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Nutrition and Neurosurgery: Designing a Perioperative Pathway for Elective Spine Fusion Patients

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Abstract

Each additional hospital day related to a surgical complication costs an estimated $1,000 (Grusky et al., 2015). Due to the rising costs of healthcare, European professors designed Enhanced Recovery After Surgery pathways to mitigate potential adverse surgical outcomes and associated costs. A primary focus of these pathways emphasizes the importance of pre-procedure nutritional optimization. Literature increasingly supports malnutrition as an independent predictor of postoperative complications and increased length of stay (LOS) (Adogwa et al., 2014). The neurosurgical population has a wide variety of comorbidities that place them at increased risk for nutritional compromise. Thus, a perioperative nutrition pathway was implemented at a Midwest neurosurgery office for elective spinal fusion patients. The pathway incorporated twenty-nine (n=29) patients who were screened and provided with Ensure Pre-Surgery drinks preoperatively. Result yielded no statistically significant difference in hospital LOS or 30-day readmission rates among patients in the pathway and those in a historical comparison group. However, the pathway did highlight the importance of a standardized process to identify patients at risk of nutritional compromise. A total of three (n=3) patients received nutrition consults postoperatively due to screening answers and body mass index (BMI) results. Additionally, the pathway identified the need for future guidelines addressing diabetic preoperative clearance. Future recommendations from the pathway highlight the importance of a nutritional algorithm for diabetic patients, utilization of information technology and comprehensive nutritional screening tools.

Keywords: *nutrition, neurosurgery, enhanced recovery, diabetes*

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Appendices

Nutrition and Neurosurgery: Designing a Perioperative Pathway for Elective Spine Fusion Patients

Prior to any surgical intervention, it is crucial for patients to be nutritionally optimized to reduce postoperative complications. Postoperative complications can include pulmonary embolism, respiratory failure, urinary retention, poor glucose control, and ileus; these can lead to an increased length of stay (LOS), surgical site infections (SSI) and readmissions within thirty days of a procedure (Gruskay, Fu, Bohl, Webb, & Grauer, 2013). Complications not only harm the patient but are also detrimental to hospital reimbursement (Adogwa et al., 2016). In fact, recent data suggests that each additional day spent in the hospital related to a postoperative complication costs approximately $1,000 (Grusky et al., 2015).

In order to address the negative impact of postoperative complications, a group of European professors formed a collaborative group called the Enhanced Recovery After Surgery Society (ERAS). The mission of ERAS is to develop perioperative pathways that are centered on evidence-based interventions in order to improve both recovery time and population outcomes (ERAS, 2017). ERAS emphasizes a multimodal, evidence-based, interdisciplinary approach to perioperative care. One of the many focuses of ERAS pathways is optimizing preoperative nutritional status in order to negate the surgical stress response in patients undergoing elective surgical procedures.

Currently, ERAS pathways are well cited in the literature for elective colorectal procedures. These pathways have demonstrated shortened LOS, reduced readmission rates, and reduction in postoperative complications (Liang et al., 2018). Despite significant evidence supporting ERAS pathways, the current state of a spine surgery program at a Midwest health care system does not incorporate an evidence-based, multimodal ERAS pathway for Spine

Surgery, including a nutrition component. With over 700 surgeries performed annually by the neurosurgery team, it is imperative that the organization adapts ERAS perioperative nutritional interventions to improve outcomes.

In 2018, lumbar fusion procedures were the most common spinal surgery performed in the United States. It is estimated there are over 350,000 spinal fusions are performed annually (iData, 2018). Persons undergoing spinal fusion procedures often have significant comorbidities that place them at risk for nutritional compromise. Comorbidities include, but are not limited to: obesity, chronic pain, diabetes, poor functional mobility, and tobacco use disorder (Blumberg, Woelber, Bellabarba, Bransford & Spina, 2018). Therefore, as the rate of lumbar fusions is projected to increase, the need for ERAS pathways for this population is crucial for improving patient outcomes. According to the National Surgical Quality Improvement Program, preoperative malnutrition is one of the primary modifiable risk factors known to impact surgical outcomes (Wischmeyer et al., 2018). The neurosurgery office has identified the need to improve outcomes through a perioperative nutrition component embedded in an ERAS pathway. Therefore, the purpose of this project defense is to review results of an implemented perioperative nutrition pathway for elective spinal fusion patients.

A recent meta-analysis of randomized control trials (RCT's) utilizing ERAS pathways in colorectal procedures found that designed protocols reduce overall morbidity [relative ratio (RR) = 0.60, (95% CI 0.46-0.74)], shorten length of stay (LOS) by 2.28 days, and decrease overall readmission rates (Greco et al., 2014). Due to the success in improving patient outcomes, several other surgical specialties including urology, gynecology and orthopedics have begun to adopt ERAS protocols (ERAS, 2017). However, despite the numerous published benefits of ERAS

pathways, there is minimal research involving ERAS pathways in spinal surgery, thus indicating a current gap in literature.

Assessment of the Organizational

The Burke Litwin Causal Model of Organizational Performance and Change (1992) was utilized to perform an organizational assessment of a hospital-affiliated neurosurgery clinic (Appendix A). Special attention was given to perioperative nutrition screening measures, as this is not a current practice for this organization. Assessment included readiness for an institutional quality improvement project and an analysis of the strengths, weaknesses, opportunities and threats (SWOT) of the organization (Appendix B).

Burke and Litwin (1992) highlight twelve key transformational-transactional variables that influence organizational change. Utilizing the 12 transformational-transactional variables, assessment of the organization, including the neurosurgery clinic, was performed. The assessment yielded a wide variety of facilitators, as well as potential barriers, to a quality improvement initiative. One of the primary facilitators of organizational change is the external environment. The neurosurgery clinic is affiliated with a local Midwest physician network and hospital. This hospital is a member of the Michigan Spine Surgery Improvement Collaborative (MSSIC). MSSIC is a statewide spine surgery quality improvement initiative funded by Blood Cross Blood Shield (BCBS) insurance company. The studied organization is one of twenty-six hospitals across the state participating in this quality initiative. MSSIC utilizes a data registry to analyze patient data including demographics, surgical intervention, and patient outcomes. This registry allows surgeons and hospitals to compare clinical data to statewide outcomes, identifying opportunities for quality improvement. Recently, the organization was noted to be one of the top performing health care institutions within MSSIC. Additional facilitators include

the mission and strategy, culture, leadership, structure of care delivery, management systems, work unit climate, and individual and organization performance.

Identified barriers to initiating a quality improvement project included individual tasks and motivation. Clinic registered nurses (RNs) at the organization are tasked with a wide variety of administrative and nursing tasks; thus, leaving little time for active participation in quality improvement initiatives. In past initiatives, resistance to change by clinic nurses has been found. This resistance resulted in a lack of motivation for change processes within the organization. For the purpose of the quality improvement initiative, the nurses were key stakeholders in successful implementation. In regard to the perioperative pathway, staff motivation for change and current work demands did not pose a threat to successful implementation and evaluation.

Stakeholders

Key stakeholders are individuals who have an impact on the implementation and sustainment of the desired project (Moran, Burson & Conrad, 2017). Within the identified setting, key stakeholders included clinic RNs, physician assistants and neurosurgeons, as planned intervention(s) impacted their workflow and potential surgical candidates. Additional stakeholders included neuroscience administration, medical assistants, hospital employed dietitians, surgery schedulers, anesthesia providers, and most importantly, elective spinal fusion patients.

SWOT

Strengths, weaknesses, opportunities and threats (SWOT) analysis was performed at the Midwestern neurosurgery clinic; a member of the health care organization (Appendix B). Strengths of the neurosurgery clinic included was its recognition as a top leading MSSIC institution and recognized by this external group as an innovative force within spine surgery.

Strengths of the clinic were represented by relatively low levels of postoperative complications and high patient experience scores (Appendix C). Due to the Centers of Medicare and Medicaid's (CMS) reimbursement policies, improving care outcomes for elective surgical procedures can positively impact patient outcomes and organizational reimbursement. Implementing evidence-based perioperative nutritional screening measurements and interventions was an identified opportunity, allowing the organization to become a being a statewide competitor in spine surgery.

Weaknesses and threats inherent in this neurosurgery clinic included that many of the patients had co-morbidities, including obesity, which placed them at risk for nutritional compromise and postoperative complications. Findings from the literature increasingly support that preoperative nutrition status has a significant impact on postoperative outcomes, yet there was no required preoperative nutrition screening by the organization. A busy work environment, staff motivation, and lack of provider understanding for nutrition screening and established preoperative practices had potential to threaten the integration of a perioperative nutrition pathway. Another significant threat to the proposed pathway was that each clinical setting utilized a different electronic health record. Thus, making it difficult to streamline a new surgical process through utilization of health information technology.

Clinical Practice Question

Accordingly, an evidence-based project to answer the following clinical question was proposed: Does an evidence-based perioperative nutrition guideline improve care outcomes for elective spinal fusion patients?

Review of the Literature

Method

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline served as the framework for this review (Appendix D) (Moher, Liberati, Tetzlaff, Altman, & PRISMA Group, 2009). A comprehensive electronic search was conducted in CINHAL and PubMed. Literature was limited to reviews in the English language during the period of 2013 to 2018. Keywords were preoperative nutrition, spinal surgery, enhanced recovery after surgery, ERAS, and outcomes. In order to optimize search results, key words were listed with * (wild card) as well as modifiers including OR, AND. For example, ERAS AND nutrition AND spinal surgery were combined to yield population specific information.

The reviewed literature included persons 16 and older undergoing an elective surgical procedure. Exclusion criteria included persons undergoing emergency surgical repair, enteral and parental nutrition, or conditions that affected oral intake. Interventions that were reviewed included ERAS pathways and preoperative nutrition interventions. Comparison was made between the surgical standard of care and ERAS pathways. Outcomes reviewed included the impact of ERAS versus the standard of care on length of stay (LOS), surgical site infection (SSI), and hospital readmission. The search in CINHAL and PubMed yielded 36 articles. Each review was screened using inclusion and exclusion criteria according to PRISMA criteria (Moher et al., 2009) (Appendix D). Review of titles and abstracts resulted in removal of 26 articles that did not meet the inclusion criteria.

Summary of Results

A total of 7 articles met the inclusion criteria including a nutrition guideline, a randomized control trial (RCT), retrospective reviews, and a Cochrane review (Appendix E). The authors assessed different preoperative nutritional interventions and the impact on LOS and readmission rates. Postoperative complications were covered, as a broad category and therefore,

SSI could not be individually evaluated. Studies utilized different preoperative carbohydrate drinks administered at different intervals and volumes. Additionally, nutrition screening tools varied among studies.

Evidence Used for Project

A variety of outcome measures were analyzed. Studies reviewed the effectiveness of ERAS on LOS and readmission rates. LOS was considered as the days from surgery to discharge (Liang et al., 2018). Readmission rates in all of the studies were considered inpatient readmission within 30 days of an elective procedure (Liang et al., 2018). The Johns Hopkins Nursing Evidence Based Practice (JHNEBP) scale was utilized to analyze the strength and quality of the literature. The JHNEBP was also used to synthesize the results based on level of evidence. Several RCT's and meta-analysis of RCT's were reviewed, thus indicating a high level of clinical evidence. Retrospective studies and systematic reviews yielded significant results; however, these were graded as level IV evidence according to the JHNEBP.

Length of Stay. A primary outcome measurement in ERAS pathways was comparing LOS between persons receiving ERAS versus the standard of care. Much of the data surrounding LOS was performed in surgical specialities including colorectal and orthopedic procedures. Persons undergoing elective laparoscopic liver resection who followed the ERAS pathway had a significant decrease in LOS compared to the standard of care. LOS for ERAS patients was statistically significant with 6.2 $\pm$ 2.6 days in comparison to the standard of care which was 9.9 $\pm$ 5.9 days ($p < 0.001$) (Liang et al., 2018). A randomized pilot study performed in patients undergoing elective total hip arthroplasty (THA) demonstrated that the comparison group which received immune-nutrition preoperatively had a statistically significant decrease in LOS (3:6) (Alito & Aguilar-Nascimento, 2016). A meta-analysis of RCT's performed by Varadhan and

colleagues (2010), found that persons included in ERAS for elective colorectal surgery had decreased LOS in comparison to control groups. Results indicated that persons managed with the perioperative ERAS pathway had on average a decreased in LOS by 2.5 days (P <0.001).

A recent Cochrane review performed by Smith and colleagues (2014) found that persons who received preoperative carbohydrate loading had a decreased LOS in comparison to the placebo or standard fasting groups. Patients who received carbohydrate loading preoperatively were discharged on average between 0.04 – 0.56 days sooner than the comparison groups. Another strong predictor of LOS is the utilization of serum albumin levels. Serum albumin levels are often incorporated into nutrition screening to quantify nutritional risk. Blumberg and associates (2018) found a statistically significant correlation between serum albumin and LOS. For every decrease in serum albumin of 1g/dL, there was a 3.7 day increase in LOS. Conclusions from these studies emphasized the importance of preoperative nutritional status as a contributing factor to both LOS and 30-day readmission rates (Blumberg et al., 2018).

Readmission Rates. In a meta-analysis of six RCT's, performed by Varadhan and colleagues (2010), there was no statistically significant difference in 30-day readmission rates among persons receiving ERAS versus the standard of care. Results yielded a relative ratio of [0.80, (95% CI) (0.32, 1.98) p = 0.62)], demonstrating no clinical significance. Similarly, an RCT utilizing ERAS in laparoscopic liver resection found no statistically significant difference in readmission rates (6.9 vs. 8.2%; p=1.000). A pre and post difference study compared elective colorectal surgery patients to those undergoing GI surgery and hip fracture repairs with persons undergoing other orthopedic procedures. ERAS pathways implemented in elective colorectal (p=0.65) and hip fracture repairs (p=0.78) demonstrated no statistically significant difference in 30-day readmission rates to the control group. However, Adogwa and colleagues (2016)

analyzed preoperative albumin levels for patients undergoing elective spinal procedures. Findings reveled that persons deemed "malnourished" with an albumin level less than 3.5g/dL were at a three-fold increase of 30-day readmission (malnourished: 27.50%, nourished 9.52% (p=0.01).

