareness of the care plan. Other interventions were agreed upon based on the clinical experience of the expert consultation group; these included removing indwelling urinary catheters early and mobilizing patients on POD 0, flagging patients with Cushing's disease and acromegaly for high risk of obstructive sleep apnea, and providing endocrine consultation for the management of diabetes. Through implementation of these measures, we aimed to decrease length of stay, reduce the risk of adverse events, improve patient quality of life outcomes, and improve the quality and ability of prospective data collection for patients undergoing skull base surgery.

As with any change in procedure, we encountered some challenges during the creation and implementation of the protocol. A major consideration was whether to enroll all skull base patients in

the protocol, or whether a pilot study would be more appropriate. Given the focused evidence-base supporting the protocol, it was decided that all new patients would be managed with the ERAS program. Flexibility in implementation supported the expectation that they would “come off” during their inpatient stay if necessary—for example, if a patient had a chronic pain condition and required adjustment in the standard post-operative analgesia regimen they would be removed from the protocol. Such changes were recognized to have the potential to create confusion as to individual patient ERAS status. We continue to discuss different methods to “flag” which patients remain on protocol, including the possibility of creating an alert on the electronic health record or issuing patients with a bracelet to denote their pathway status.

An important question remains as to whether there are meaningful changes that result from initiation of the ERAS program compared with prior to implementation, and whether we are adequately able to capture the positive and negative changes. It is conceivable that standardization of the few evidence-based practices for management of skull base tumors will not lead to significant improvement compared with a more individualized approach. However, this is not consistent with the evidence derived from other ERAS programs. Consequently, until we can obtain a larger volume of prospectively collected data regarding patient outcomes, we continue to work towards standardization in perioperative management.

A key step in the development of this protocol was the identification of KPIs to objectively measure patient outcomes, as well as PROs to report the subjective aspects of the patient experience. The skull base multidisciplinary team strongly supports the collection of these data as part of the audit cycle. Identifying the most appropriate indicators is a nuanced exercise, and we continue to monitor and adjust our KPIs accordingly. We believe that this vigilance will facilitate greater understanding of the strengths and limitations of this protocol. We intend to publish these data as they become available. It is important to recognize that the purpose of this manuscript was not to describe our outcomes since the program is early in the process.

We hope that our experience provides some direction for other institutions to design and implement their own skull base ERAS programs. It remains to be seen whether implementation of this pathway translates into clinically meaningful improvements in the perioperative care of skull base patients. We encourage other centers to report their own experiences in order to improve patient outcomes in this rapidly evolving field.

## CONCLUSION

We have demonstrated that the integration of ERAS protocols for pituitary tumors is feasible with multidisciplinary engagement. ERAS protocols facilitate the delivery of the best evidence-based perioperative management for these often-complex patients and enables

prospective data collection that efficiently optimizes assessment of quality of care and related quality improvement initiatives.

## DISCLOSURES

The authors declare no conflicts of interest.

## MEETINGS/PRESENTATIONS

This research was presented at the North American Skull Base Society 2020 meeting in San Antonio, Texas.

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#### SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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