

Enhanced Recovery After Surgery Nutrition Protocol for Major Head and Neck Cancer Surgery

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Abstract

Objective. To determine whether an enhanced recovery after surgery (ERAS) nutrition protocol is reasonably possible among our head and neck cancer (HNC) population with respect to system feasibility and patient compliance. Second, we aim to identify improvements in patient outcomes as a result.

Methods. Preexperimental research design among patients undergoing major HNC surgery after implementation of the ERAS nutrition protocol from July 2018 to July 2019 as quality improvement (QI). Preoperative clinical nutritional assessment and laboratory values were completed the same day as informed surgical consent in the clinic. Protocol focus was patient consumption of nutritional supplements perioperatively, monitored by our outpatient dietitian. Early postoperative enteral nutrition was initiated with monitoring of nutritional laboratory values. To support our model, we provide preliminary analysis of HNC patient outcomes after implementation of the ERAS nutritional protocol.

Results. Twenty-five patients were enrolled. Preoperatively, 40% of patients were malnourished, and 100% complied with perioperative nutrition supplementation. Health care provider compliance obtaining preoperative laboratory values was 56%. There was a strong negative correlation between modified Nutrition-Related Index (mNRI) and number of complications ($P = .01$), specifically, fistula rate ($P = .04$) and unplanned reoperation ($P = .04$). Enrolled patient average length of stay was 7 ± 4.4 days.

Discussion. Our patients demonstrated compliance with implementation of an ERAS nutrition protocol likely facilitated by dietitian engagement. mNRI potentially reflects risk for head and neck surgery complications.

Implications for Practice. QI processes demand reassessment and modification to ensure efficient and targeted approaches to improving patient care.

Keywords

quality improvement, QI, head and neck cancer, head and neck surgery, nutrition, enhanced recovery after surgery, ERAS

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Enhanced recovery after surgery (ERAS) is a multidisciplinary, evidence-based practice that targets perioperative care to optimize postoperative outcomes. The ERAS protocol was first implemented in colorectal surgery to standardize perioperative care and was shown to improve patients' postoperative function, decrease postoperative complications, and reduce hospital length of stay.¹ The implementation of ERAS protocols in a multitude of surgical specialties has achieved reductions in length of stay, complication rates, narcotic usage, and hospital readmissions.²

Introduction of the ERAS protocol in head and neck surgery is promising given the extensive and complex procedures performed. Tumor extirpation, particularly in the setting of surgical salvage, involves wide access and frequent need for microvascular reconstruction. Furthermore, patients with head and neck cancer (HNC) have medical morbidities associated with tobacco and alcohol abuse, which further increase the risk for postoperative complications and contribute to malnutrition.³

In 2017, a consensus review and evidence-based recommendations for an ERAS protocol for major HNC surgery associated with free flap reconstruction was issued by the ERAS Society.³ One element of the head and neck surgery ERAS protocol focuses on perioperative nutritional care. The rate of malnutrition in patients with HNC varies widely in the

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literature, from 8% to 58%. This is partially due to the lack of a standardized definition of malnutrition and the various methods used to assess nutritional status.⁴

The primary site of tumor involvement and tumor extent contributes to severity of dysphagia and resultant malnutrition. Malnutrition increases the rate of postoperative complications such as infection, delayed wound healing, and mortality.⁵⁻¹¹ Preoperative nutritional supplementation is shown to decrease postoperative complications and hospital length of stay.¹²⁻¹⁴ Focus on 1 high-yield element of a multimodal ERAS protocol may provide substantial improvement of quality of care.

The purpose of this project was to design and implement the nutritional aspect of a multimodal ERAS protocol to improve quality of care in patients with HNC by demonstrating the feasibility of our protocol. We provide a value stream analysis demonstrating our process of perioperative nutrition management for our patients with HNC undergoing complex surgery prior to our protocol initiation, as well as the first iteration of our standardized ERAS nutrition protocol. Second, we aim to show the impact on head and neck surgery patient outcomes after implementation of protocols where our patient cohort received standardized preoperative and postoperative nutritional support. In this preexperimental study, we also examine the preliminary impact of other tumor-related and patient factors that may contribute to overall nutritional status and surgical outcomes.