Literature Review Conclusion. Findings of this review suggested that ERAS pathways that incorporated nutritional screening and interventions improved patient outcomes by reducing both LOS and 30-day readmission rates. ERAS pathways demonstrated significant benefits for elective surgical patients (Liang et al., 2018). Preoperatively, the ERAS emphasizes the importance of nutritional screening and intervention to surgically optimize patients (ERAS, 2017). One evidence-based tool is the Malnutrition Screening Tool (MST), which has been commonly utilized in clinical practice (Appendix F). The purpose of a screening tool was to identify patients at risk for nutritional compromise in order to optimize their nutrition prior to the operating room. Recommendations from the American Society of Enhanced Recovery emphasized that in addition to nutritional screening, persons deemed at nutritional risk should receive supplemental nutritional support. Recently, Abbott, a leading company in clinical nutrition, designed a preoperative shake called Ensure Pre-Surgery (Abbott, 2018). This drink contains fifty grams of carbohydrates and includes a wide variety of amino acids, antioxidants, and vitamins to optimize nutritional status. Initiating oral nutrition in patients who are identified at risk of nutritional compromise is one of the key concepts outlined in ERAS protocols. In conclusion, this review highlighted that preoperative malnutrition can significantly impact LOS and postoperative care for elective fusion patients. Thus, designing a perioperative nutrition pathway was an opportunity to improve care for elective spinal fusion patients.

Limitations

Several identifiable limitations to the literature review were identified. First, there were few randomized control trials. Additionally, much of the literature stemmed from surgical specialties other than spine surgery. Regarding nutrition, studies varied on nutritional screening and interventions preoperatively, thus making it difficult to distinguish concise recommendations on nutritional screening tools.

Phenomenon Conceptual Model

The conceptual model utilized to explain the phenomenon of perioperative nutrition optimization for this project was the Donabedian model (Appendix G). This model emphasized three key aspects: structure, process, and outcomes.

Donabedian (1988) defined structure as any component that contributes to the care at a specific setting. This included both human and material resources, as well as organizational structure. One of the primary components of material resources included financial allocations. Within the neuroscience department, specific funding was available for improvement of patient care or experience. After sharing the evidence, the Enhanced Recovery Spine Team, an interdisciplinary team, determined that preoperative care could be improved with the incorporation of nutritional screening and interventions. In addition to financial resources, the organizational structure of the neurosurgery clinic was crucial in evaluation of the ability to implement and sustain a quality improvement initiative. The organizational leadership rely on clinical support staff to manage daily patient care. A key responsibility of clinic RNs included ensuring required preoperative paperwork and patient education was completed prior to scheduling surgery. This structure of utilizing RNs scope of practice to implement preoperative nutrition screening was crucial to the success of the project.

Project Plan

Purpose of Project and Objectives

The overall goal of the quality improvement project was to improve care for elective spinal fusion patients. The aim of the quality improvement project was to design a perioperative nutritional pathway to improve key quality or patient care measures. The project aimed to answer: Does an evidence-based perioperative nutrition guideline improve care outcomes for elective spinal fusion patients? Improving care was determined by collecting data regarding the following sub-questions:

1. Did a perioperative nutrition pathway improve patient care as evidenced by an increase in staff knowledge surrounding surgical nutrition?
2. Did a perioperative nutrition pathway for elective spinal fusion patients improve patient care by reducing LOS?
3. Did a perioperative nutrition pathway for elective spinal fusion patients improve patient care by reducing 30-day hospital readmission?
4. Did utilizing an evidenced based nutrition-screening tool identify patients at risk for nutritional compromise?
5. Did staff adhere to the recommended nutritional pathway for elective spinal fusion patients?
6. Did patients adhere to the recommended nutrition interventions including utilization of Ensure Pre-Surgery Clear drinks?
7. Is a nutritional pathway for elective spinal fusion patients sustainable for the organization?

Design for the Evidence-based Initiative

The design for the evidence-based quality improvement project was based on the Plan, Do, Study, Act (PDSA) model (Appendix H). The Doctor of Nursing Practice (DNP) student carefully analyzed each step of the PDSA cycle to determine project relevance and appropriate quality improvement implementation strategies. Prior to beginning a quality improvement initiative within the organization, the DNP student submitted an institute review board (IRB) application to GVSU's Human Research Review Committee. Upon their approval as a quality improvement initiative, a formal IRB application was submitted to the organization for quality improvement exception. Project implementation did not begin until both institutions granted formal IRB approval.

Setting and Participants

The project took place at a Midwest health care system. The key stakeholders included an interdisciplinary team of neuroscience administration, medical assistants, registered nurses, physician assistants, and neurosurgeons. Additional staff participation included preoperative nurses, surgery schedulers, and a registered dietitian. Inclusion criteria included persons over the age of eighteen undergoing any level of elective lumbar fusion by one of any three employed neurosurgeons. Patients also had to be able to sign their own surgical consent to be included in the quality improvement initiative. Exclusion criteria included any emergency lumbar fusion, persons under the age of eighteen, pregnancy, and Type 1 or Type 2 diabetic patients.

Model Guiding Implementation: Plan, Do, Study Act

For the purpose of the project, the PDSA cycle was used to guide planning, implementation and evaluation of a perioperative nutrition pathway improved care for elective spinal fusion patients.

Plan

The project plan included designing and implementing a perioperative process change for patients undergoing elective spinal fusion procedures. The process change included the incorporation of an evidence-based nutritional pathway. Each step in the pathway was constructed to allow process and outcome metrics to be gathered and evaluated. The plan was divided by surgical phase: preoperative, day of surgery, and postoperative (Appendix I). Each step of the project was outlined under the Implementation Strategy of this document.

Do

The second portion of the PDSA cycle was implementation. Upon receiving IRB approval as a quality improvement initiative, implementation began with staff education. This was completed through a brief educational session for clinical staff. At this educational session, staff was provided with scripting to educate patients on the purpose of nutritional screening and the Ensure Pre-Surgery Clear drinks. Upon completion of the educational session, the go-live date was reviewed with staff. In addition to the clinic staff, pre-procedure nurses were given scripting information to inquire if the Ensure drinks were consumed as instructed. Detailed instructions were outlined for where the pre-procedure nurses were to chart drink compliance prior to surgery.

Study

Data included MST score, compliance to drinks and if the patient received a nutrition consult. Additional metrics of evaluation included quantitative data regarding LOS and 30-day hospital readmissions over a month span (Appendix K). A total of 29 spinal fusion patients were included in the perioperative nutrition pathway. To determine significance of the pathway, 29 patients from one-year prior were reviewed for comparison in demographic data. Demographic information included age, race, sex, and body mass index (Appendix L). The overall goal of

improving care for spinal fusion patients was determined by analysis of data gathered from each evaluation metric. Evaluation of pathway compliance, LOS and 30-day readmission rates were analyzed to determine significance. Descriptive statistics analyzed a significant portion of data; however, t-test statistical analysis was used to determine if a significant change in 30-day readmission rates and LOS occurred.

Act

Based on the data gathered, revisions to the pathway were recommended (see Implications for Practice). Outcome and process metrics were utilized to make future practice changes and revisions of the PDSA cycle.

Implementation Steps and Strategies

Objectives for this DNP project aimed to improve care for elective spinal fusion patients by implementing a nutritional pathway into the current standard of care. In order to ensure timely project management, a monthly timeline including all necessary project steps was followed (Appendix J). This timeline consisted of necessary meetings to ensure adequate time for implementation, data collection, analysis and final project defense. The project objectives with supporting implementation strategies included:

1. The DNP student provided education to both the Spine Team and Enhanced Recovery Team on a perioperative nutritional pathway on November 19, 2018. Educating key stakeholders, including neurosurgery providers, surrounding the evidence on malnutrition as a risk factor for postoperative complications was crucial in achieving provider "buy-in." Educational meetings allowed for formal presentation and feedback through open discussion. Steps to achieve this objective included:

- A formal educational luncheon was held November 19, 2018 for clinic staff, explicitly outlining steps for the intervention. Clinic staff were provided with scripting to educate patients on the purpose of nutritional screening and Ensure Pre-Surgery clear drinks. Feedback and questions were addressed by allowing open discussion. Conducting educational meetings and providing educational material to key stakeholders was identified as an important implementation strategy (Powell et al., 2015)
- Instructions were provided for elective spinal fusion patients. The instructional handout was written at a fifth-grade reading level and was included in an established spine surgery education binder (Appendix O)
- Additionally, a reference brochure of the perioperative pathway was provided to staff at the educational session. The brochure outlined the pathway, including the evidence behind each step (Appendix P)
- Pre-procedure nurses received an email outlining scripting to ask patients if they adhered to the recommended Ensure Pre-Surgery clear drinks. These instructions also included where the pre-procedure nurses were to document drink adherence in the electronic health record (Appendix Q)

2. The nutritional pathway was imbedded into practice for elective spine fusion patients as a standard practice on November 20, 2018. This pathway required modifications to the paper and EHR processes. Setting a timeline for project implementation provided a clear outline to allow sufficient time to gather relevant data. Steps to complete this objective included:

- Met with Enhanced Recovery team on November 19, 2018 to review implementation go-live date and address further questions
- Beginning December 10, 2018, the DNP student performed weekly chart audits with a goal to include a minimum of 30 elective spine fusion patients in the initiative
- The DNP student functioned as the project facilitator by being present at the clinic on the go-live date in order to assist staff with designed process change
- Beginning December 1, 2018, the DNP student performed weekly chart audits until a minimum of 30 elective spine fusion patients were included in the initiative

3. Gathering data through chart auditing allowed the DNP student to monitor, evaluate, and modify the project initiative (Powell et al., 2015). Data collected is best performed in real time in order to allow timely adjustment if needed. To achieve this objective, the following steps were performed:
    - Weekly chart audits were performed to gather key clinical data (Appendix K)
    - The DNP student collected and reviewed MST scores on a weekly basis to identify patients at risk for nutritional compromise
    - The DNP student placed nutrition consults for those deemed malnourished during their inpatient stay
    - The DNP student asked for informal feedback from clinical staff including clinic registered nurses, medical assistants, and physician assistants on a bi-weekly basis to identify barriers and facilitators for future pathway revision

- The DNP student sent monthly updates to interdisciplinary persons to provide feedback for different components of the pathway to promote continued compliance

4. The project final report was provided to the organization as well as the educational institute. The DNP student defended the project on April 4, 2019. Furthermore, the final copy of the defense was uploaded to Scholarworks. Refer to timeline in Appendix J.
    - Presented results to Enhanced Spine Team Meeting on April 17, 2019.
    - Presented results to Spine Team at monthly meeting April 24, 2019.
    - Posted final project results in neurosurgery office in April of 2019 which included the following:
        - Future recommendations for project revision

Measures & Data Collection Procedures

The DNP student conducting the project collected data on weekly intervals at the organization. Data elements that were collected are outlined in Appendix K. In addition, the DNP student followed a data-gathering plan to assist with data collection (Appendix M). Patient demographic data was obtained from the electronic health record (EHR). Instruments used in the project to provide essential data included the utilization of the MST (Appendix F).

Data Management & Analysis

In alignment with the organization's preferences, secured data was accessed at the organization through a password-protected computer. Patient data was logged in the online REDCap database. REDCap is a secure, HIPAA approved database designed to store patient data for the purpose of research and quality improvement. De-identified data was then extracted from REDCap and provided to the university statistician for analysis.

The proposed project only included quantitative data. Analysis of quantitative data was represented significantly by percentages and illustrated through visual graphs. Descriptive statistics were utilized to analyze data including patient demographics and compliance to pathway. Outcome data including LOS and 30-day readmission were analyzed utilizing t-test to demonstrate significance. Since this was a pilot project, gathered data was compared to the standard of care at the same time one-year prior.

Ethics and Protection of Human Subjects

Prior to implementation, possible ethical considerations for this project were reviewed. The DNP student submitted a project application to the organization's Institutional Review Board (IRB) and Grand Valley State University's Human Research Review Committee. Upon approval, the student proceeded with a quality improvement project.

The purpose of the project was limited to a quality improvement initiative among elective spinal fusion patients. Identifiable patient information was collected and secured in Redcap. Only de-identified data was presented to the organization and educational institution. All safeguards to protect patient health information aligned with regulations of the organization as well as the Health Insurance Portability and Accountability Act (HIPAA). Within the scope of a quality improvement project, there were no identified physical, social, economic or legal threats to patients included in the project. Participation in the project was voluntary and patients were provided education on the purpose. To ensure all components of the project aimed to protect patient information, members of the team including the DNP student completed the human subject's protection training through the Collaborative Institute Training Initiative (CITI). To ensure protection of participants, data was only accessed at the organization. Access to the electronic health record required a username and password. De-identified data was shared with

the university statistician via email for additional statistical analysis.

Resources & Budget

To facilitate project implementation considerations were made regarding human and financial resources. The human resources required for this project included a variety of interdisciplinary professionals including neurosurgery clinic staff, neuroscience administration, neurosurgery medical director, surgery schedulers, clinical nurse specialist, clinical nurse leader, and a registered dietitian.

Additional resources needed for this project included funding for Ensure Pre-Surgery drinks, which was allocated by means of neuroscience foundation dollars. Staff resources included utilization of clinic RNs and medical assistants to perform nutritional screening. Technology resources included utilizing the organization's (EHR), Powerchart and Athena, to upload the nutrition-screening tool.

Material resources included printed educational fliers for both the staff and patients. A printed Malnutrition Screening Tool (MST) to include in the pre-procedure work was also necessary. A visual budget was designed to assess proposed project costs (Appendix N).

Results

The project aimed to answer the following clinical question: "Does an evidence-based perioperative nutrition guideline improve care outcomes for elective spinal fusion patients?" The DNP student evaluated both process and outcome metrics to determine significance of pathway and implications for future practice.

Process Metrics

Donabedian (1988) emphasizes that structure, process and outcomes are key elements influencing organizational change. Incorporating a perioperative nutrition pathway into current

practice required *process* change in each clinical setting. The three clinical settings were individually analyzed to determine process compliance and barriers.

Pre-operative

In the neurosurgery office, thirty-nine elective spinal fusion patients were screened utilizing the MST tool. Screening was performed by office MAs and RNs. Of the thirty-nine screened, a total of twenty-nine (n=29) patients were included in the perioperative pathway. Ten patients were excluded in the final results due to time constraints, surgery cancellations and changed operative procedures. Through informal interviewing, staff disclosed that the MST was easy to complete, and the primary barrier was remembering which surgical patients were included in the initiative. Additionally, they disclosed that patients were highly receptive to the Ensure Pre-Surgery clear drinks. Patients eagerly took the bottles and education materials as a part of their preoperative surgical preparation.

Day of Procedure

The pre-procedure area was the primary area where the perioperative nutritional process was not consistently followed. The responsibility of nurses in this clinical area was to document patients "nothing by mouth" (NPO) status in the pre-procedure form per hospital policy (Appendix Q). Thus, for the perioperative pathway nurses in this setting were expected to identify the patient was a having an elective spinal fusion and additionally ask about the number of ensure drinks the patient consumed. Through extensive chart auditing, pre-procedure nurses were consistent in checking the box "NPO per policy," however discrepancies occurred among staff in documentation of how many ensure drinks were completed (0,1,2,3). Of the twenty-three (n=23) patient who received the Ensure Pre-Surgery drinks, thirteen of them (n=13) had some form of documentation about the drinks, the remaining ten (n=10), only had the "NPO per

policy" charted (Appendix R). The DNP student, functioning as the project facilitator, followed up with patients postoperatively who received the Ensure drinks. Several patients confidently responded they consumed all three Ensure Pre-Surgery drinks, however pre-procedure documentation failed to reflect their participation. Thus, patients who followed the preoperative instructions may not be captured in pathway due to fragmented pre-procedure documentation.

