Early Mobility Protocol in Postoperative Spine Patients

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Abstract

Background: Early mobilization after surgery has been beneficial to multiple groups of patients, but the compliance to mobilization targets has been low.

Purpose: The purpose of this project was to measure the effect of a nurse-driven early mobility protocol (EMP) on the length of stay (LOS) in patients following spine surgery.

Method: This was a quality improvement (QI) project with a before and after study design. The EMP was tested using Plan-Do-Study-Act (PDSA) cycles, modified and then implemented for 8 weeks. Education was provided to the nursing staff, and charge nurses acted as champions. The LOS was determined based on the patient's admission time to the neurosurgery unit and the time the discharge order was entered in the electronic medical record (EMR). The data and time of first mobilization was obtained manually from the EMR and the EMP worksheet for each patient.

Results: Fifty patients received the EMP, and the results were compared with fifty-six patients in the pre-EMP group. The staff’s compliance with the EMP was high at 92.6%. The mean LOS decreased by 11 hours between the two groups, 46.3 hours to 35.3 hours, although it was not statistically significant. The first time to out of bed significantly decreased by 5 hours from 8.9 hours in the pre-EMP group to 3.9 hours in the EMP group ($U = 620$, $p < .001$, $r = .44$).

Conclusion: Implementing a nurse-driven EMP was successful. This intervention was effective as shown by the decreasing LOS and the first time to out of bed. Feasibility was demonstrated by high compliance with the use of the EMP. It also showed an impact of a nurse-driven protocol by changing the process of care, designed by utilizing the Donabedian framework and PDSA cycles. Finally, sustaining a culture change that supports continuing the use of the EMP will depend on the use of champions, engaging nurses and management to ensure sustainability.

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Introduction and Background

Back pain and spinal disorders are commonly encountered medical problems in the health care system, and approximately 80% of the population will suffer from lower back pain at some point in their lifetime (Rubin, 2007). A recent analysis estimated that 87.6 billion was spent annually on back pain in the U.S. which accounted for the third-highest amount of health care spending (Dieleman et al., 2016). Spinal procedures, including lumbar spinal fusions, may improve lower back pain and quality of life. Over the last decade, the number of elective lumbar fusions increased by 62.3%, and patients older than 65 years were the majority of this increase (Martin et al., 2019).

To achieve positive outcomes after spinal fusion, developing an evidence-based protocol can enhance recovery after spine surgeries. Kehlet first introduced the enhanced recovery model in 1997 as a multimodal, evidence-based plan to improve patient care in the perioperative period (Kehlet, 1997). This program called the Enhanced Recovery After Surgery (ERAS) program has been implemented in most areas of surgery. Spinal surgery was one of the later specialties to integrate this new multimodal program (Debono et al., 2019). Although ERAS programs vary by the facility, ERAS programs often consist of the preoperative, intraoperative, and postoperative phases, and the postoperative protocol includes early mobilization, pain management, and nutrition (Chakravarthy et al., 2019).

The benefits of early mobility after surgery include decreased length of stay (LOS), rates of urinary tract infections (UTIs), the incidence of wound complications, pulmonary complications, and thromboembolism (Epstein, 2014; Calotta et al., 2019). Moreover, early mobilization can improve functional capacity following elective surgery (De Almeida et al., 2017) as well as emotional and social well-being (Kalisch et al., 2013; Pashikanti & Von Ah, 2012). In contrast, the traditional practice of bedrest following a surgical procedure has been associated with negative outcomes such as thromboembolism, pneumonia, muscle wasting, and physical deconditioning as reported in a seminal study by Allen et al., in 1999.

Early mobilization is encouraged following spinal procedures and has been linked to reduced morbidities such as respiratory decompensation, UTIs, deep vein thrombosis, pulmonary embolism, sepsis or infection, and a reduced average length of stay by 34% (Burgess & Wainwright, 2019; Adogwa el al., 2017). Among patients who underwent spine surgeries, those who mobilized early were more likely to be discharged to home rather than a skilled nursing facility (Chakravarthy et al., 2019). Moreover, there was strong evidence synthesized in a 2009 Cochrane review that an intensive exercise program during the postoperative period increased the return to work and improved functional status (Ostelo et al., 2009).

Despite the recognized importance of early mobilization after surgery, compliance to mobilization targets has been reported as low (Braga et al., 2014; Doherty-King et al., 2014; Smith et al., 2019), which can lead to a higher risk of postoperative (post-op) complications. Currently, at the doctoral student’s practice site, there are no standard recommendations on early mobility for postoperative spine patients, for instance, postoperative day (POD) 0 vs. POD 1. The site is a 612-bed academic medical center and spine surgeries are performed by a neurosurgery team or orthopedic surgery team. Post-operatively, the unit of care and mobility orders depend on the complexity of the surgery and the primary team. The patients can be cared for in the neurological intensive care unit, surgical intensive care unit, neurosurgery acute care unit, or orthopedic acute care unit. Significant variability exists in the setting in times to the first mobilization after spinal surgery, given the size and diversity of this population and the number of health care providers involved in patient care (B. Sarosiek, personal communication, July 27, 2020).