Methods

A waiver was obtained from the University of Mississippi Medical Center institutional review board for this quality improvement (QI) study.

Study Population

The study population consisted of a prospective cohort who underwent major head and neck surgery, defined as procedures involving the upper aerodigestive tract with either pedicled or free flap reconstruction at a tertiary referral center. Surgery occurred between July 1, 2018, and June 30, 2019, after the implementation of our ERAS nutrition protocol. Major head and neck surgery was defined as the following *Current Procedural Terminology (CPT)* codes: 38724, 31360, 21555, 21556, 61605, 35701, 42420, 42425, 41120, 41130, 41140, 41150, 41116, 42844, 21045, 42890, 42892, 42894, 31225, 65110, 21045, 69120, 69110, 60600, 15757, 20969, and 15734. CPT codes are described in **Table 1**. Patients who underwent 38724, 42420, 42425, 41120, and 41130 in isolation were excluded due to lower complexity of these procedures performed in isolation. Patients under the age of 18 were also excluded. For comparison purposes, 25 patients who underwent surgery between July 1, 2017, and June 30, 2018, and were case matched regarding tumor site, tumor stage, demographics, and procedure performed were used.

Nutritional Protocol

Patients underwent a preoperative nutritional assessment with our dedicated HNC dietitian. During this assessment, patients

received nutritional education as well as disclosed details of their prior nutritional intake, weight loss, swallowing symptoms, and level of activity and function. Boost Plus (Nestlé Health Science), a liquid oral nutritional supplement (ONS), was provided to all patients to consume 3 times daily for 2 weeks before surgery in addition to their regular diet. Diabetic patients received Boost Glucose Control (Nestlé Health Science) as a substitute. Patients were provided an ONS data-sheet to record Boost consumption. Two weeks is the typical timeframe from informed surgical consent for our patients with HNC to date of surgery. Patients already receiving enteral tube feeding had their current feeding regimen reviewed and optimized. Optimization by our dedicated nutritionist involved caloric and protein needs assessment based upon ideal body weight (IBW) accompanied by prescription of any needed increase in the patient's current ONS formula. Preoperative laboratory tests, including C-reactive protein (CRP), albumin, prealbumin, and thyroid-stimulating hormone (TSH), were drawn at the time of the primary nutrition assessment corresponding to day of informed consent for surgery. A second nutritional assessment was conducted with the dietitian 1 week before surgery via telephone that assessed compliance with ONS, tolerance, and continued nutritional education.

On the day of surgery, patients submitted their ONS record for compliance assessment. Nutritional laboratory values (CRP, albumin, and prealbumin) were reassessed on the day of surgery and again on the fourth postoperative day to monitor nutrition stability. Enteral nutrition with IMPACT Peptide 1.5 (Nestlé Health Science) started at 6 AM on the first postoperative day. IMPACT 1.5 was chosen for previously reported reduction in surgical complications and hospital length of stay in patients with HNC.^{15,16,17,18} Beneprotein (Nestlé Health Science) is a concentrated protein powder for oral or enteral feeding use. Supplementation with Beneprotein was provided based on the day of surgery prealbumin level (<10 = 3 packets/d, 10-15 = 2 packets/d, >15-20 = 1 packet/d). A third assessment was conducted during hospitalization by an inpatient dietitian who assessed tolerance and provided additional nutritional education along with a discharge nutrition plan. Patients were discharged home with tube feeding or ONS depending on their swallowing function or surgical reconstruction for a minimum of 2 weeks. During their postoperative follow-up appointment, a final nutritional assessment was conducted to assess tolerance and compliance with postoperative ONS. All patients complied with postoperative nutrition recommendations as they were discharged from the hospital with their prescribed formula and bolus schedule of the formula with free water. This was verified at the patient's first postoperative visit with the outpatient dietitian at 2 weeks.