Postoperative

Of the 29 patients included in the perioperative nutrition pathway, one patient was identified at risk of malnutrition based on the MST completed in the pre-operative setting. After chart auditing, a total of three patients (n=3) in the intervention group received a nutrition consult. These consults relied on the DNP project facilitator to perform timely chart audits to ensure a nutrition consult was placed while the patient was admitted to the hospital unit.

Outcome Metrics

Although the overall purpose of the quality improvement initiative was to change a current surgical process, it is imperative to look at quality indicators including hospital length of stay and thirty-day readmissions. The pre-intervention group has an average hospital length of stay (LOS) of 3.52 days in comparison to 3.88 days in the post pathway group (Appendix S). The slight increase in LOS may be related to discharge planning needs, insurance authorization, surgical complications, or other extraneous factors. In regard to thirty-day readmission rates among the pre and post pathway group, there was no clinical difference. Thirty-day readmissions were defined as readmission to the hospital unit as an inpatient. Each of the groups had two patients (n=2) readmitted to the hospital within thirty days of a procedure. Reviewing key quality measures including hospital LOS and 30-day readmission are important to the organization as these outcomes affect reimbursement for care.

Missing Data

Of the thirty-nine patients that were screened and provided with the Ensure Pre-Surgery clear drinks, ten were not included in the data set as their surgery was scheduled outside the time constraints of this project. A small subset of patients (n=3) were missing charted body mass index (BMI). Through extensive chart auditing the DNP student observed that if obesity was listed as a medical problem, the BMI was documented. However, if obesity was *not* listed as an active medical problem, BMI charting was inconsistently performed by pre-procedure nurses. Another area of missing data regarded the "Adult Pre-Procedure" documentation. In the pre-intervention group a total of six (n =6) patients did not have a completed electronic pre-procedure form completed. Of the twenty-nine patients included in the intervention group only one patient was missing preoperative documentation. In regard to the MST tool, four (n=4) of the patients did not have the form completed. Patients that were diabetic were unable to receive the Ensure Pre-Surgery drinks due to carbohydrate content; therefore, it is possible that the four patients may have had the diagnosis of diabetes.

Limitations

Several identifiable limitations of the perioperative nutrition pathway have been identified. First and foremost, the DNP student functioned as the sole project facilitator. Project responsibilities included collecting hard copies of the MST each week, organizing patients into a surgery calendar to track when to audit patients and lastly placing nutrition consults for those deemed at nutritional risk. This is a significant limitation to the project because without the DNP student coordinating the nutrition pathway, the project will be difficult to sustain.

An additional limitation to the project is that the organization currently utilizes different electronic health records between the inpatient and outpatient settings. Due to the project

spanning the perioperative timeframe, there is a disruption in information from the outpatient to inpatient setting. Therefore, significant coordination of care by the student was required to ensure the process was followed in each surgical phase. Thus, it is important to consider how a seamless EHR between inpatient and outpatient settings could improve process compliance. Alerts incorporated into the EHR could prompt a nurse to complete screening, ask about Ensure Pre-Surgery drinks and generate a nutrition consultation. Utilizing health information technology will be imperative to future compliance and success of a nutritional pathway for elective spinal fusion patients.

Another limitation that potentially impacted project results included utilization of the Malnutrition Screening Tool (MST). Although this is an evidenced-based nutrition screening tool widely utilized in clinical practice, a limitation to the tool is its subjectivity. Nutritional risk is based on a person's responses to questions about weight loss and appetite. Although some answers can be strong indicators of malnourishment, these questions fail to include objective measurements. Measurements including body mass index would have been helpful in capturing additional patients at risk for malnourishment. A tool that took into account objective measurements including BMI, Hemoglobin A1c, and other pertinent lab values may capture more patients at nutritional risk. This means that for future sustainability, a more comprehensive screening tool should be utilized in order to identify a wider risk population.

Discussion

In review of the preceding data, it is essential to determine if the clinical question was answered. "Does an evidenced based nutrition pathway improve care outcomes for elective spinal fusion patients?" In order to answer this question, it is important to define *care outcomes*.

According to the Agency of Healthcare Research and Quality (AHRQ), health care quality outcomes include structural, process and outcome measurements. Structural measures include an organization's "systems and process designed to provide high quality care" (AHRQ, 2011, para. 1). The perioperative pathway relied heavily on the current structural processes of the organization in order to successfully integrate a new surgical process. Utilization of the EHR permitted for the MST to be a part of the patient's permanent medical record; allowing the DNP student to identify patients who required a nutrition follow up. Maximizing the use of current structural processes was demonstrated through utilization of licensed clinical staff completing the MST, required preoperative paperwork and appointments, and the EHR as means of communication.

In addition to structural measures, process measures include anything the provider or organization does to maintain or improve patient's health (AHRQ, 2011). Thus, process measures include evidence-based guidelines. As previously mentioned, the designed perioperative nutrition pathway aligns with evidence-based recommendations from both the Enhanced Recovery after Surgery (ERAS) Society and the American Society of Anesthesiologist (ASA). Integrating a nutrition pathway required changing the current surgical *process* in order to impact care outcomes for the designated population. Although there were no statistically significant changes in outcome measurements, successful implementation of a new surgical process was demonstrated through the inclusion of twenty-nine (n=29) elective spinal fusion patients in the perioperative nutrition pathway.

An additional strength of the perioperative nutrition pathway was the positive reception by both clinical staff and patients. Through informal interviewing patients found it "impressive" and "beneficial" that their nutrition was a key priority prior to surgical intervention. Patients also

had positive comments regarding about the Ensure Pre-Surgery strawberry clear drink. Staff feedback reinforced the ease of the MST screening and the positive reception of patients. These patient perceptions have potential to positively impact future *outcome* measures including patient satisfaction ratings.

Implications for Practice

The perioperative nutrition pathway was successfully implemented into the current surgical process for elective spinal fusion patients. Based on the discussion of results and limitations of the quality improvement initiative, there are several key implications for future practice and sustainability.

Population Recommendations

As outlined, Type 1 and 2 diabetics were excluded from receiving the ensure drinks due to the high carbohydrate content of each drink. Of the twenty-nine patients included in the pathway, six (n=6) had a diagnosis of diabetes Surgical recommendations for diabetic patients aim to ensure patients' blood sugar levels are optimally controlled. Surgery creates a metabolic stress response that can often lead to wide fluctuations in blood sugar levels. High blood sugars slow wound healing by impairing necessary blood flow to the surgical incision site (Collins & Tobia, 2010). Hemoglobin A1c measurements are commonly performed on diabetic patients to determine diabetes control. A recent study published by Underwood and colleagues (2014) emphasized that persons with an A1c >8% preoperatively had longer hospital LOS then those with an A1c below 8%. Additionally, researchers at Florida State University College of Medicine created a diabetic surgical algorithm. Suggestions include analyzing the risk/benefit ratio in patients who have an A1c between 7-8.5%. Additionally, researchers recommend that

when surgery is not medically urgent/emergent, persons with a HbA1c greater than 8.5% should have elective procedures postponed in order to optimize diabetes management.

Of the six diabetic patients incorporated in the pathway, only four (n=4) had a hemoglobin A1c taken within three months of the surgery date. Hemoglobin A1c results ranged from 6.1% to 9.8% among the pathway group. In the pre-intervention group, preoperative A1c measurements ranged from 6.9% to 10.4%. These results indicate that surgery is performed on diabetic patients who are not optimally controlled. In order to improve patient outcomes, it is crucial that the Midwest neurosurgery office have a formal process for ensuring diabetic patients are meeting A1c requirements prior to elective intervention. Thus, based on clinical guidelines, the DNP student designed a diabetes algorithm to assist the clinic in carefully identifying and optimizing diabetic patients prior to surgical intervention (Appendix U). This algorithm outlines that the neurosurgery provider and physician assistant must assume *ultimate* responsibility to determine if the A1c level has been completed prior to surgery. However, delegation to clinical staff including RNs and MAs to coordinate care with the patient's primary care provider (PCP) is a useful approach. Ultimately, surgery should not be scheduled until the hemoglobin A1c lab is completed and within a therapeutic range. If hemoglobin A1c is not within recommended surgical guidelines (<8.5%) the patient should be referred back to PCP for additional management.

Health Information Technology

One of the primary factors affecting future sustainability of the perioperative nutrition pathway relies on the utilization of health information technology. The current noncommunicating EHR systems required the DNP student to spend significant time ensuring there was a seamless transition of information between clinical settings. Without a project

facilitator consistently performing chart audits, the perioperative pathway will be difficult to sustain. In the upcoming months, the organization will be transitioning to a single, integrated EHR system that allows communication between outpatient and inpatient settings. In order to continue the perioperative pathway, it is essential that the nutrition pathway is built into the new EHR. Currently, much of surgery scheduling is performed on paper; requiring the clinic secretary to upload all documents into both inpatient and outpatient electronic health records. In order to streamline a perioperative nutrition pathway, it will be imperative to transition preoperative paperwork to electronic forms. In the integrated EHR, alerts can immediately notify the RN that the patient should be screened for nutritional risk based on anticipated surgical intervention or entered objective measurements. The electronic form is a tool to alert the RN from continuing until the nutrition screening is performed. If the patient is deemed "malnourished" by the screening tool, an immediate consult can be placed for a postoperative nutrition follow up. Building a perioperative nutrition pathway into the upcoming EHR would positively impact the sustainability of the project.

Nutrition Screening Tool

Although the MST tool is widely utilized in clinical practice, it fails to incorporate objective measurements that may identify patients at risk of nutritional compromise. Future practice recommendations include utilizing a more comprehensive nutrition screening tool. The "Mini-Nutritional Assessment" (MNA), one of the organization's approved screening tools, incorporates objective measurements including BMI which would be useful in identifying additional patients at risk (Appendix T). The American Cancer Society (ACS) identifies persons with a BMI less than 18.5 as "underweight." This may imply the patient has poor nutritional

intake and would benefit from nutritional interventions. Contrary, persons with a BMI over 30 are classified as "obese." These patients would also benefit from nutritional screening, education and interventions to optimize nutritional status preoperatively. The MNA incorporates measurements including BMI to score nutritional risk ranging from 0-14. Persons scoring 0-7 are deemed "malnourished." Those between 8-11 are classified as "at risk." Lastly, those scoring between 12 and 14 have a normal nutritional status. Therefore, if the MNA was incorporated into preoperative surgical paperwork, persons deemed "at risk" or "malnourished" would automatically receive a postoperative consult. Clinic RNs would be responsible for completing the screening in the preoperative setting during surgery scheduling.

Nutritional Interventions

Nutritional interventions utilized in the perioperative nutrition pathway included Abbott's Ensure Pre-Surgery clear drink. This drink contained a wide variety of carbohydrates, vitamins, and antioxidants to help reduce the surgical stress response. Carbohydrates are important in reducing the surgical stress response by reducing the fasting period prior to surgery. Patients included in the pathway were given detailed instructions about the contents of the beverage as well as presurgical instructions on when to consume (Appendix O). There was a significant amount of positive patient feedback about the Ensure Pre-Surgery drinks. Although it is difficult to measure if the drinks impacted outcome measures (LOS, 30-day readmission rates) it certainly has the potential to impact patient satisfaction ratings. As the healthcare system transitions to value-based care, offering *free* nutritional interventions including the Ensure Pre-Surgery clear drink to may impact both patients' surgical stress response and perception of care. These drinks cost approximately $3.00 a bottle. Abbott recommends at least three beverages prior to planned

surgery. Thus, each patient requiring the drinks would cost the organization approximately $9.00. However, positive patient satisfaction ratings could potentially offset this cost in value-based healthcare reimbursement.

Conclusion

In conclusion, the National Surgical Quality Improvement Program emphasizes that preoperative malnutrition is a primary modifiable risk factor known to impact surgical outcomes (Wischmeyer et al., 2018). An evidence-based nutrition pathway is a evidence-based solution proposed by the ERAS society to identify and intervene for patients prior to the operating room. The designed perioperative pathway utilized the organization's current structure and surgical process to embed a nutrition pathway for elective spinal fusion patients. Ultimately, twenty-nine (n=29) patients were successfully incorporated into the perioperative pathway. Three patients (n=3) received a nutrition consult postoperatively due to their MST results or BMI status. Future recommendations include repeating the Plan, Do, Study, Act (PDSA) cycle to include a more comprehensive screening tool, health information technology and a diabetes algorithm for surgical care. The aim is that through future revisions of the pathway, the organization will realize patients nutritionally optimized prior to surgery and continued improvement in key quality measures including LOS and 30-day readmissions.

Dissemination of Results

Results of the perioperative nutrition pathway were disseminated to key stakeholders in a variety of formats. Project results were presented to both the organization's Neurosurgery Spine team as well as the interdisciplinary Enhanced Recovery Spine team. Additionally, community members including organizational leadership were invited to the DNP project defense at Grand

Valley State University. Results including the diabetes algorithm were posted in the neurosurgery office as a reference for future clinical practice. Lastly, the DNP student has been invited to present results of the perioperative nutritional pathway at a breakout session for the organizations' annual neuro-symposium conference fall of 2019.

Reflection on DNP Essentials

The American Association of Colleges of Nursing (AACN) (2006) outlines eight Essentials that are the core competencies of practice for a DNP prepared Advanced Practice Registered Nurse (APRN). These eight Essentials must be addressed throughout the doctoral curriculum through both project work and other local health forums.

Essential I: Scientific Underpinnings for Practice. The doctoral project required the DNP student to assess a clinical phenomenon that required change. The designed perioperative nutrition pathway required the DNP student to incorporate nursing science to improve health care delivery and optimize patient outcomes.

Essential II: Organizational and Systems Leadership for Quality Improvement and Systems Thinking. The DNP student achieved this Essential through developing an evidenced based nutrition pathway to improve patient care. This required an in-depth organizational assessment to determine barriers and facilitators to organizational change.

Essential III: Clinical Scholarship and Analytical Methods for Evidenced Based Practice. This Essential was achieved through an in-depth review to identify evidence-based literature to support the proposed nutritional pathway. This required the DNP student to rank literature based on clinical significance and then design interventions based on current clinical knowledge of the phenomenon.

Essential IV: Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care. Utilization of health information technology was a key component of successful implementation of the perioperative nutrition pathway. The DNP student utilized the electronic health record to gather data to support the need for clinical change.