Studies report on barriers to early mobilization of spinal surgery patients. For instance, one study reported that inadequate staffing, unstable patient status, high patient turnover, and high acuity on the unit were the primary factors interfering with ambulating patients (Sepulveda-Pacsi et al., 2016). In addition, nurses have relied on physical therapists to ambulate patients regardless of the patient's ability to ambulate or the extent of dependence or independence (Doherty-King et al., 2014; Kalisch et al., 2011). Furthermore, there is a misconception that patients require formal physical therapy (PT) evaluation before nurses could assist patients for mobilization (Rupich et al., 2018). Therefore, a nurse-driven intervention to overcome the barriers or misconceptions about early mobilization in the post-spinal surgery period has the potential to improve patient outcomes.

The nursing team plays an essential role in promoting the daily mobility of the patient. Nurse-driven mobility programs increased early ambulation on medical-surgical units and were associated with improved patient functional status and a reduced length of stay (LOS) in several studies (Padula et al., 2009; Pashikanti & Von Ah, 2012). Padula and colleagues conducted a study to examine the impact of a nurse-driven mobility protocol on functional status and the LOS of hospitalized older adults, and the study showed that participating in a mobility protocol improved functional status and decreased the LOS (Padula et al., 2009). Furthermore, a review of literature to examine the efficacy of an early mobility protocol in medical-surgical inpatient population found that an early mobility protocol reduced the LOS (Pashikanti & Von Ah, 2012). Yet, one study reported that only 32% of patients participated in mobility activities with their nurses (Doherty-King et al., 2014). This study emphasized that having designated resources to promote patient ambulation may increase both the frequency and duration of patient ambulation as ambulation-dependent patients have few nurse-initiated mobility activities in the hospital setting (Doherty-King et al., 2014). Patients with spine surgery will be assistant-dependent in the early phase in the postoperative period. Therefore, there is a need for developing a nursing intervention to promote early mobilization of post-op spine patients.

The average LOS in a hospital is often used to measure the efficiency of a healthcare facility, and according to the Agency for Healthcare Research and Quality, the national average in-patient LOS was 4.6 days in 2016 (Freeman et al., 2018). At the doctoral student’s practice site, the average in-patient LOS was 6.4 days in 2019, and there was a need to reduce to 6 days (S. Prather, personal communication, August 21, 2020). Strong evidence exists to support the use of early mobilization to decrease the LOS (Adogwa et al., 2017; Blackburn et al., 2016; Bradywood et al., 2017; Burgess & Wainwright, 2019; Elsarrag et al., 2019; Epstein, 2014; Feng et al., 2019; Kilic et al., 2019; Liu et al., 2020; Rupich et al., 2018; Shields et al., 2017; Sivaganesan et al., 2019; Staartjes et al., 2019; Wainwright et al., 2016; Wang et al., 2017). In addition, these studies showed that the early mobility protocols reduced costs and contributed to better pain control as well as reduced surgical site infection rates in two of these studies in patients with spine surgery. Therefore, use of an early mobility protocol (EMP) can be beneficial to decrease the average LOS.

The purpose of this project was to measure the effect of a nurse-driven early mobility protocol on the LOS in patients following spine surgery.

Review of Literature

Search Methods

A systematic literature review was conducted to investigate the effects of early mobility protocol among adult patients who underwent spine surgeries. A search was performed using PubMed, OVID Medline, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Library, and the Joanna Briggs Institute EBP Database (JBI).

Search terms included *early mobilization*, *early ambulation*, *early mobilization protocol*, *spine surgery* as well as *spinal fusion*, one of the most common types of spinal surgery. (*Early mobilization* OR *early ambulation* OR *early mobilization protocol)* AND (*spine surgery* OR *spinal fusion)* was used in PubMed (579) databases, which was then limited to publication in the last ten years (232).

In the OVID Medline database, an advanced stepwise search was conducted with keyword *early mobilization* or MeSH term *early ambulation* (5,124), keyword *early mobilization protocol* (30), keyword *spine surgery* (7,854), and both keyword *spinal fusion* or MeSH term *spinal fusion* (27,368) were combined in the same way as in the other databases (140 results). These results were limited to published in the last ten years (47 results).

In the CINAHL database, an advanced stepwise search was conducted with, *early mobilization* (1,342) as a keyword, *early ambulation (1,223)* as both Medical Subject Headings (MeSH) term and keyword, *early mobilization protocol* (17) as a keyword, spine surgery (4,758) as a keyword, and MESH term *spinal fusion* or keyword *spinal fusion* (9,094) were searched with the “Suggested Subject Terms” applied. The results of *early mobilization*, *early ambulation*, and *early mobilization protocol* were combined using OR (1,881), and the results of *spine surgery* and *spinal fusion* were combined using OR (12,820). These two search results were combined using AND (29 results), and then limited to published in the last ten years (19 results).