Variables

There were 2 surgeons involved, extirpative (L.J.) and reconstructive (G.D.J.). The variables for analysis obtained from the preoperative visit included age, sex, height, current weight, usual weight, weight 6 months prior, consistency of

Table 1. Major Head and Neck Surgery *Current Procedural Terminology (CPT)* Codes.

Procedure	CPT code
Modified radical neck dissection	38724 ^a
Excision soft tissue mass, neck	21555
Excision tumor, deep neck	21556
Resection parapharyngeal space tumor	61605
Vessel exploration	35701
Total parotid with facial nerve dissection	42420 ^a
Total parotid with facial nerve sacrifice	42425 ^a
Partial glossectomy without primary closure	41120 ^a
Hemiglossectomy without primary closure	41130 ^a
Total glossectomy	41140
Composite resection	41150
Excision of floor of mouth lesion	41116
Resection of retromolar trigone or oropharyngeal tumor	42844
Excision mandible tumor	21045
Limited pharyngectomy	42890
Laryngectomy (all types)	31360 (31370, 31375, 31380, 31382, 31367)
Pharyngectomy	42892, 42894
Maxillectomy	31225
Orbital exenteration	65110
Segmental mandibulectomy	21045
Auriculectomy, complete and partial	69120, 69110
Carotid body tumor excision	60600
Free flap (radial forearm or anterolateral thigh)	15757
Free flap (osteocutaneous fibula or radial forearm)	20969
Pectoralis flap	15734

^aPatients who underwent these CPT codes in isolation were excluded.

oral intake, functional status, cancer site and stage, tobacco use, alcohol use, previous radiation treatment, preoperative laboratory values (CRP, TSH, albumin, and prealbumin). The variables for analysis obtained from the hospitalization included CPT codes performed, operative time, and post-operative laboratory values (CRP, albumin, and prealbumin). Body mass index (BMI), percentage of weight loss in the past 6 months, and modified Nutrition-Related Index (mNRI) were calculated and used in the analysis.

The Nutrition-Related Index (NRI) is a previously validated measure of nutritional status that uses a ratio of serum albumin and weight loss. The NRI as a measure of malnutrition was shown to independently predict postoperative pulmonary complications, bleeding or need for transfusion, and 30-day mortality in patients undergoing surgery for head and neck cancers with free flap reconstruction.¹⁰

The mNRI was calculated according to the following formula: $mNRI = (1.519 \times \text{serum albumin}) + [41.7 \times (\text{mass}/\text{ideal body weight})]$. Serum albumin was entered in grams per liter, and IBW was entered in kilograms. The validated mNRI differs from the originally published NRI by using IBW as a replacement for usual weight (UW) secondary to patient unreliability to recall UW.^{15,16} IBW was calculated using the Devine formula for men and the Robinson formula for women as follows: IBW for males over 60 inches = $50 + [2.3 \times$

$(\text{height} - 60)]$, IBW for males under 60 inches = 50, IBW for females over 60 inches = $48.67 + [1.65 \times (\text{height} - 60)]$, and IBW for women under 60 inches = 48.67.^{10,15,16} The preoperative albumin value was used ($n = 16$) for the calculation followed by the albumin value from the day of surgery ($n = 9$) if the preoperative albumin was not collected.

The outcome measures evaluated were the length of stay, number of complications, and presence of the postoperative complication, including systemic infection, surgical site infection, wound dehiscence, fistula, flap necrosis, unplanned return to the operating room, and hospital readmission. The value stream analysis of the current process and of our planned interventions with potential outcome measures is illustrated in **Figure 1**.

Statistical Analysis

A preliminary analysis was completed using StataSE 16 (StataCorp LLC). Descriptive statistics were performed to analyze the demographics, and 2-sample Wilcoxon rank-sum (Mann-Whitney) test or independent *t* test was performed to analyze the continuous data depending on the distribution of normality. Categorical data were analyzed using the Fisher exact test. To determine the association between the mNRI index and complications, Spearman correlation tests were performed.