Essential V: Health Care Policy for Advocacy in Health Care. The DNP student was actively involved in health care policy initiatives both at the organizational and state level. Organizational advocacy occurred through the doctoral project work. State level advocacy was achieved through attending the Michigan Counsel for Nurse Practitioners advocacy day at the state capital.

Essential VI: Interprofessional Collaboration for Improving Patient and Population Health Outcomes. The DNP student was actively involved in two different interdisciplinary organizational teams that included neurosurgeons, mid-level providers, neuroscience leadership, clinic RNs and a registered dietitian. These teams identified areas for clinical improvement to improve population health outcomes for neurosurgical patients.

Essential VII: Clinical Prevention and Population Health for Improving the Nation's Health. The DNP student designed a perioperative nutrition pathway to promote optimal health prior to surgical intervention. Evaluation of the organization's ability to implement the proposed pathway was crucial in promoting health and minimizing risk to the identified patient population.

Essential VIII: Advanced Nursing Practice. The DNP student achieved this objective through utilizing APRN skills including assessment, diagnosis and treatment planning. These skills allowed the DNP to formulate a treatment plan for a specific population as well as monitor outcomes throughout the project work.

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Appendix A

Burke-Litwin Model of Organizational Performance and Change

Figure 1. A model of organizational performance and change. Reprinted from "A Causal Model of Organizational Performance and Change." By W.W Burke and G.H Litwin, 1992, *Journal of Management, 18*(3), 528. Copyright 1992 by Southern Management Association

Appendix B

SWOT Analysis of West Michigan Neurosurgery Clinic

Strengths	**Weaknesses**
• Top performing organization in spine surgery per MSSIC metrics • Established program • Experienced staff • Surgeons are employed by the organization and not contracted • Required preoperative clearance paperwork • Positive outpatient experience outcomes • Over 700 surgeries performed annually	• Significant untreated patient comorbidities • Poor understanding of nutritional screening by providers • Busy work environment • Applicability for all patients • Limited literature regarding neurosurgical patients and preoperative nutrition optimization. • Wide variety of screening tools • Variation in clinical practice between surgeons and clinical teams in same practice • Lack of interoperability of the electronic health record
Opportunities	**Threats**
• Currently no nutritional screening measure in place. • MSSIC leader • CMS reimbursement opportunities • Reduction in postoperative complications including LOS and 30-day hospital readmission	• Surgeon buy-in • Nursing to adherence to screening • Information dissemination • Busy clinic environment • Organizations pre-approved nutritional screening • Lack of literature about nutrition and neurosurgical patients • Cost of drink • Adherence by patients

*Figure1.*SWOT Analysis of Midwest neurosurgery clinic

Appendix C

Current Spine Surgery Metrics

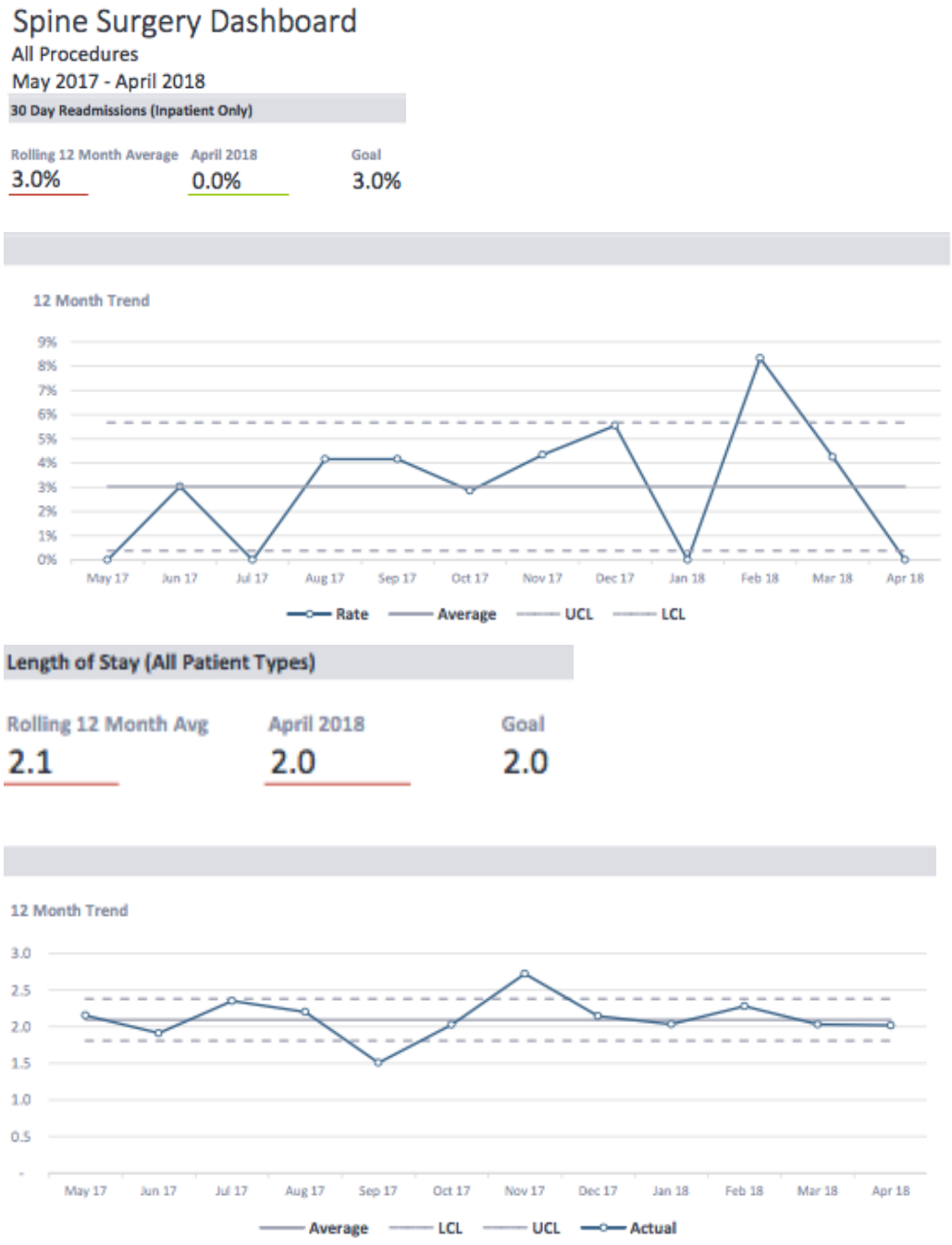


Figure 1. Spine Surgery Dashboard.

Appendix D

PRISMA Diagram

PRISMA 2009 Flow Diagram

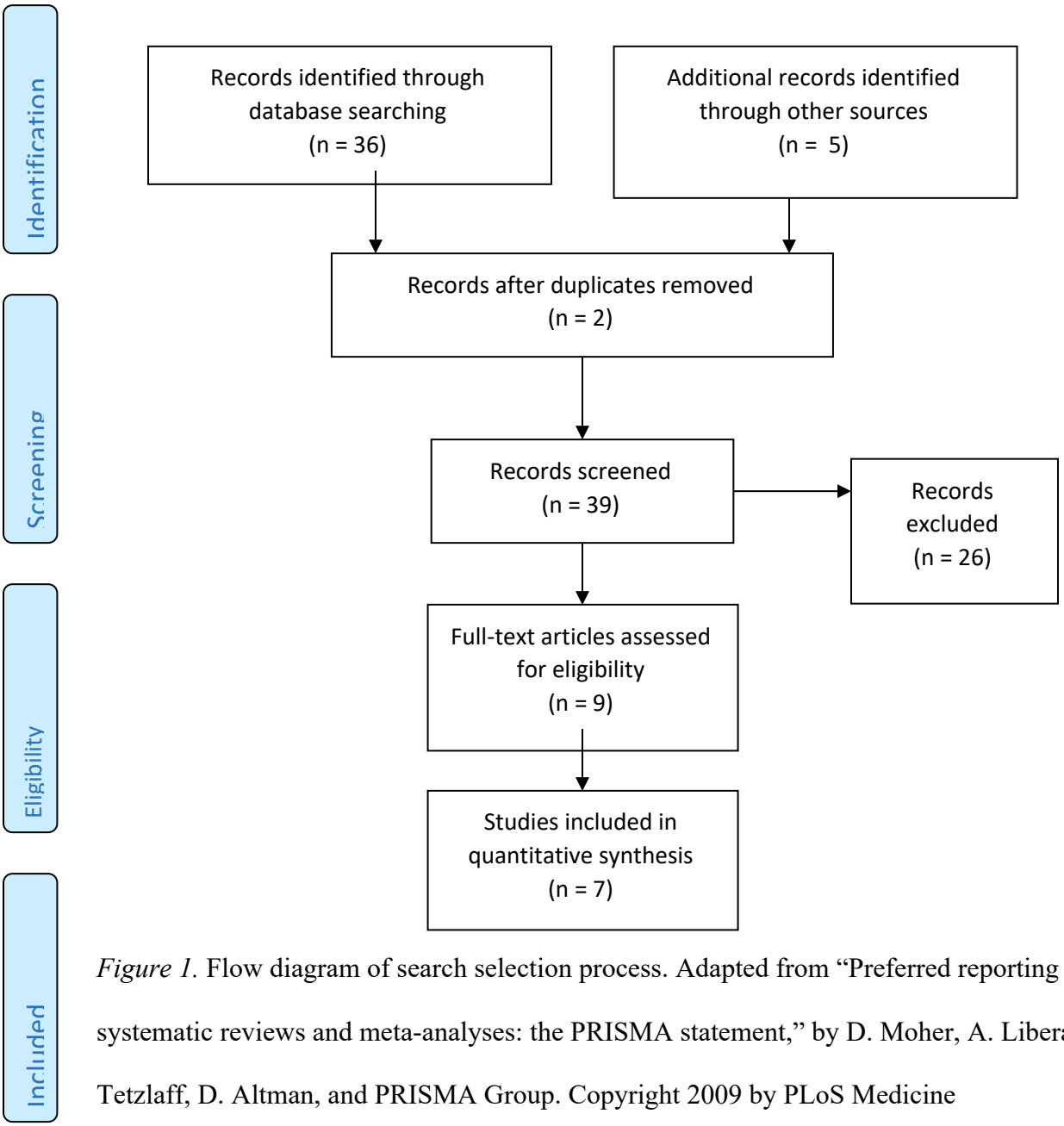


Figure 1. Flow diagram of search selection process. Adapted from "Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement," by D. Moher, A. Liberati, J. Tetzlaff, D. Altman, and PRISMA Group. Copyright 2009 by PLoS Medicine

Appendix E

Literature Review

Author (Year) Purpose	Design (N)	Inclusion Criteria	Intervention vs Comparison	Results	Conclusion
Adogwa et al., 2016 Objective: Investigate whether preoperative nutrition is an independent risk factor for unplanned 30-day readmission after elective spine surgery.	Retrospective Cohort Review	n=145 patients n=105 (nourished) n=40 (malnourished) 145 medical records were reviewed for adult patients undergoing elective spine surgery at a major academic medical center from 2008-2010.	No intervention performed n= 105 (nourished patients) with a preoperative serum albumin >3.5g/dL had significantly better post operative results (see results section) n=40 (malnourished patients) with a preoperative serum albumin <3.5 had higher rates of complications including readmission (see results)	There were no statistically significant results ($p<0.05$) between the groups in comparing age, BMI, or comorbidities including diabetes, COPD, CAD, PVD, AFib, and smoking status Unplanned 30-day readmission rates: nourished patients 9.52% Malnourished having a 27.52% (P=0.02). LOS: Nourished: 3.80+4.13 days Malnourished: 8.67+9.48 days (P=0.01) No differences in incidence of deep/ superficial SSI, PE, Cardio arrest.	Preoperative malnutrition is an independent risk factor for readmission within 30 days of discharge after elective spine surgery
Alito, M. A., & de Aguilar-Nascimento, J. E. (2016).	Randomized pilot study	n=32 patients ages 18-80 undergoing elective THA secondary to osteoarthritis	N= 15 immuno-nutrition group 5 days (200ml) preoperative + 2hr carb drink N= 17 control group, neither.	The median LOS was 3 days in the experimental group and 6 days in control group ($p<0.001$)	Preoperative prophylactic immune-nutrition can reduce LOS in patients undergoing THA
Blumberg et. al. 2018	Retrospective cohort study -	n=90 all persons undergoing spine surgery over a 3 year span Inclusion: prior admission for spine surgery with	No intervention was performed.	Review of patient data including age, gender, weight, BMI, payer status, CRP, ESR, WBC, albumin, LOS, time between operation and readmission, details of original operation including site, indication and levels of	Evaluation preoperatively may assist in optimizing modifiable risk factors and therefore reduce LOS and SSI.