The Boolean search phrase, (*early mobilization* OR *early ambulation* OR *early mobilization protocol),* AND (*spine surgery* OR *spinal fusion*) was used with Cochrane Library (62 results), and the JBI (2 results), both results were limited to published in the last ten years with same results.

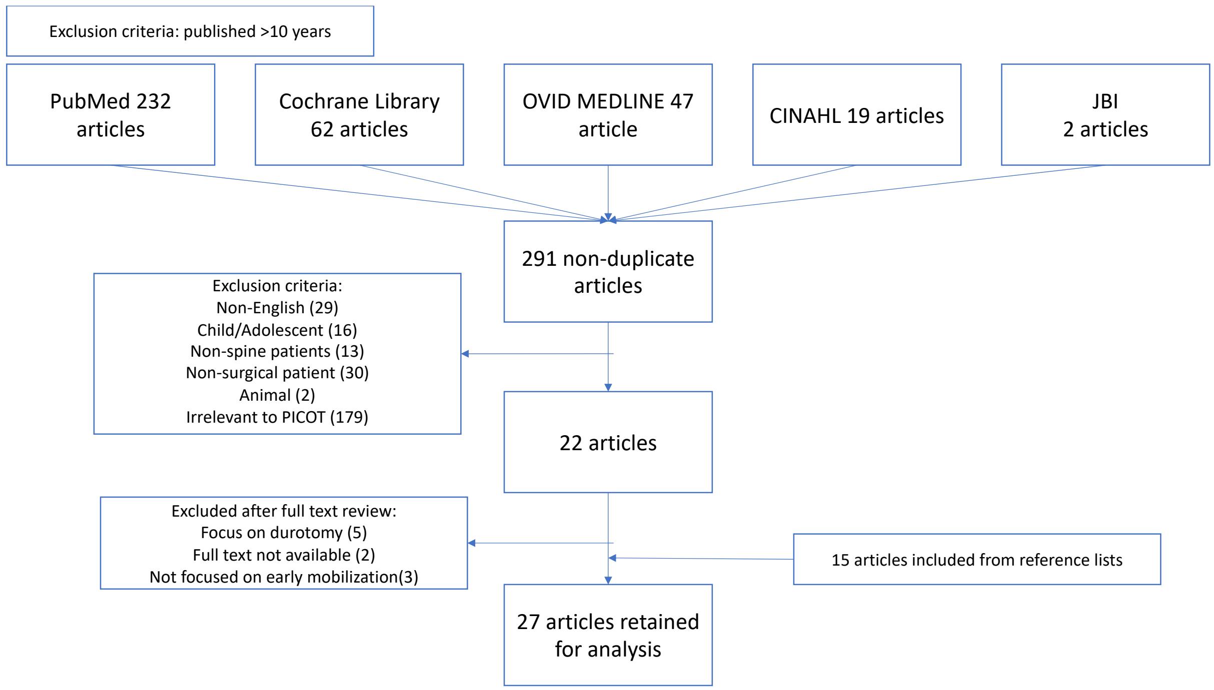
The total number of articles retrieved from the five databases was 362. After removing all duplicates (71), 291 articles were remaining. Exclusion criteria included non-English (29), child/adolescent (16), non-spine surgery population (13), non-surgical population (30), animal (2). 201 articles remained when these criteria were applied. After the title and abstract reviews, 179 articles were removed because they were not relevant to the PICOT question for the following reasons: different types of surgical techniques in spine surgery, effects of medications, pain management, and treatments option for spinal fractures. When these exclusion criteria were applied, 22 articles were retained.

Analysis

Five articles were excluded after the full-text screen because they were focused on spine surgery patients who had incidental durotomies, which often require a bedrest order after incidental durotomies. Two articles were excluded because the full text was not available, and three articles were removed because they did not include early mobilization in the interventions. From the reference lists, 15 sources were added for review. A total of 27 sources were retained for final analysis. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram is provided in Figure 1 to summarize the search results.

Figure 1

PRISMA flow diagram



Note. PRISMA flow diagram for the systemic literature search process. CINAHL = Cumulative Index to Nursing and Allied Health Literature; JBI = Joanna Briggs Institute EBP Database.

Using the Johns Hopkins Nursing Evidence-Based Practice guideline, all 27 articles were appraised for the level and quality of evidence individually. Among 27 articles, four articles were level I evidence, thirteen articles were Level II evidence, and ten articles were Level III evidence (Table 1). Five of the 27 articles had high quality (Quality A) with consistent, generalizable results, sufficient sample size for the study design, and definitive conclusions. The remaining articles had good quality (Quality B) with reasonably consistent results, sufficient sample size for the study design, and fairly definitive conclusions.

The objective of the systematic review was to examine the effects of nurse-driven EMP on the LOS of spine surgery patients. Three articles (Burgess & Wainwright, 2019; Epstein, 2014; Rupich et al., 2018) demonstrated the effects of EMP on spine surgery patients. The majority of the articles showed the effects of a multimodal intervention that was inclusive of an EMP as a part of ERAS protocol, preventative protocol, or multidisciplinary meetings with ambulation protocol.