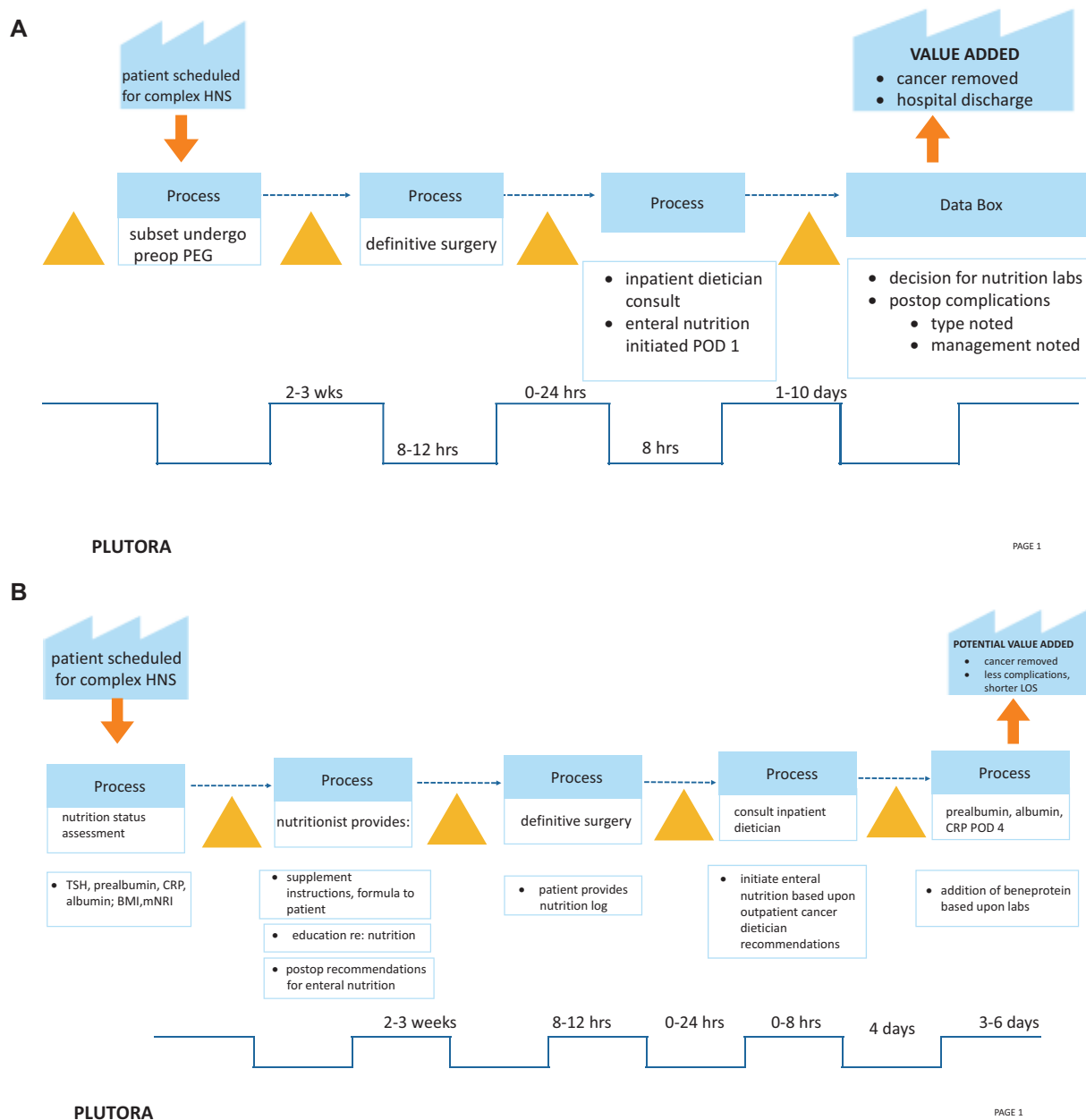


Figure 1. Value stream maps of pre-enhanced recovery after surgery (ERAS) and ERAS nutrition protocols. (a) Pre-ERAS nutrition protocol value stream map. (b) ERAS nutrition protocol value stream map. BMI, body mass index; CRP, C-reactive protein; HNS, head and neck surgery; mNRI, modified Nutrition-Related Index; PEG, percutaneous endoscopic gastrostomy tube; POD, postoperative day; TSH, thyroid-stimulating hormone.