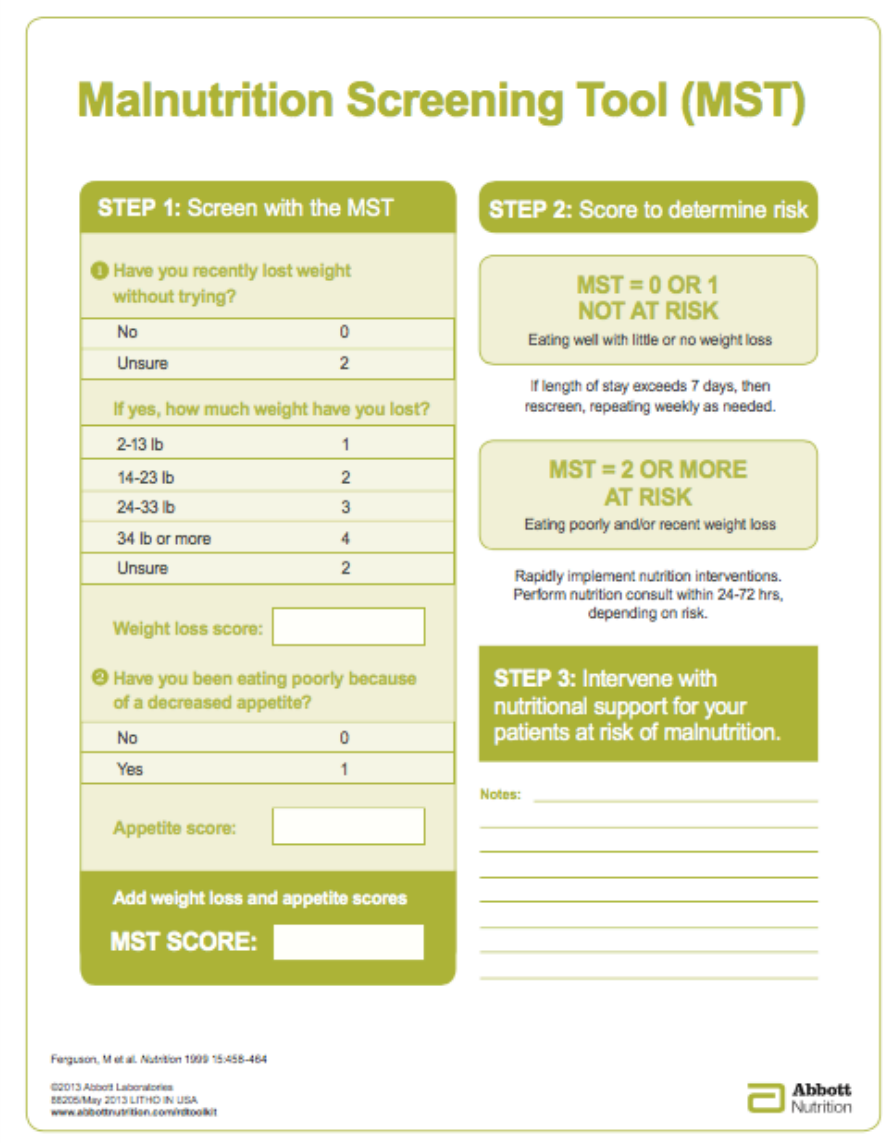
		discharge from the hospital and return to the OR for tx. Of postop SSI.		fusion, and invasiveness score. 3,101 surgeries were performed, 146 returned with an SSI. 73 readmissions occurred within 30 days LOS and serum albumin was statistically significant for readmission within 30 days. Each decrease in serum albumin was associated with a $8,081 increase in costs and 3.7 increase in LOS	
Gruskay et al (2015) To gather an understanding of the variables affecting LOS for elective posterior lumbar spine surgery	Retrospective case series at a tertiary care center	N=103 undergoing elective 1-3 posterior lumbar instrumented fusion (w or w/o decompression) from January 2010 to June 2012. n= 81 (LOS 4 days or less) n=22 (LOS 5 days or more) Exclusion criteria: combined anterior/posterior approach, minimally invasive techniques, patient requiring more than 3 levels of instrumentation, and trauma cases.	No intervention was performed for this study	Results yielded that the only statistically significant preoperative variables that affected LOS included age (p=.038) and ASA score (P =.001). Postoperative complications included anemia, MS, pneumonia, and hardware complications were found to increase LOS. LOS for patients with a postoperative complication was 5.1+2.3 vs 2.9+0.9 for patients with no complications.	Several patient factors including age, ASA score, history of heart disease, discharge to a SAR, were all associated with increased LOS. Although some of these factors can potentially be modified, it is unclear as too how much would impact the LOS
Lui et al., 2017	Original study- pre and post differences study to compare changes in practices and	n= 3768 patients undergoing elective colorectal resection (ERAS) n=5556 comparative group undergoing	ERAS protocols were implemented in perioperative pain, mobility, nutrition and patient engagement.	ERAS implementation had better scores for ambulation, nutrition, and opioid use postoperative complications were 0.68 (95% CI, 0.46-0.99; *P* = .04) for patients undergoing colorectal	ERAS programs implemented across 20 hospitals significantly improved key metrics including hospital LOS and

	outcomes between targer and comparator groups	elective GI surgery n=5002 emergency hip fx. Repair (ERAS) n=1523 undergoing orthopedic surgery (control group)	Pre and post studies were gathered.	resection and 0.67 (95% CI, 0.45-0.99, *P* = .05) for patients with hip fracture. decreased rates of hospital mortality (0.17; 95% CI, 0.03-0.86; *P* = .03), whereas among patients with hip fracture, implementation was associated with increased rates of home discharge (1.24; 95% CI, 1.06-1.44; *P* = .007).	surgical complication rates among persons with elective colorectal resection and emergency hip fx.
Liang et al., 2017	RCT single blind trial. laparoscopic liver resection	n=119 n= 58 persons in ERAS n= 61 in traditional Exclusion: 1) pregnant or lactating women; (2) unwillingness to participate; (3) inability to give written informed consent; (4)	Preoperative Nutrition: Traditional group – NPO 8 hours before surgery. ERAS: 400ml oral carb drink 2h before surgery. ERAS patients met with nutritionist and were given a nutrition support based on their NRS 2002 score	Primary outcome measures included LOS. Secondary outcome measures – complications from the CCI index, hospital costs, visual analog scale and thirty day readmissions. LOS was Significantly reduced in ERAS group (6.2 ± 2.6 days vs. 9.9 ± 5.9 days; p< 0.001) More than a quarter of patients (16/58) discharged by POD 3 in ERAS group and most patients (49/58) by POD 7. In traditional care group, only three patients discharged on POD 3 and less than half(23/61) by POD 7 Number of patients with complications was significantly reduced in ERAS group (21 vs. 34;p= 0.033). Comprehensive Complication Index (CCI). Patients in ERAS group had less CCI score (7.2± 12.3 vs. 12.9 ± 15.3;p= 0.028)	Patient undergoing ERAS pathways for laproscopic liver resection had less pain, complications and shorter hospital stays.
Smith et al., 2014	Cochrane Review	27 control trials n= 1976 participants	Patients either received the 12.5g/100ml	In 19 of the 27 studies, results yielded that mean LOS for patients receiving	LOS can be decreased by carbohydrate

		undergoing elective surgical procedures of the abdomen, bones/joints, heart and thyroid.	Carbohydrate drink 2 hrs preoperatively, standard fasting or a placebo	preoperative carbohydrate drink was 0.04-0.56 days shorter than the placebo or standard fasting	optimization, however no impact on readmission rat
Wainwright et al., (2016) Examines the relevance of applying Enhanced Recovery After Surgery (ERAS) approach to patients undergoing major spinal surgery	Narrative Review	111 potentially relevant articles were initially identified, narrowed down to 15 for relevance Major spinal surgery was defined as a complex fusion and decompression	No intervention was performed for this study	<u>Neurosurgery</u> ERAS reduced length of stay by 4.7 days in patient undergoing spinal surgery (Fleege, et al) Of 37 patients undergoing spinal reconstructive surgery, 87% of them became malnourished during their hospital stay, additionally they had longer LOS (Mandelbaum et al)	ERAS has been successfully implemented in other surgical specialties including colorectal and orthopedics, ERAS pathways would benefit spinal surgery patients due to the chronicity of their pain and the complexity of spinal surgery.
Yeung et al., 2017	Prospective Cohort Study	Consecutive convenience sampling Inclusion: colorectal surgery Exclusion: inability to accurately record PO intake, comborbidities that interfered with intake, enteral/parenteral nutrition	n=115 n=46 conventional care n=69 ERAS care Data collected included preoperative Malnutrition Screening Tool (MST) score, 3-d food records, postoperative nausea, LOS, and complications	Total protein intake was significant higher in ERAS group due to preoperative oral nutrition The ERAS group had shorter LOS (P= 0.049) and fewer total infectious complications (P= 0.01) Each unit increase in preoperative MST score predicted longer LOSs of 2.5 d (95% CI: 1.5, 3.5 d;P,0.001)	ERAS patients consumed more protein due to the inclusion of oral nutrition supplements.

Appendix F

Malnutrition Screening Tool



Abbott (2018). *Malnutrition screening tool.*

Retrieved from: https://abbottnutrition.com/ensure-surgery

Appendix G

Donabedian Quality Framework

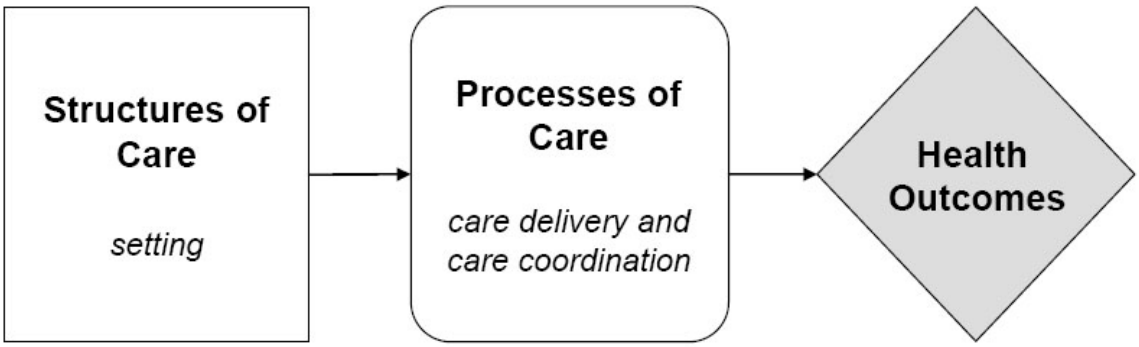


Figure 1. Donabedian, A. (1988). The quality of care how can it be assessed? *Journal of the American Medical Association.* doi:10.1001/jama.1988.03410120089033

Appendix H

Plan, Do, Study, Act Implementation Model

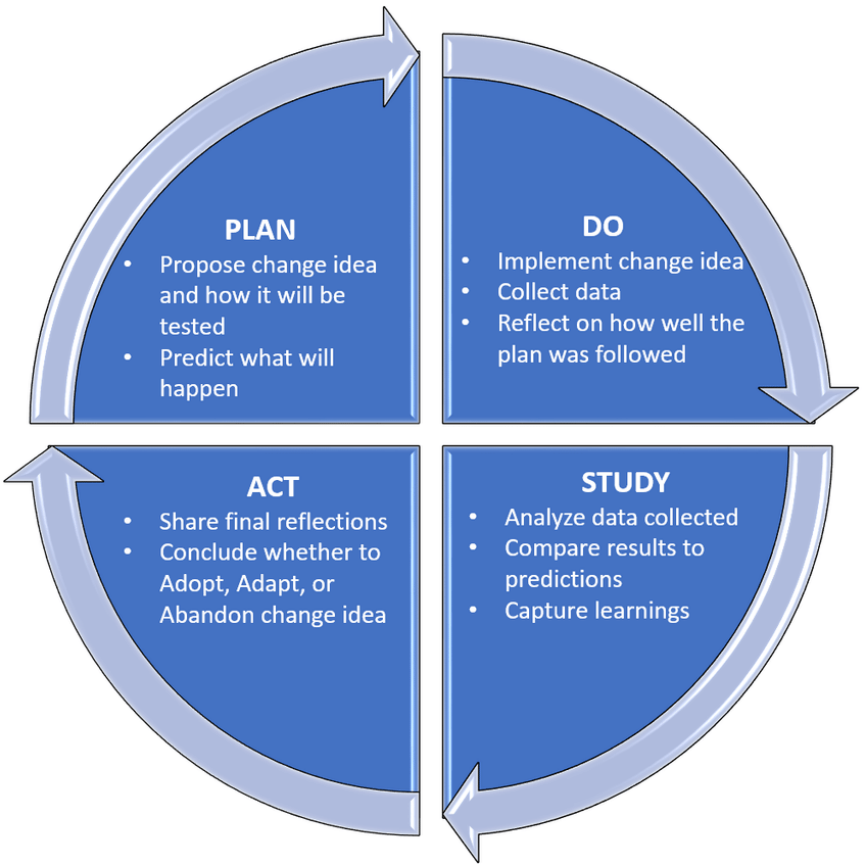
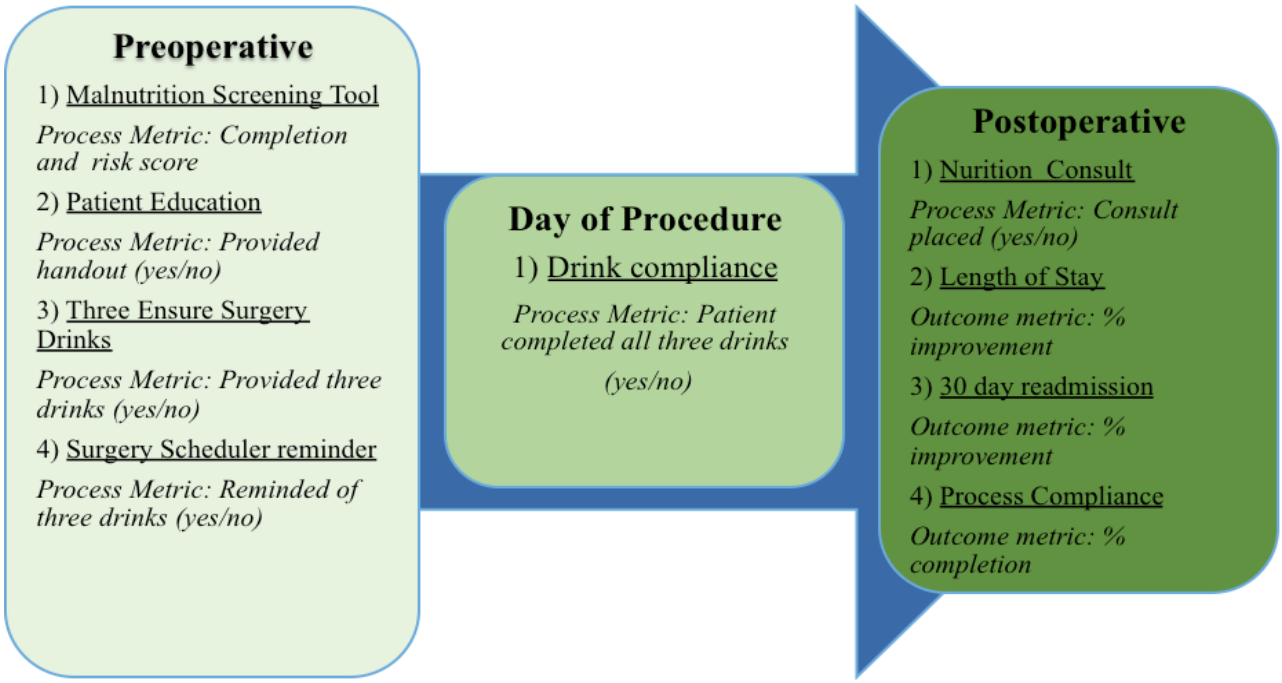


Figure 1. Agency for Healthcare Research and Quality. (2018). *PDSA cycle*. Retrieved from: https://innovations.ahrq.gov/qualitytools/plan-do-study-act-pdsa-cycle

Appendix I

Perioperative Nutrition Pathway



Appendix J

Monthly Project Timeline

October	November	December	January	February	March
Proposal 10/30	IRB approval	Go live 12/10	Continue weekly audits	Complete data collection	Defend project
IRB Application	Staff Education Luncheon	Start weekly Auditing	Data collection	Write project defense	Submit to scholar works
Enhanced Recovery Meeting(s)	Set Go live date	Enhanced Recovery Meeting(s)	Enhanced Recovery Meeting(s)	Enhanced Recovery Meeting(s)	Enhanced Recovery Meeting(s)
Spine team meeting	Spine team meeting	Spine team meeting	Spine team meeting	Spine team meeting	Spine team meeting