LOS, postoperative complications, pain control, and readmission rates were the primary outcome measures of the early mobility protocol, followed by patients' satisfaction, compliance, functional status, Roland Morris Questionnaire (RMDQ), 12-Item Short-Form Health Survey (SF-12), discharge disposition, surgical site infection, and blood administration. The details of EMP, for instance, getting out of bed on POD 0 vs. POD 1, varied by the facility or ERAS protocols.

Level 1 Evidence

The major strength of the four Level 1 studies was the rigorous design of a randomized control trial (RCT). Chen and colleagues conducted an RCT study on 60 patients who underwent decompression surgery for lumbar stenosis from December 2012 through May 2012 to examine outcomes of perioperative rehabilitation intervention in Chang Gung Memorial Hospital, Taiwan. The perioperative group with early rehabilitation showed significant pain relief and improvement of disability as well as improved quality of life. Still, there were no significant functional improvements compared to the control group. However, the number of participants in both intervention and control group dropped gradually at 1-month follow up (participants finished study in intervention group 41.3% vs. control group 35.5%), 3-month (44.8% vs. 38.7%), and 6-month (31.0% vs. 54.8%), so it is hard to evaluate the long-term effects of early rehabilitation after lumbar decompression surgery. This study did not measure early rehabilitation on LOS but reported pain relief, disability, and quality of life (Chen et al., 2015).

Nielson and colleagues conducted an RCT study on 60 patients who underwent spine surgery for a degenerative lumbar disease to evaluate the outcome after spinal surgery when adding pre-habilitation to the early rehabilitation in Bispebjerg Hospital, Denmark in the 18-month period from 2003 to 2005. Early rehabilitation with early mobility protocol resulted in improved functionality in the intervention group and was discharged earlier (5 vs. 7 days, $p = 0.007$). There was no difference in postoperative complications, adverse events, low back pain, radiating pain, and quality of life, but patient satisfaction did increase. Interestingly, the shorter hospital stays and better functionality in this study were not related to reduced complications in the intervention group. The investigators suggested that this was because of the low complication rate and the small number of participants (28 in the intervention group vs. 32 in the control group). In addition, this study noted that the differences between therapists' and patients' expectations and goals may influence the LOS as well as delayed discharge procedures, so this suggested the possibility of other factors that could affect the LOS (Nielsen et al., 2010).

In two RCTs by Liu et al. (2020) and Qvarfordh et al. (2014), the intervention group with the EMP demonstrated better postoperative pain scores, a decreased use of analgesia, and greater ambulation but no differences in postoperative complication rates. Liu and colleagues followed 94 patients who underwent spine tumor surgery to evaluate the safety and efficacy of an ERAS program between 2016 to 2017 in Tangdu Hospital, China. The study showed a significant reduction in LOS (5 vs. 8 days, $p < 0.001$) (Liu et al., 2020). In the study by Liu et al., patients were encouraged to ambulate 6 hours after surgery and early ambulation on POD 1. According to the univariate analysis, other factors including preoperative carbohydrate loading, absorbable skin suture, early removal of urinary catheter (within 6 hours postoperatively), early restoration of solid diet, early ambulation on POD 1, and avoidance of surgical site drains were found to be associated with a reduced LOS. Moreover, in the multivariate analysis, early urinary catheter removal was an independent predictor for the LOS, and early urinary catheter removal improved ambulation. However, the lack of blinding and heterogeneity in the sample affected the generalizability of the results (Liu et al., 2020).

Qvarfordh and colleagues followed 23 patients who underwent lumbar discectomy to investigate the feasibility and safety of early mobilization in the Post Anesthesia Care Unit (PACU) in Glostrup Hospital, Denmark. In contrast, this pilot study did not show a significant difference in LOS between the intervention and control group, although this study only had 23 participants with no statistical comparisons (Qvarfordh et al., 2014), which can indicate a lack of generalizability based on a small sample size. Despite a small number of participants, this pilot study indicated that it might be feasible and safe to mobilize patients shortly after lumbar disc surgery by walking Post-Anesthesia Care Unit (PACU) to the acute care floor while expressing patient's satisfaction by walking instead of being driven in a bed.

Level II Evidence

The majority of studies with level II evidence used a retrospective design to compare the outcomes of pre-intervention and post-intervention. Most studies demonstrated a reduced LOS, reduced pain score, and the use of analgesics after the introduction of the intervention. The intervention tested by Li et al. (2018) was bedside standing and walking on POD 1 with assistance. Compliance with bedside standing and assisted walking on POD 1 was relatively high (90.43%). Furthermore, the study emphasized the role of preoperative patient education to set reasonable expectations after spine surgery which could influence the LOS (Li et al., 2018). In another study that tested a nurse-driven EMP on a neuroscience unit, Rupich and colleagues showed benefits including a significant decrease in LOS of patients who underwent lumbar laminectomy, a decrease in variability of postoperative care, engagement of patients in their postoperative mobility plan, and reduced costs. In addition, this study emphasized that a nurse-driven protocol allowed nurses more autonomy in patient care, which acted as a facilitator for patient involvement in postoperative care (Rupich et al., 2018).