As the primary goal for this study was to determine feasibility of our protocol and if compliance with the preoperative nutritional intervention could improve patient outcomes, a predictive model was explored. Negative binomial regression analysis was used to predict the number of complications by using different predictor variables. A P value of $<.05$ was used for determining statistical significance.

Results

There were 25 patients undergoing major surgery for head and neck cancer enrolled in the ERAS nutrition protocol.

Forty-percent (40%) of our patients were considered malnourished using a mNRI cutoff of less than 97.5 as described by Parhar et al.¹⁰ Self-reported compliance with ONS assessed the day of surgery was 100%, as documented by the patient self-datasheet. Compliance with preoperative laboratory attainment was lower than anticipated at 56%. Preoperative average albumin (4.0 g/dL) and prealbumin (23.0 mg/dL) levels were within normal limits on average 2 weeks before surgery. There were only 7 preoperative nutritional laboratory values for the case-matched controls. Baseline demographics are displayed in **Table 2**. Preoperative nutritional assessment laboratory

Table 2. Descriptive Analysis.

Variable	After case matching, preprotocol (n = 25)		Postprotocol (n = 25)		After case matching, <i>P</i> value ^a
	No. of patients	%	No. of patients	%	
Staging ^b					
Stage I	3	12	3	12	.89
Stage II	0	0	0	0	
Stage III	2	8	4	16	
Stage IVA-C	20	80	18	72	
History of radiation	6	24	4	16	.73
Current smoker	7	28	8	32	>.99
Current alcohol use	12		9		.57
History of diabetes	5	20	4	16	.42
Sex, male/female	20/5	80/20	20/5	80/20	>.99
Age, mean (range), y	62 (24-82)		62 (43-84)		.62
No. of CPT codes, median (range)	3 (2-7)		3 (1-7)		
Free flap surgery	18	72	18	72	>.99
Cancer location					>.99
Oral cavity	9	36	9	36	
Oropharynx	2	8	2	8	
Supraglottis	5	20	5	20	
Hypopharynx	1	4	1	4	
Larynx	4	16	4	16	
Subglottis	0	0	0	0	
Salivary, lacrimal	3	12	3	12	
Skin, lip	1	4	1	4	
Unknown primary	0	0	0	0	
Preoperative albumin, g/dL	3.26 (2.8-3.9) [n = 7]		4.0 (3.4-4.8) [n = 16]		
Preoperative prealbumin, mg/dL	Not available		23 (18-43) [n = 13]		
Preoperative CRP, mg/dL	Not available		1 (0-4) [n = 13]		
Preoperative TSH, mIU/L	Not available		2.09 (0.32-3.91) [n = 12]		
POD 0 albumin, g/dL	Not available		3.5 (2.8-4.0) [n = 18]		
POD 0 prealbumin, mg/dL	Not available		16.9 (9-26) [n = 19]		
POD 0 CRP, mg/dL	Not available		3.37 (0.08-18.6) [n = 20]		
POD 4 albumin, g/dL	Not available		3.1 (2.4-4.0) [n = 18]		
POD 4 prealbumin, mg/dL	Not available		12 (7-19) [n = 18]		
POD 4 CRP (mg/dL)	Not available		11.2 (4.4-21.4) [n = 18]		
mNRI	89.5		105		.03

Abbreviations: CPT, Current Procedural Terminology; CRP, C-reactive protein; mNRI, modified Nutrition-Related Index; POD, postoperative day; TSH, thyroid-stimulating hormone.