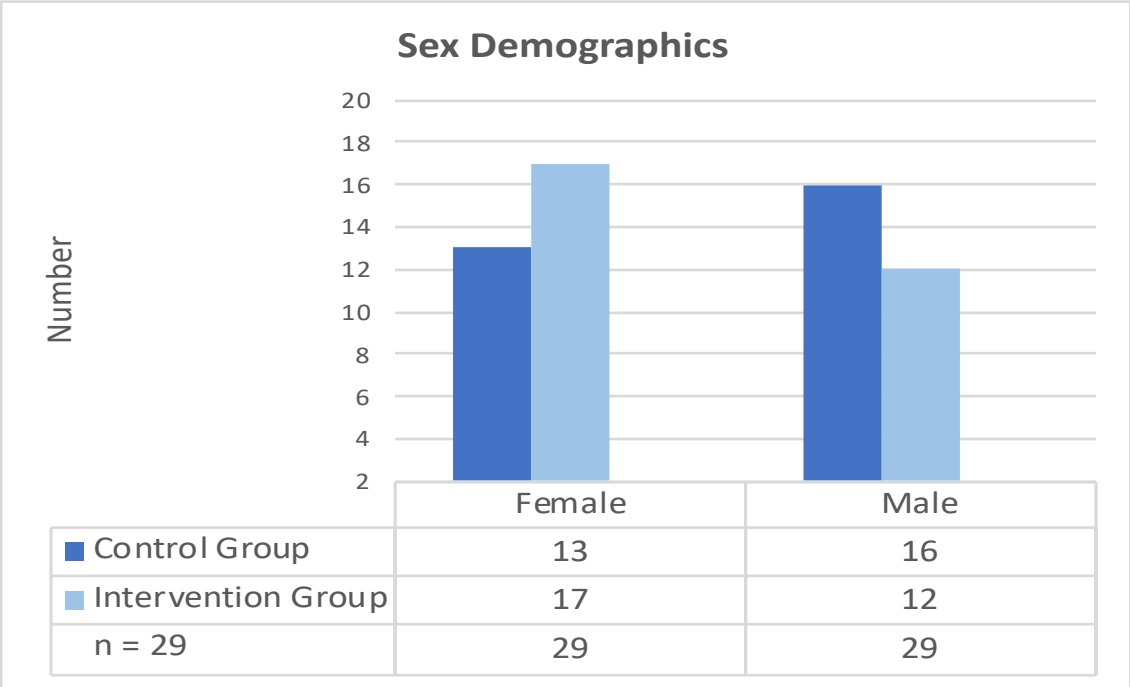
Appendix K

Excel Codebook for Data Collection

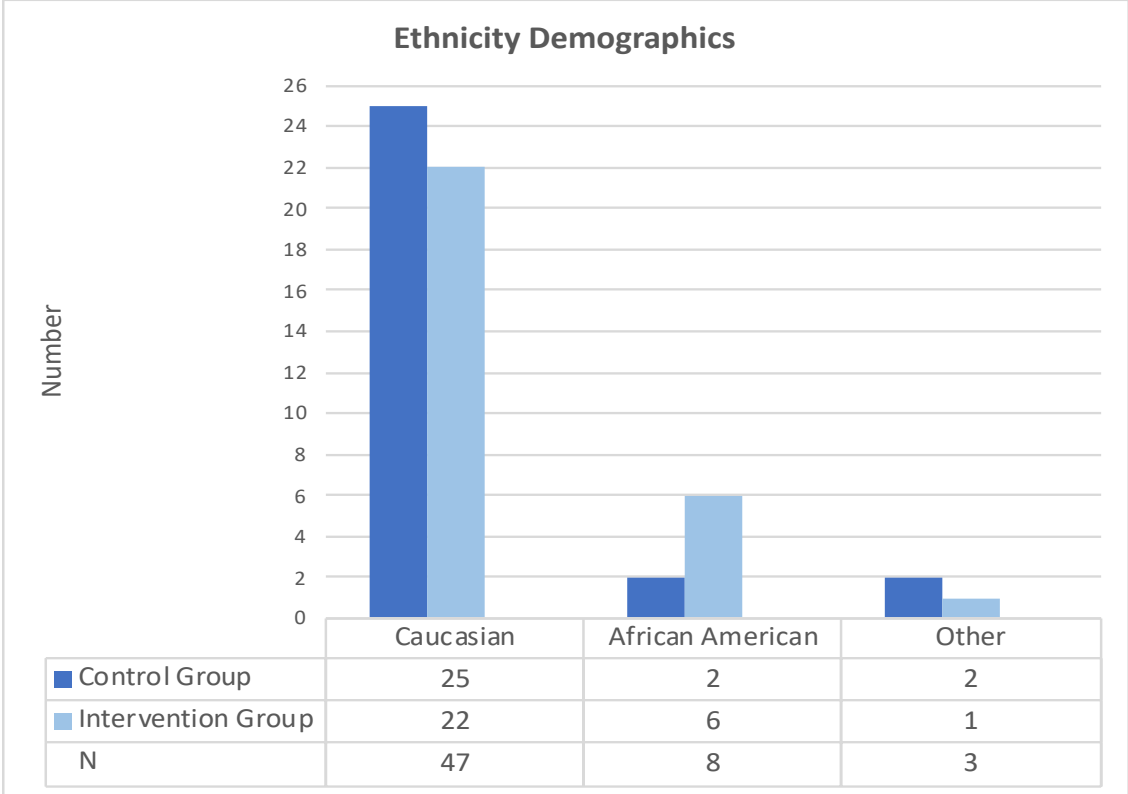
SAS Descriptor Code	SAS Descriptor Code	Data Description	Type of Data
Age	Age in Years	Discrete: Collected through Chart audit	Quantitative
Gender	1= female 2= male	Collected through Chart audit	Quantitative
Race	1= Caucasian 2= African American 3= Other	Collected through Chart audit	Quantitative
BMI	number	Numerical: Collected through Chart audit	Quantitative
Diabetes_II	0=no 1=yes	Collected through Chart audit	Quantitative
A1C	number	Numerical: Collected through Chart audit	Quantitative
Boost_drink	# of drinks	Discrete: Collected through Chart audit	Quantitative
LOS	number in days	Numerical: Days: discharge date and time - admission date and time.	Quantitative
30_ Day Readmission Rate	0=no 1=yes	Discrete data: Collected through Chart audit	Quantitative
Compliance to Pathway	0=no 1=yes 2=partially	Collected through Chart audit	Quantitative
MST	0/1= no risk 2= at risk	Collected through Chart audit	Quantitative

Appendix L

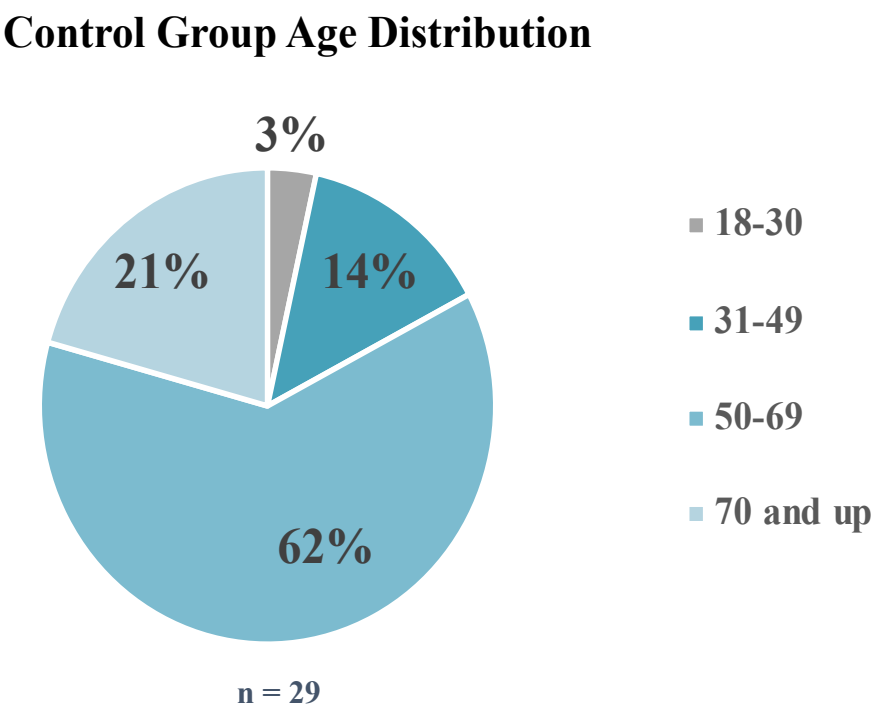
Patient Demographic Data

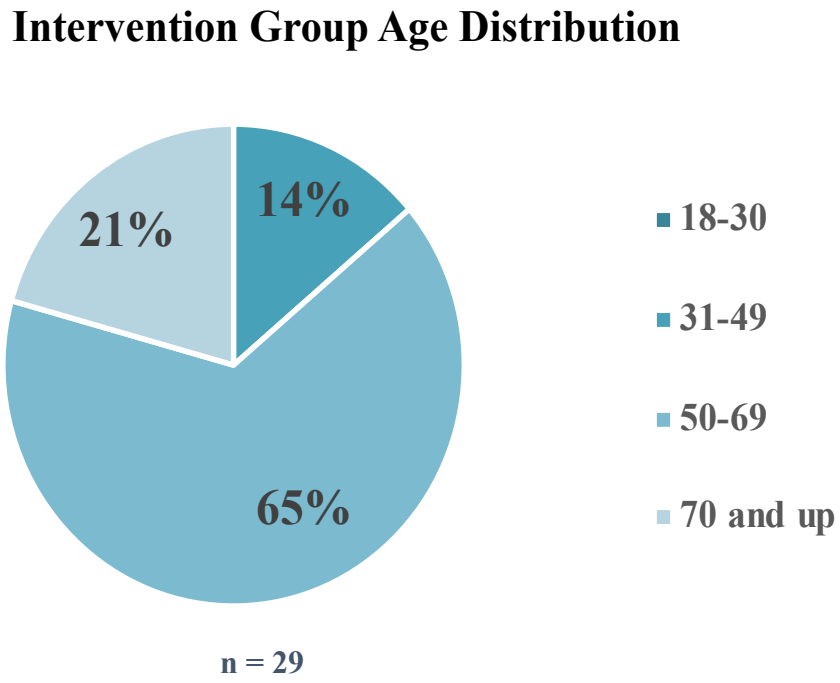


	Female	Male
Control Group	13	16
Intervention Group	17	12
n = 29	29	29

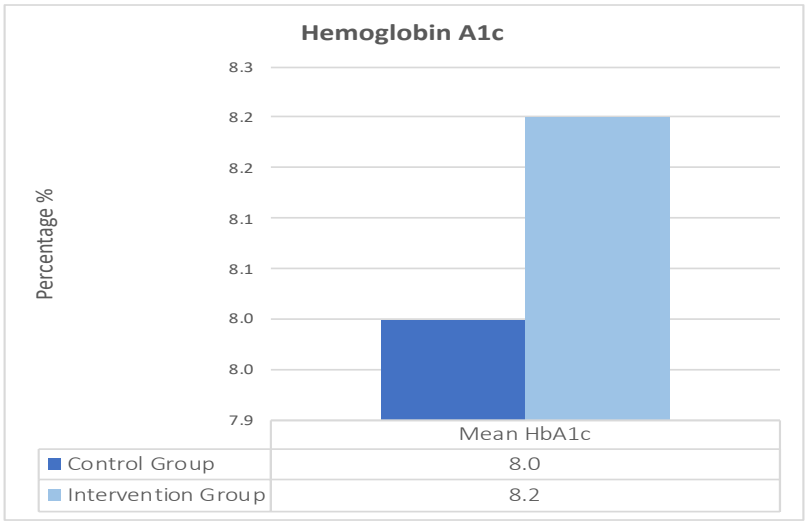


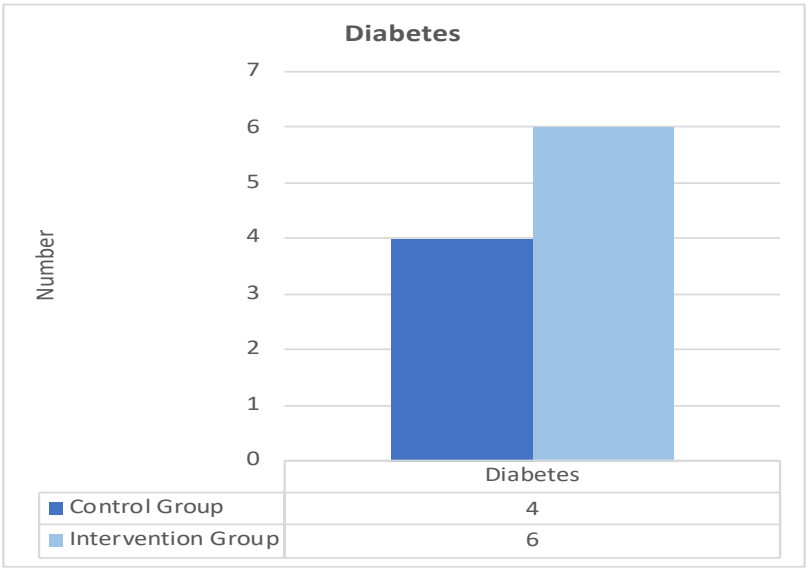
	Caucasian	African American	Other
Control Group	25	2	2
Intervention Group	22	6	1
N	47	8	3


Control Group Age Distribution
3%
14%
21%
62%
18-30
31-49
50-69
70 and up
n = 29


Intervention Group Age Distribution
14%
21%
65%
18-30
31-49
50-69
70 and up
n = 29

Surgery Group	N= 29	Label	Mean	Median	Minimum	Maximum
pre pathway	29	Age (years)	59.14	60.00	19.00	78.00
		BMI	33.38	33.05	22.10	43.00
		Hemoglobin A1C	8.08	7.40	6.90	10.60
		Date difference between fixed dates	84.71	78.28	26.22	151.38
post pathway	29	Age (years)	60.66	62.00	38.00	80.00
		BMI	30.34	30.35	18.50	41.00
		Hemoglobin A1C	8.20	8.45	6.10	9.80
		Date difference between fixed dates	93.14	89.67	73.30	132.37