Blackburn and colleagues developed the Spinal Enhanced Recovery Program by a process to redesign the clinical pathway for patients undergoing elective spine surgery to improve quality of care and reduce LOS between 2013 to 2016 in Musgrove Park Hospital, England. The mean age of spinal surgery patients was 55 years, and 55% were female. Elective spinal surgery was defined as non-emergency surgery, including discectomy, decompression, fusion, and realignment operations to the cervical, thoracic, and lumbar spine. The Spinal Enhanced Recovery Program included “Bums off Beds”, which meant getting patients out of bed on POD 0 either standing or walking. This resulted in reduced LOS by 52%, improving from an average of 6 days to 2.9 days as well as reduced readmission rates from 7% to 3% (Blackburn et al., 2016). Two studies (Grasu et al., 2018; Kilic, et al., 2019) implemented ERAS programs with early mobilization (out of bed on POD 0 or POD 1). Grasu and his colleagues conducted a retrospective cohort study with 97 patients who underwent spine surgery for metastatic tumors at the University of Texas MD Anderson Cancer Center from April 2015 through September 2016. Another retrospective cohort study by Kilic and colleagues followed 120 patients who underwent a single-level lumbar microdisectomy at Umraniye Training and Research Hospital in Istanbul, Turkey. Both studies demonstrated significantly better pain control but no significant differences in LOS although both studies still showed reduced LOS with early mobilization (Grasu et al., 2018; Kilic, et al., 2019).

For readmission rates and postoperative complication rates, there were mixed results from Level II evidence that some studies showed a significantly reduced rate versus no difference between the two groups. Smith et al. (2019) pointed out that these mixed results could derive from compliance with the protocol. For instance, to help patients get out of bed on POD 1, the protocol required urinary catheters to be removed in the morning after surgery. However, compliance was poor with no change between the two groups, which could contribute to late mobilization (Smith et al., 2019).

There is strong evidence that early mobilization decreases surgical site infection rates according to studies by Chakravarthy et al. (2019) and Castella et al. (2019). Chakravarthy and colleagues conducted a retrospective analysis to determine the effectiveness of ERAS protocols for spine surgery with a total of 1770 patients, and ERAS protocols were associated with a decrease in surgical site infection rates (Chakravarthy et al., 2019). A quasi-experimental study by Castella and colleagues was performed to evaluate the efficacy of a preventive intervention, including an early mobility protocol with 139 patients who underwent spine surgery, and the study reported a significant decrease in the incidence of surgical site infection rates with a preventive intervention (Castella et al., 2019).

Cost savings associated with early mobilization of spine surgery patients was shown to be statistically significant in several studies (Feng et al., 2019; Shields et al., 2017; Sivaganesan et al., 2019; Staartjes et al., 2019). Shields and colleagues conducted a retrospective analysis to introduce the utilization of multidisciplinary committee meetings with ambulation protocol to decrease LOS following spinal fusion surgery with 1978 patients. LOS improved over the three years of intervention implementation, and a significant improvement in cost was also reported (Shields et al., 2017). Sivaganesan and colleagues also performed a retrospective analysis with patients who underwent elective lumbar or cervical surgery to compare 90-day outcomes and complications before and after implementation of the perioperative elective spine surgery protocol, which showed reduced LOS and improved 90-day complications, which was associated with reduced costs (Sivaganesan et al., 2019). Another retrospective analysis in patients with minimally invasive lumbar fusion by Feng and colleagues reported that patients with the ERAS pathway demonstrated shorter LOS and lowered cost than the pre-ERAS group. However, there were no significant differences in complications rate, 30-day readmission, and reoperation rate (Feng et al., 2019). In addition, Staartjes and colleagues reported that implementing the ERAS protocol in elective degenerative spine surgery decreased the average LOS, which contributed to an estimated reduction in costs of 46.7 % for fusion procedures (Staartjes et al., 2019). Lastly, early mobility can be a valuable quality improvement to provide the best care outcomes at the lowest cost, according to a retrospective analysis by Bradywood and colleagues (Bradywood et al., 2017).

Level III Evidence

Most studies with level III evidence also showed a significantly reduced LOS and decreased postoperative complication rate with an early mobility protocol. Four articles were systematic reviews of mixed study designs and demonstrated reduced LOS after implementation of an early mobility protocol (Burgess & Wainwright, 2019; Elsarrag et al., 2019; Epstein, 2014; Wainwright et al., 2016).

Burgess and Wainwright (2019) reviewed fourteen studies on the effects of EMP in patients undergoing spinal surgery. They concluded that goal-directed early mobilization may reduce the length of stay and complications in these patients. However, included studies were in

English only, and those studies with multimodal interventions could not clearly indicate the effect of early mobilization alone (Burgess & Wainwright, 2019).