^aType of statistical test: Fisher exact test.

^bAmerican Joint Committee on Cancer staging manual, eighth edition.

values were not regularly obtained prior to implementation of this protocol, as reflected in **Table 2**. The mean mNRI for the patients in the ERAS nutrition protocol was significantly higher (better nutritional status) than historically (105 [n = 16] vs 89.5 [n = 7], *P* = .03). There were no occurrences of refeeding syndrome.

The average length of stay for patients enrolled in the protocol was 7 ± 4.4 days compared to 7.7 ± 5.3 days historically (*P* = .52). For patients enrolled in the ERAS nutrition protocol, we also found a strong negative correlation between the mNRI and number of complications (*P* = .01), as demonstrated in **Figure 2**, specifically fistula rate (*P* = .04) and unplanned reoperation (*P* = .04). Two significant moderate

negative correlations were identified with the number of complications: preoperative albumin (*P* = .02) and day of surgery albumin (*P* = .01). A significant moderate negative correlation was also identified between postoperative day 0 albumin and length of stay (*P* = .03).

Discussion

We demonstrated feasibility of implementing an ERAS nutrition protocol for patients with HNC, as demonstrated by 100% patient compliance with preoperative nutrition assessment and consultation with the outpatient dietitian and adherence to the preoperative and postoperative nutrition regimens. Providers complied with inpatient laboratory assessments and

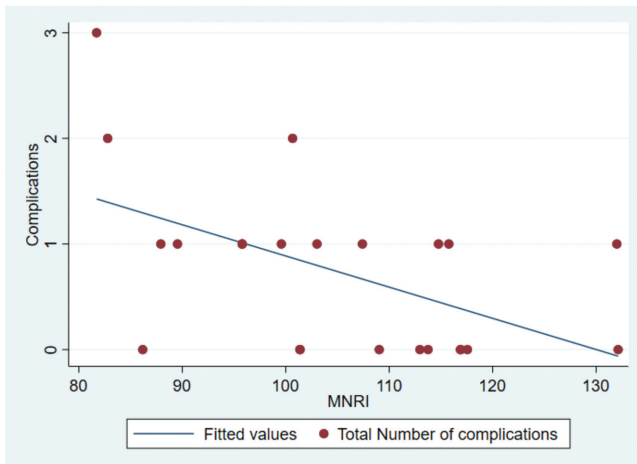


Figure 2. Spearman correlation between the modified Nutrition-Related Index (mNRI) and number of complications.

ordering the protocol-recommended inpatient nutrition. The inpatient dietitians reviewed the outpatient dietitian recommendations and inpatients' laboratory values to guide nutrition regimen adjustments as needed.

Upon discharge, all patients received their 2-week nutrition formula from the discharge nurse, thus demonstrating the multidisciplinary patient and team engagement with this initiative. Feasibility improvement requires amendment to the protocol to maximize obtaining preoperative nutritional laboratory assessment with a standardized order set.

The rate of 40% malnutrition among our patients with HNC is consistent with rates previously published.⁴ The HNC patient population is considerably vulnerable to malnutrition due to pain and mechanical obstruction of the upper aerodigestive tract.⁴ The strong negative correlation between the mNRI and number of complications suggests that patients with poor nutritional status are more likely to have increased complications, specifically, fistulas and unplanned reoperations. A higher fistula rate was previously shown in patients with hypoalbuminemia.¹⁹ Consistent with our mNRI findings, albumin levels obtained either preoperatively or on the day of surgery correlate with increased complications and increased length of hospital stay. Because albumin levels typically decrease with intravenous fluid provision,⁴ we substituted postoperative day 0 albumin levels to calculate mNRI for patients who did not have preoperative laboratory values. This substitution in calculation would also therefore decrease the calculated mNRI nutritional status, thereby not unduly creating a greater nutritional status used in our exploratory model for complications. Our study is preexperimental and therefore limited by lack of power to make extrapolatable conclusions. Furthermore, the case-control cohort lacked nutritional laboratory assessment, rendering comparison to the pilot cohort impossible. However, we did find similar relationships between different markers of nutritional status, such as preoperative serum albumin level, and complications previously published. These findings led to the inclusion of nutrition intervention in the consensus recommendations from the