Appendix M

Data Gathering Tool

Preoperative

- Did clinic RN complete MST tool?
  - Measured: 0=no 1=yes
  - Represented as a percentage
  - Retrieve data from EHR Cerner/Athena
- How many patients were deemed "malnourished" based on screening?
  - Measured 0=no risk 1= risk
  - Represented as a percentage
  - Data retrieved from scanned MST tool into Cerner/Athena.
- Did patient receive Ensure Pre-Surgery drinks with patient education?
  - Measured 0=yes 1=no
  - Represented as a percentage
  - Those who receive the drink will be identified by placing a patient sheet including name and anticipated surgery date in a folder at the clinic for the DNP student to track through perioperative process.
- Did Surgery PAS remind patient about timing of Ensure Pre-Surgery Drink?
  - Measured 0= yes 1=no
  - Represented as a percentage

Postoperative

- How many Ensure Pre-Surgery drinks did the patient consume?
  - Measured: # of drinks/ # total provided
  - Aggregate data: represented as a percentage
  - Data retrieved from pre-procedure admission charting
- Was a nutrition consult placed for persons deemed malnourished during their stay?
  - Measured: 0=yes 1=no
  - Represented as a percentage
  - Data retrieved from chart audit
- Was there a decrease in LOS among persons included in QI project versus standard of care?
  - Measured: % change in comparison to data one year prior
  - Data retrieved from Monthly MSSIC report
  - Analyzed through t-test analysis
- Was there a decrease in 30-day readmission among persons included in the QI project versus standard of care?
  - Measured: % change in comparison to data one year prior
  - Analyzed through t-test analysis
- Was the pathway followed completely?
  - Measured 0= no 1= yes 2= partially
  - Represented as a percentage
  - Data gathered from chart audits

Appendix N
Proposed Project Budget

Doctor of Nursing Practice Project Financial Operating Plan	
Project Title: Evidence-Based Nutrition Pathway for Elective Spinal Fusion Patients	
Reimbursement	
Project Manager Time (in-kind donation)	15,500.00
Team Member Time:	
Neuroscience Manager (Site Mentor) (in-kind donation)	3,525.00
Neurosurgery Physician Assistant (Site Lead) (in-kind donation)	550.0
Clinic Registered Nurse (in-kind donation)	3,315.00
Consultations	0.00
Colorectal Enhanced Recovery leader (one time occurrence)(in-kind donation)	38.00
Registered Dietitian (in-kind donation)	840.00
Statistician (in-kind donation)	100.00
Cost avoidance	
Length of Stay	2,000.00
30 day readmission	16,000.00
TOTAL INCOME	41,868.00
Expenses	
Project Manager Time (in-kind donation)	15,500.00
Team Member Time:	
Neuroscience Manager (Site Mentor)	3,525.00
Neurosurgery Physician Assistant (Site Lead)	1,120.00
Clinic Registered Nurse	3,315.00
Time Spent Completing Questionnaire	15.00
Consultations	
Colorectal Enhanced Recovery leader	38.00
Registered Dietitian	840.00
Statistician	100.00
Cost of print/copy/fax	15.00
Ensure Pre-Surgery drinks	1,600.00
Luncheon + Education session	100.00
TOTAL EXPENSES	26,168.00
Net Operating Plan	15,700

Appendix O

Optimizing Your Nutrition Before Spine Surgery

Did you know?

- Poor nutrition before surgery can complicate your recovery, including having a longer hospital stay.
- Poor nutrition can also impact the time it takes for your surgical wound to heal.

What can I do to help?

- The Ensure Pre-Surgery Clear drinks are designed to give you the necessary carbohydrates, vitamins, and antioxidants to help with recovery after surgery.
- Carbohydrates are important in helping to reduce the stress response after surgery, by helping to reduce the period of fasting before surgery.
- Your surgery will *not* be cancelled if you chose not to consume all three drinks. However, we *highly* recommend you do, to help with healing after surgery.

What do the drinks contain?

- Carbohydrates, antioxidants and vitamins.
- The drinks are gluten-free, fat-free, lactose-free, kosher, and Halal safe.
- Each drink is 296ml

When Do I drink the Ensure Pre-Surgery Clear drinks?

- Before drinking, shake the bottle thoroughly. It is recommended to consume the drink cold. Refrigerate the drink after opening.
- **Day before surgery:** One drink in the morning, one drink in the afternoon or evening
- **Day of Surgery:** Drink your last bottle while **on your way** into the hospital

Day of Surgery

- The surgery nurse will ask how many of the drinks you consumed.
- If you choose not to drink any, this will *not* affect you having surgery.

Day before Surgery

Morning:

Evening:

Day of Surgery

On your way to the hospital:

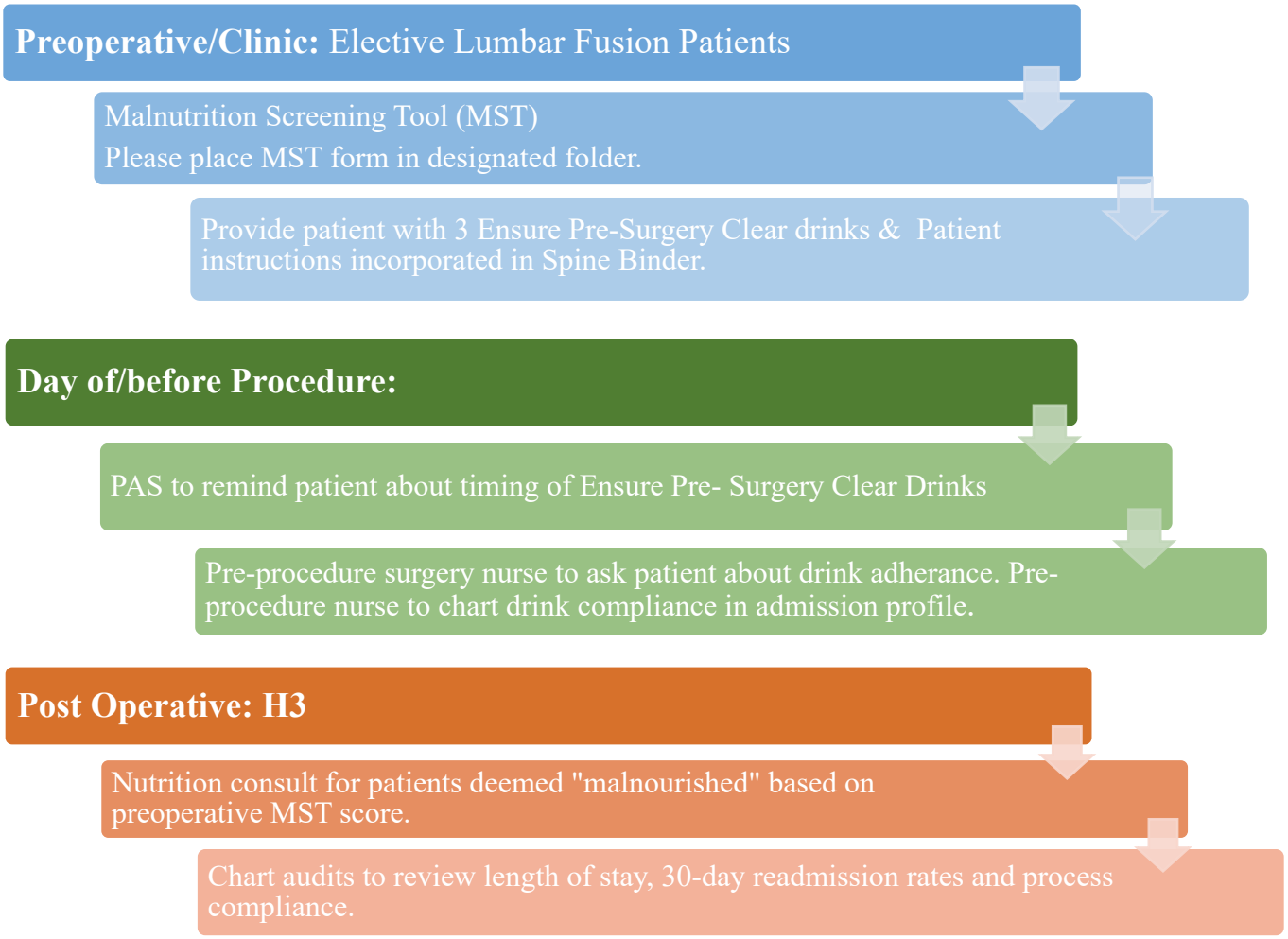
	Amount per Serving	% DV*	% RDI
NUTRIENT DATA			
Calories	200		
Total Fat, g	0	0	
Sodium, mg	180	8	
Total Carbohydrate, g	50	18	
Total Sugars, g	6		
Added Sugars, g	6	12	
Protein, g	0		
MINERALS			
Selenium, mcg	11	20	
Zinc, mg	3	25	

* Not a significant source of saturated fat, trans fat, cholesterol, dietary fiber, vitamin D, calcium, potassium and iron. The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

This is the nutrition label for the Ensure Pre-Surgery Strawberry clear drink (296ml). Image taken from Abbott.

Appendix P

Perioperative Nutrition Pathway for Elective Spine Fusion



Patient teaching tips:

- Each bottle contains 50g of carbohydrates and is supported by the ERAS Society as a pre-surgery clear carbohydrate beverage. Carbohydrates help reduce the body's inflammatory response by reducing the period of fasting.
- The drink is fat free, kosher, gluten free and safe for persons who are lactose intolerant.
- Shake well, drinking cold is recommended. Refrigerate after opening.
- The first drink should be consumed the morning before surgery, the second should be consumed the evening/night before and the last one on the way into the hospital.
- Surgery will not be cancelled if they choose not to participate.
- Finish drink #3 while driving into the hospital before surgery.
- Anesthesia has approved this as a clear fluid.
- If they can't drink all three, one is better than nothing.
- Diabetics cannot receive the drink because of the carbohydrate load and dosing of diabetic medications.

Appendix Q

Enhanced Recovery Spine Surgery & Ensure Drinks

Situation: Our current process does not include any nutrition screening or interventions for spine fusion patients.

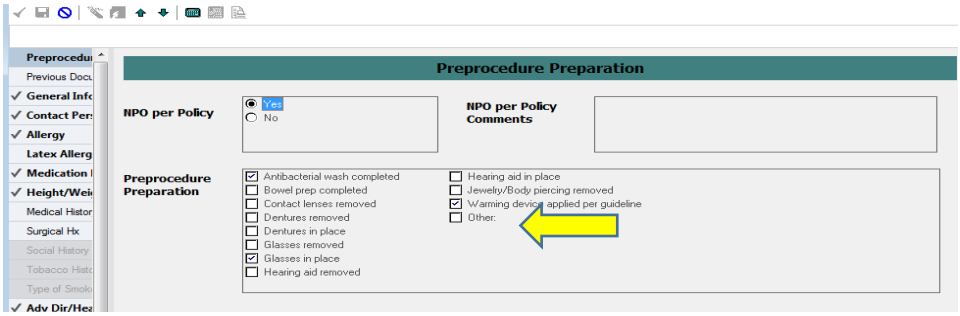
Background: Current guidelines from the Enhanced Recovery After Surgery (ERAS) Society recommend screening for nutrition status preoperatively. ERAS also recommends nutrition recommendations for patients who are deemed "malnourished."

Assessment: Assessment of nutrition status will take place utilizing the Malnutrition Screening Tool (MST) in the preoperative clinic visit. Regardless of nutrition score, patients undergoing an elective spinal fusion will receive three Ensure Pre-Surgery drinks. The following details are below:

- **When:** Starting **November 20, 2018** patients being scheduled for elective spine fusion surgery by Dr. X,Y will be screened and provided with three Ensure Surgery Strawberry clear drinks in the neurosurgery clinic.
- **Who:** Elective spine fusion patients only. Type 1 and Type 2 Diabetic patients are excluded (due to the amount of carbohydrates in each bottle).
- **What:** Elective spine fusion patients will be instructed to drink *three* Ensure Pre-Surgery Clear drinks prior to surgery. Patients are instructed to drink one the morning before surgery, one the evening before surgery and the last one on the way into the hospital. Similar to other programs, as this drink is a clear fluid, anesthesia has approved this at *least 2* hours prior to surgery.

Recommendation:

- Starting **November 20, 2018** all elective fusion patients should be asked how many Ensure Surgery drinks they consumed prior to arriving at the hospital (screening/drink handouts start 11/20 – may take a few days/weeks until these patients present for surgery).
- Please chart how many drinks the patient completed under the Adult pre-procedure comprehensive assessment form, under the pre-procedure prep band pre-procedure prep section under Other. Please chart either 0, 1, 2, 3.



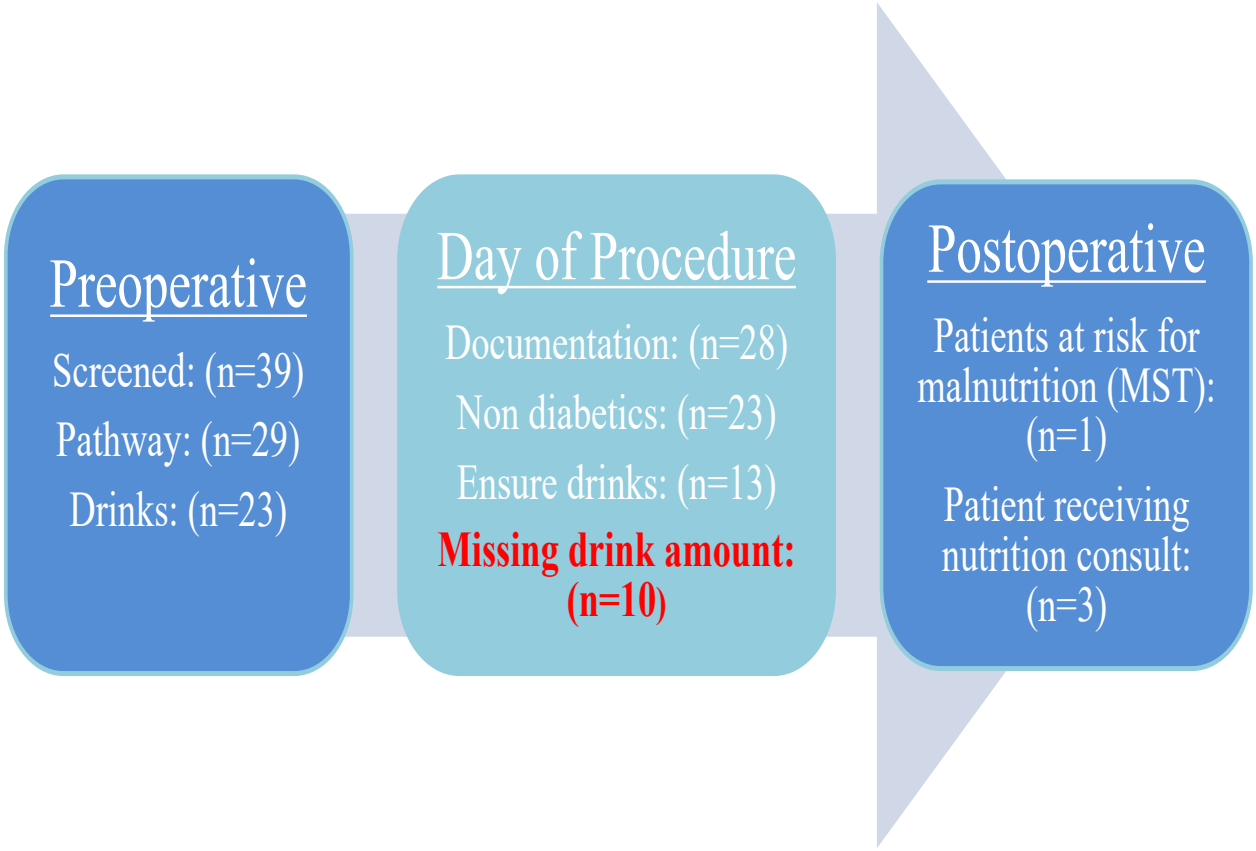
Patient talking points: "Mr. Smith, your anticipated procedure today is a L4-L5 lumbar fusion. Recently, patients who have been scheduled for this procedure in the neurosurgery office have been provided three bottles of Ensure Surgery Strawberry clear drinks to consume prior to surgery. Were you given these in the office? If so, how many of the three provided drinks did you consume?