The benefits of early mobilization following spine surgery were reviewed by Elsarrag et al. (2019), Epstein (2014), and Wainwright (2016). Elsarrag and colleagues reviewed twenty full-text articles of all design studies to examine studies investigating the application of formal ERAS programs, including early mobilization in patients undergoing spine surgery. Most studies demonstrated reduced LOS and no increase in rates of readmission or complications after the introduction of an ERAS program (Elsarrag et al., 2019). Epstein reviewed multiple early mobility protocols along with other factors within these protocols that contributed to a reduction in both morbidity and LOS. This review demonstrated early mobility protocols reduced the rate of complications and morbidities such as respiratory decompensation, pneumonia, DVT, PE, UTI, sepsis, or infection, along with the average LOS (Epstein, 2014). A systematic review of fifteen all design studies by Wainwright and colleagues concluded that an ERAS pathway including early mobilization was likely to enable patients to recover more quickly by reducing LOS and hospital costs (Wainwright, 2016).

The impact of an ERAS pathway that included early mobilization was studied by Soffin and colleagues in 2019 in 51 patients who underwent lumbar decompression between April and November 2017 in a New York hospital. The compliance of the ERAS program was 85%, and there was no correlation between surgical subtype and LOS (Soffin et al., 2019). Besides Soffin's study, Zakaria and colleagues in 2019 analyzed the relationship between ambulation on the day of surgery and adverse events among patients underwent cervical (Zakaria et al., 2019b) and lumbar spine surgery (Zakaria et al., 2019a). Studies found that early mobility by ambulating on POD 0 was associated with a significantly decreased risk of adverse events following cervical and lumbar spine surgery (Soffin et al., 2019; Zakaria et al. 2019a; Zakaria et al., 2019b). Wang and colleagues in 2017 conducted a case study to review the effects of an ERAS program for 42 patients who underwent lumbar fusion, and they reported that an ERAS program with early mobilization showed a significant improvement in the disability index score at the early follow-up, and a reduction of over 2 days on average (3.9 vs. 1.29 days) compared with standard lumbar fusion surgery, which suggested the ERAS program including early mobilization can be safe and effective (Wang et al., 2017).

Adogwa and colleagues (2017) followed 125 patients who underwent elective spinal surgery to examine the effect of early mobilization on patient outcomes, complications, and 30-day readmission rate, and this study reported the number of postoperative days between surgery and first ambulation to be significantly shorter with early ambulation as compared to late ambulation (0.93 vs. 2.83 days, $p = 0.01$). The LOS was 34% shorter in the early ambulator cohort when compared to the late ambulator group (5.33 vs. 8.11, $p = 0.01$).

Pitter and colleagues conducted a 10-year Danish nationwide cohort study to investigate outcomes after spinal surgeries and risk factors for an extended length of stay and readmission within 90 days by following 892 patients. Although the study by Pitter et al. (2019) did not investigate the impact of early mobilization after spine surgeries, it indicated the mobilization difficulties can extend the LOS (Pitter et al., 2019), which suggested promoting mobilization could decrease the LOS after spine surgeries.

Conclusions of Analysis

Strong evidence exists to support the use of early mobilization to decrease the LOS (Adogwa et al., 2017; Blackburn et al., 2016; Bradywood et al., 2017; Burgess & Wainwright, 2019; Elsarrag et al., 2019; Epstein, 2014; Feng et al., 2019; Kilic et al., 2019; Liu et al., 2020;

Rupich et al., 2018; Shield et al., 2017; Sivaganesan et al., 2019; Staartjes et al., 2019; Wainwright et al., 2016; Wang et al., 2017). In addition, some of these studies showed that the EMP reduced costs and contributed to better pain control as well as reduced surgical site infection rates in patients with spine surgery. However, other outcome measures, such as a post-op complication rate and readmission rate, were varied among studies.

This review was limited to studies published in the English language and therefore, may have excluded relevant evidence published in a different language. This review included studies not only in the United States but also in other countries such as the United Kingdom, China, Taiwan, Denmark, Spain, and Turkey. However, outcomes in this population cannot be solely attributed to an EMP as reported by multiple investigators (Blackburn et al., 2016; Bradywood et al., 2017; Burgess & Wainwright, 2019; Chakravarthy et al., 2019; Elsarrag et al., 2019; Feng et al., 2019; Kilic et al., 2019; Liu et al., 2020; Wainwright et al., 2016). In addition, there were variations among early mobility protocols, so the evidence does not clearly support one standard EMP as most beneficial. This review did not differentiate among different types of surgical procedures, so depending on the surgical procedure, the results of EMP can be different. Lastly, the compliance rate to the protocol was either not reported or varied among studies that could impact the interpretation of these results.

This review summarized the pertinent studies across a variety of spine surgeries and suggests that the EMP was beneficial in terms of the LOS, surgical site infection rate, costs, and pain control but mixed results in other outcome measures, such as postoperative complications, readmission rates, and functional status. The purpose of this scholarly project was to evaluate the effect of a nurse-driven EMP on the LOS in patients following spine surgery. There was sufficient evidence to support early mobilization after surgery, including spinal surgeries, as an essential element of postoperative care that can lead to better patient outcomes. However, there was variability in the type of protocols, including nurse-driven protocols.