ERAS Society for perioperative care in major HNC surgery with free flap reconstruction.³

Quality improvement is an iterative process requiring reanalysis and subsequent adaptation to improve efficiency, eliminate waste, and continually improve patient care outcomes. Our ERAS nutrition protocol has evolved from our experience. The preoperative nutrition assessment can allow patient stratification where the patients identified at greatest risk of complications and increased length of stay undergo targeted interventions. Patients in our prospective cohort scheduled to undergo major head and neck surgery were 100% compliant with the 2-week ONS, which is profound for patient compliance. Subsequent albumin and prealbumin levels achieved by postoperative day 0 were within normal limits for our patients. Ideally, more than 2 weeks of preoperative nutrition optimization could improve upon the preoperative mNRI to which albumin level contributes that predicts risk for complications, but patients with cancer do not have the luxury of time. Implementation of preoperative nutrition education likely affects patient motivation to participate in care through ONS consumption. Throughout implementation of our ERAS nutrition protocol, greater participation and acceptance occurred among the various health care providers involved. This was especially pronounced in our multiple inpatient dietitians with postoperative discharge nutrition counseling. Postoperative nutrition laboratory values were not obtained since the outcome measure of complication was hypothesized to correlate with suboptimal nutrition level. We recognize that complications incurred may reflect additional factors such as surgical performance. We believe this potential bias was reduced by including only the same extirpative surgeon (L.J.) and the same reconstructive surgeon (G.D.J.).

Finally, our experience and findings resulted in protocol modifications to include fewer laboratory tests, eliminating postoperative day 4 laboratory values altogether since these values did not contribute to change in nutritional recommendations by the inpatient dietitian in comparison to the outpatient nutritional recommendations made. We have added hemoglobin A1C assessment since uncontrolled diabetes also adversely affects wound healing and contributes to malnutrition,²⁰ stratification of preoperative nutritional status to target intervention based upon *degree* of malnutrition, and earlier initiation of postoperative enteral nutrition to occur on the evening of postoperative day 0, as detailed in **Figure 3**.

The major limitation encountered in implementation of the ERAS nutrition component was not provider buy-in but rather actual remembrance by clinic providers ordering surgery to include the nutritional laboratory assessment. Despite email reminders and posting of the protocol in the resident physician lounge and clinic workroom, there was frequent failure to order the preoperative nutrition laboratory tests, for which only 56% of patients underwent this assessment. To improve upon this, we have incorporated the nutrition laboratory panel in the surgery order set. This triggers simultaneous assessment of nutritional laboratory status alongside anesthesia preoperative laboratory orders. We typically perform 100 complex head and neck surgeries annually, in which reconstructive