Please Re-emphasize:

- Patient's surgery will not be cancelled if they did not consume the Ensure Surgery Clear Drinks.
- Type 1 or Type 2 Diabetics were not included in the project and therefore would not have received the drinks

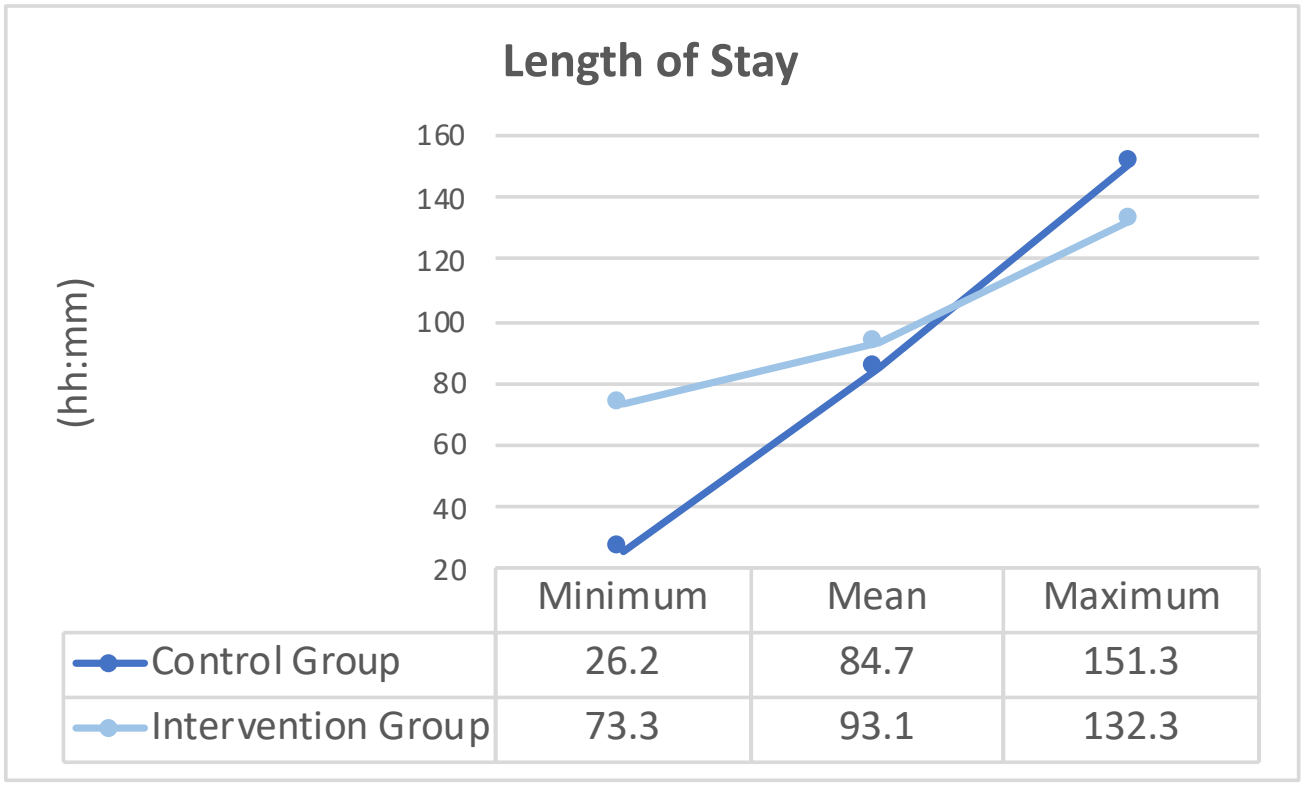
Appendix R

Process Outcomes

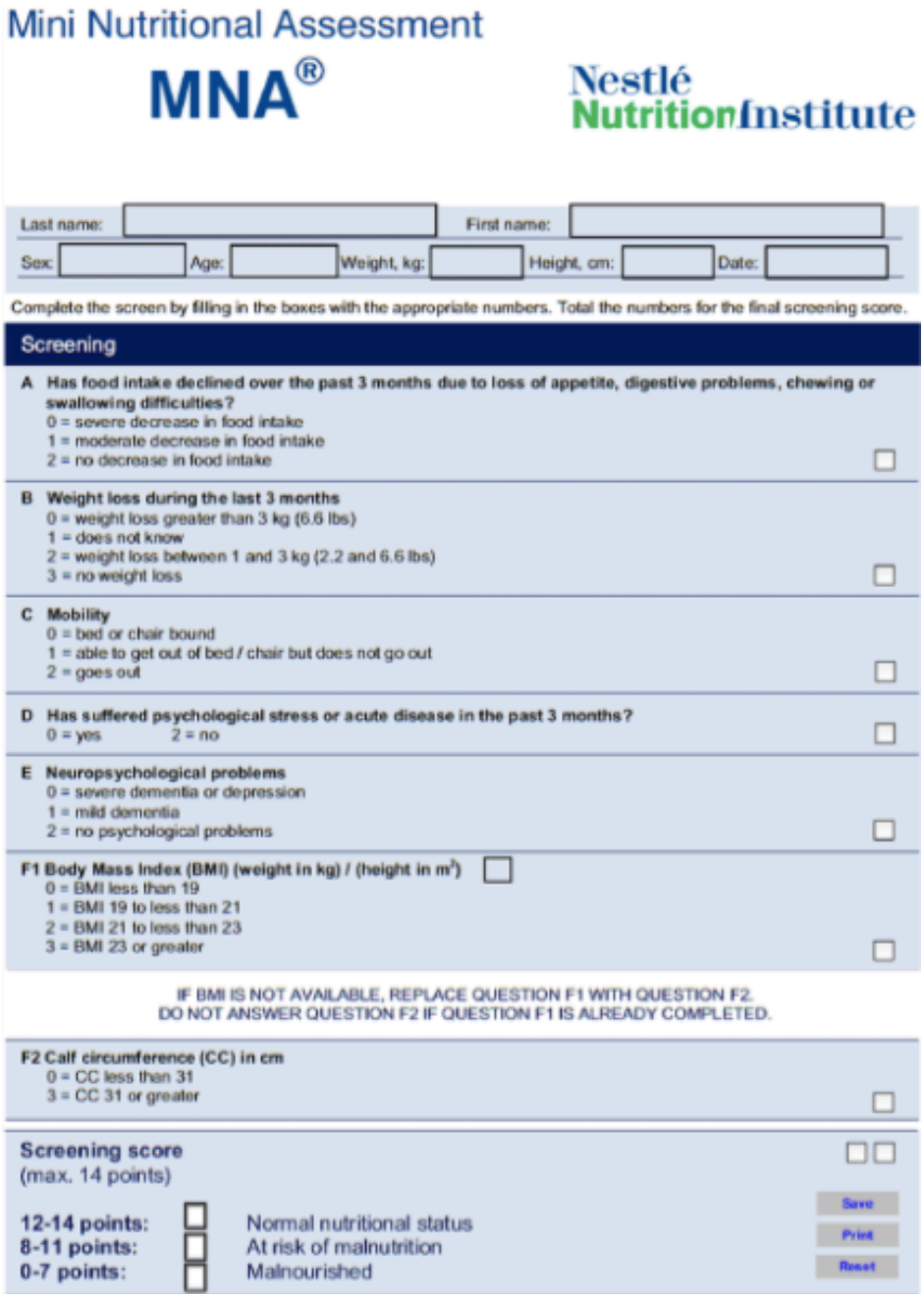


Appendix S

Outcome Measures



Appendix T



Mini Nutritional Assessment

MNA®

Nestlé Nutrition Institute

Last name: First name:

Sex: Age: Weight, kg: Height, cm: Date:

Complete the screen by filling in the boxes with the appropriate numbers. Total the numbers for the final screening score.

Screening

A Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
0 = severe decrease in food intake
1 = moderate decrease in food intake
2 = no decrease in food intake

B Weight loss during the last 3 months
0 = weight loss greater than 3 kg (6.6 lbs)
1 = does not know
2 = weight loss between 1 and 3 kg (2.2 and 6.6 lbs)
3 = no weight loss

C Mobility
0 = bed or chair bound
1 = able to get out of bed / chair but does not go out
2 = goes out

D Has suffered psychological stress or acute disease in the past 3 months?
0 = yes 2 = no

E Neuropsychological problems
0 = severe dementia or depression
1 = mild dementia
2 = no psychological problems

F1 Body Mass Index (BMI) (weight in kg) / (height in m^2)
0 = BMI less than 19
1 = BMI 19 to less than 21
2 = BMI 21 to less than 23
3 = BMI 23 or greater

IF BMI IS NOT AVAILABLE, REPLACE QUESTION F1 WITH QUESTION F2.
DO NOT ANSWER QUESTION F2 IF QUESTION F1 IS ALREADY COMPLETED.

F2 Calf circumference (CC) in cm
0 = CC less than 31
3 = CC 31 or greater

Screening score
(max. 14 points)

12-14 points: Normal nutritional status
8-11 points: At risk of malnutrition
0-7 points: Malnourished

Save Print Reset

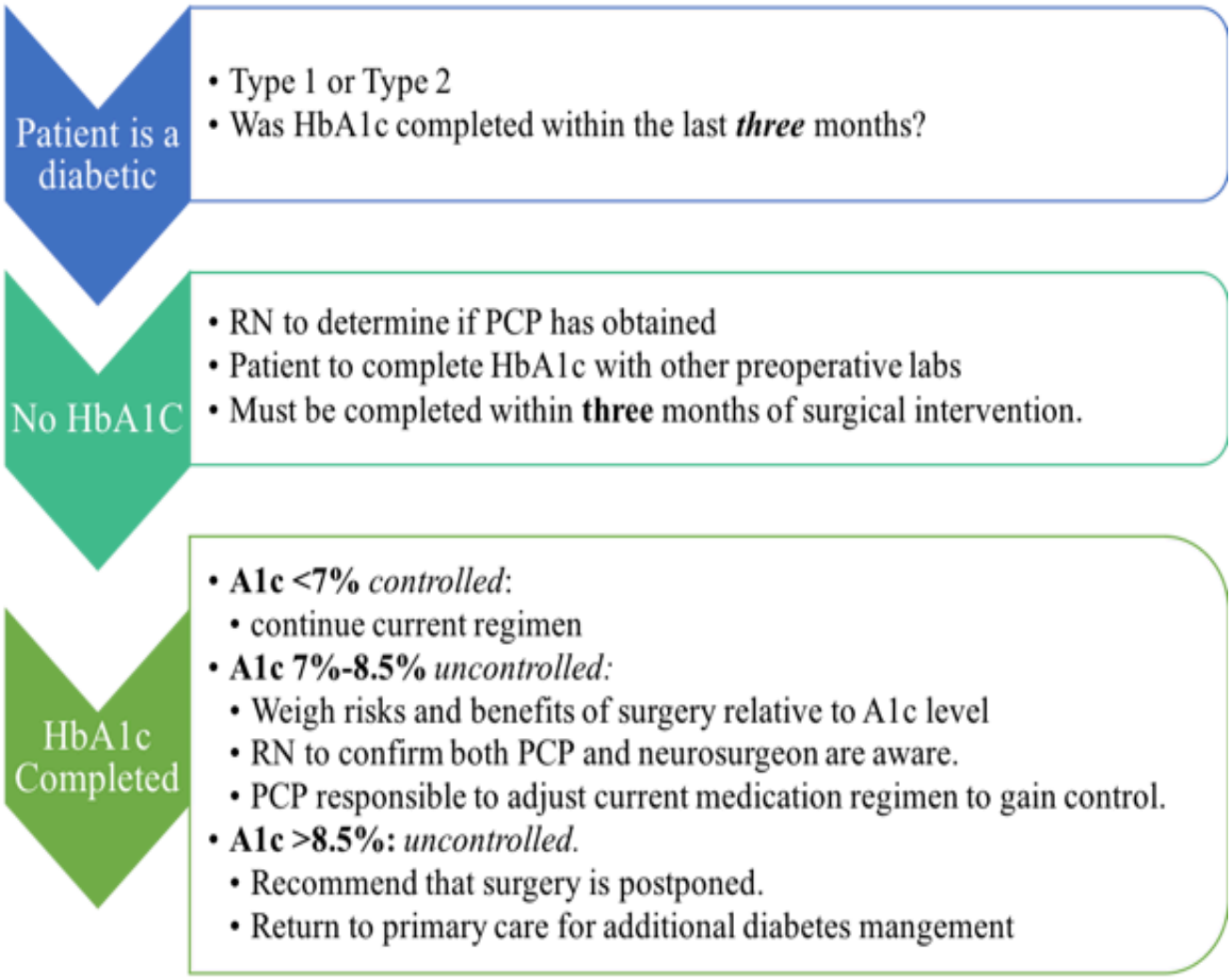
Nestle nutrition institute. (2018). *Mini nutritional assessment.*

Retrieved from: https://www.mna-elderly.com/tools_for_clinicians.html

**Rights to use include utilization of trademark in electronic health record*

Appendix U

Recommendations for Diabetic Spine Surgery Patients



American Diabetes Association. (n.d.). Hemoglobin A1c. Retrieved from: http://www.ada.com

Underwood, P., Askari, R., Hurwitz, S., Chamarthi, B., Garg, R. (2014). Preoperative A1C and clinical outcomes in patients with diabetes undergoing major noncardiac surgical procedures. Diabetes care, 37. doi.org/10.2337/dc14-0738

PCP: Primary care provider

RN: Registered nurse

HbA1c: Hemoglobin A1c