Design

Quality Improvement project

A quality improvement pre and post intervention design was used in this project. A quality improvement (QI) project is a series of systematic and continuous actions that lead to measurable improvement in health care services and the health status of targeted patient groups (U.S. Department of Health and Human Services Health Resources and Services Administration, 2011). QI projects in healthcare are generally performed by focusing on the systems or process of care, the patients, and the care team as the quality of healthcare is related to the underlying systems of care (U.S. Department of Health and Human Services Health Resources and Services Administration, 2011).

The purpose of this scholarly project was to evaluate the effect of a nurse-driven early mobility protocol on the LOS in patients following spine surgery. The aim of this project was to create a nurse-driven protocol to promote early mobility that would be easy to implement among postoperative spine patients. The mechanism of the intervention, a nurse-driven early mobility protocol, was expected to change over time in response to feedback using a Plan-Do-Study-Act (PDSA) cycle.

Human Subjects Review (HSR)

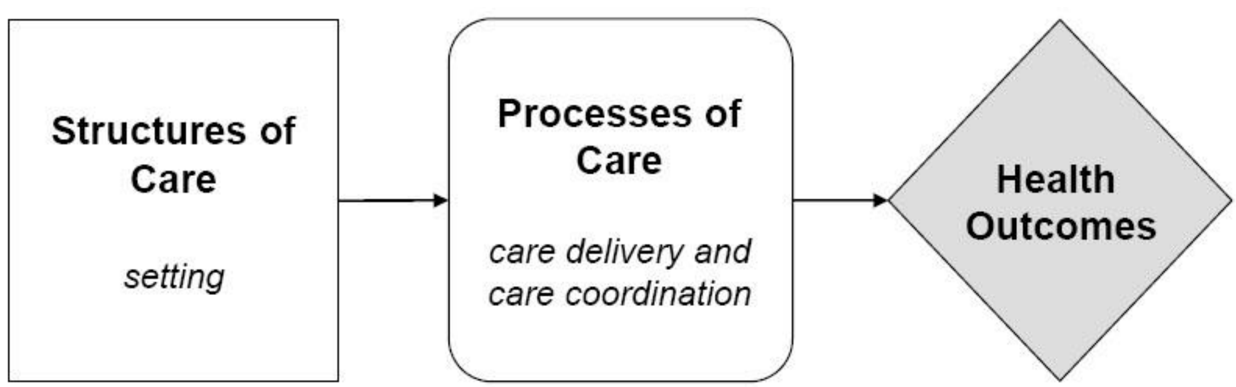
The Institutional Review Board (IRB) determination form was submitted at the doctoral student's practice site. This project was determined not to be subject to IRB-HSR oversight by the IRB.

Theoretical Framework

Avedis Donabedian's conceptual framework was utilized in this scholarly project. Based on Donabedian's conceptual framework, structure, process, and outcome were applied to evaluate the quality of care. First, the structure of health care can be defined as the physical and organizational aspects of settings such as facilities, equipment, personnel, operational and financial processes supporting medical care. Second, the process sits between the structures and outcomes by providing resources and mechanisms for patient care activities. Lastly, the outcome is the effect of care on the patient's health status. For example, outcomes can be measured as patient satisfaction, functional restoration, recovery status, and survival (Donabedian, 1988). For this project, the structure included the neurosurgery unit, mobility equipment, and nursing staff to assist mobilizing patients. The process was implementing the early mobility protocol, and the outcome was the LOS.

Figure 2

Donabedian's Quality Framework



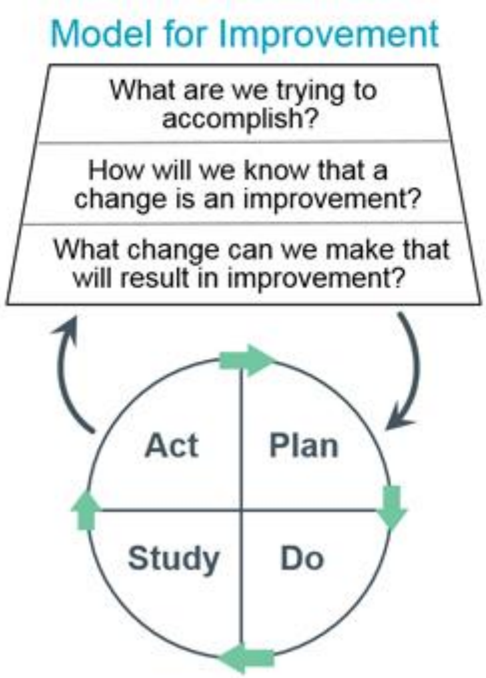
Note. Donabedian's Quality Framework is obtained from *Closing the quality gap: a critical analysis of quality improvement strategies*, by McDonald et al., Copyright 2007 by Agency for Healthcare Research and Quality.