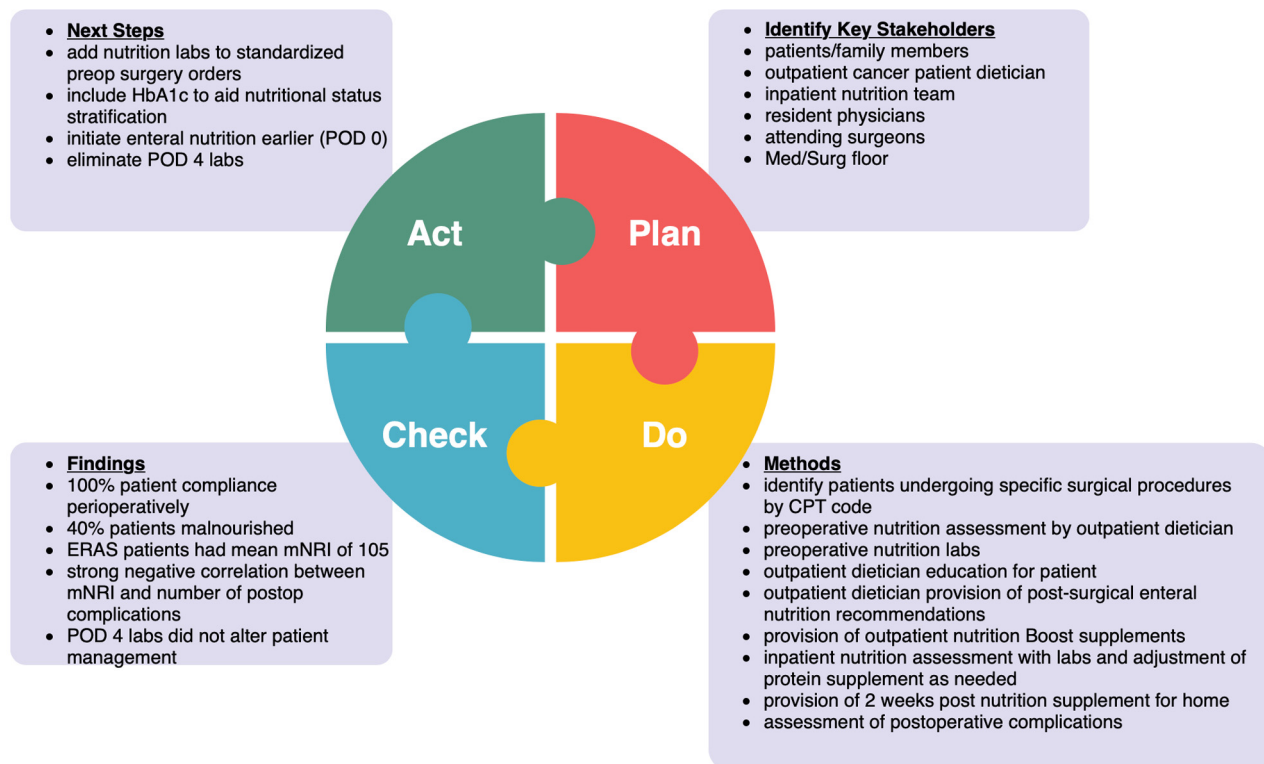


Figure 3. Plan-Do-Check-Act (PDCA) cycle for enhanced recovery after surgery (ERAS) implementation addressing malnourished patients with head and neck cancer. CPT, Current Procedural Terminology; mNRI, modified Nutrition-Related Index; POD, postoperative day.

flaps are employed. These patients have demonstrated eagerness to consult with our outpatient dietitian given their frequent preoperative dysphagia, associated weight loss, and decline in energy levels they report. We further believe that most patients undergoing our preoperative process for complex head and neck surgery are generally compliant with preoperative assessments because we try to perform all necessary imaging studies, consultations with dentistry, preoperative anesthesia, radiation oncology, medical oncology, and nutrition at 1 visit. These consultations are possible within the same building of the cancer institute. We anticipate the protocol modifications outlined will increase our understanding of the relationship of mNRI to complications and hospital length of stay. This will contribute to an even more informed preoperative discussion with our patients with HNC on the importance of optimizing nutrition.

Implications for Practice

Malnourished patients have higher rates of perioperative complications. ERAS nutrition protocols improve individualized patient-directed care and may decrease complications associated with health care costs. Quality improvement processes demand frequent reassessment and modification to ensure the most efficient and targeted approach to improving patient care.

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Author Contributions

Cindy Moore, conception/design of study, data acquisition, analysis, interpretation, manuscript drafting, final approval; **J'undra Pegues**, data acquisition, interpretation, manuscript drafting, final approval; **Vamsi Narisetty**, analysis, interpretation, manuscript drafting, final approval; **Christopher Spankovich**, interpretation, manuscript revision, final approval; **Lana Jackson**, conception/design of study, manuscript drafting, final approval; **Gina D. Jefferson**, conception/design of study, interpretation, manuscript drafting, final approval.

Disclosures

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