The Donabedian model as a theoretical framework guided the project by focusing on the process of care and how the EMP would fit into the workflow. Expecting that the protocol would need to be adjusted, the Model for Improvement as an implementation framework was needed. The Model for Improvement was developed by Associates in Process Improvement, a simple and powerful tool for accelerating progress.

Implementation Framework

Figure 3

Model for Improvement



Note. Model for Improvement developed by Associates in Process Improvement. Adapted from *The improvement guide: a practical approach to enhancing organizational performance* (2nd ed.), by Langley et al., 2009, Jossey-Bass. Copyright 2009 by San Francisco: Jossey-Bass Publishers.

The model has been used successfully by hundreds of healthcare organizations to accelerate and improve many different health care processes and outcomes (Langley et al., 2009). The steps to this model include:

1. **Forming the team**- The team for this QI project was formed with the following: the doctoral student, Doctor of Nursing Practice (DNP) practice mentor who is a nurse practitioner (NP) in the neurosurgery department, physical therapist (PT), nurse manager on the neurosurgery unit, the chair of Shared Governance, and staff nurses (nurses with 1 to 7 years of experience) to obtain inputs from different levels of clinical experiences.
2. **Setting Aims-** The purpose of this DNP project was to measure the effect of a nurse-driven EMP on LOS in patients following spine surgery. The aim of this project was to create a nurse-driven protocol to promote early mobility that would be easy to implement by nurses caring for postoperative spine patients.
3. **Outcome Measures**- The outcome measure used in this project was hospital LOS. LOS was calculated based on a patient's admission time to the neurosurgery unit to the minute the discharge order was entered in the EMR.
4. **Selecting Changes-** A nurse-driven EMP was developed to change the process by which patients who have undergone spine surgery are ambulated.
5. **Testing Changes- The Plan-Do-Study-Act (PDSA)** cycle is shorthand for testing a change by developing a plan to test the change (Plan), carrying out the test (Do), observing and learning from the consequences (Study), and determining what modifications should be made to the test (Act). The EMP was tested using PDSA cycles, and suggested improvements were implemented.

6. **Implementing Changes-** Several PDSA cycles were completed that resulted in revision of the workflow and EMP. Then, the EMP was implemented for 8 weeks.
7. **Spreading Changes-** This project can be evaluated for sustainability by tracking data and compliance with the protocol on the intervention unit. If outcomes are sustained, the EMP could be considered and evaluated for potential implementation in other specialty settings.

Definition of Terms

Key operational definitions were used in this project.

1. Spine surgery is a procedure that aims to change a patient's anatomy, such as removing a herniated disc that is causing pain, with the purpose of providing pain relief (Spine-Health, 2020). Specific surgeries for this project included spinal fusion, laminectomy, decompression, foraminotomy, and discectomy (National Institute of Neurological Disorders and Stroke, 2020).
2. The nurse-driven EMP protocol was a series of steps that the nursing staff used independently to guide the early mobilization in post-op spine patients. The EMP protocol included the mobility goals, destinations of first out of bed, and reasons for barriers to mobilization.
3. Length of stay was calculated based on a patient's admission time to the neurosurgery unit to the minute the discharge order was entered in the EMR.
4. The nursing staff was defined as both registered nurses (RNs) and unlicensed assistive personnel (UAP).

Setting and Patient population

This project was conducted in the neurosurgery acute care unit in an academic medical center in the southeast. The neurosurgery acute care unit has 30 beds in a 612-bed academic medical center where an average of 40 spine surgeries per month is performed (S. Prather, personal communication, March 12, 2021). At the time of this project, four neurosurgeons performed spinal surgery following the ERAS pathway. Patient education was begun in the preadmission clinic visits by nurse coordinators, so patients were informed about early mobilization in their post-operative period. All patients over age 18 undergoing spinal surgery and admitted postoperatively to the neurosurgery unit were eligible for this project. This QI project excluded patients who had durotomies or cerebral spinal fluid leaks due to total bedrest orders in place in the immediate postoperative period.

Procedures

1. **Developing the nurse-driven early mobility protocol**- to develop the nurse-driven EMP, input from the expert team of physical therapists, nurse practitioners, and clinical nurses was obtained. In addition to gathering input from clinical staff, evidence from the literature and mobility goals of the ERAS spine program were used to develop the first draft of the protocol. The pilot testing in 3 steps was performed by the doctoral student to test the efficiency and feasibility of the protocol. 1. The doctoral student received the list of planned spine surgery patients from the nurse manager. 2. When a patient was admitted to the neurosurgery unit, the doctoral student communicated with assigned nursing staff that the EMP would be performed by the student. 3. The patient was informed that he/she would be assisted to get out of bed by the student. 4. The EMP was performed, and the activity was documented in both the EMR and the EMP worksheet (Appendix A). The EMP worksheet contained the EMP protocol, admission time, first time to out of bed (OOB), lists of barriers to mobilization, and the benefits of early mobilization. PDSA cycles were completed three times that led to revisions in the original protocol.

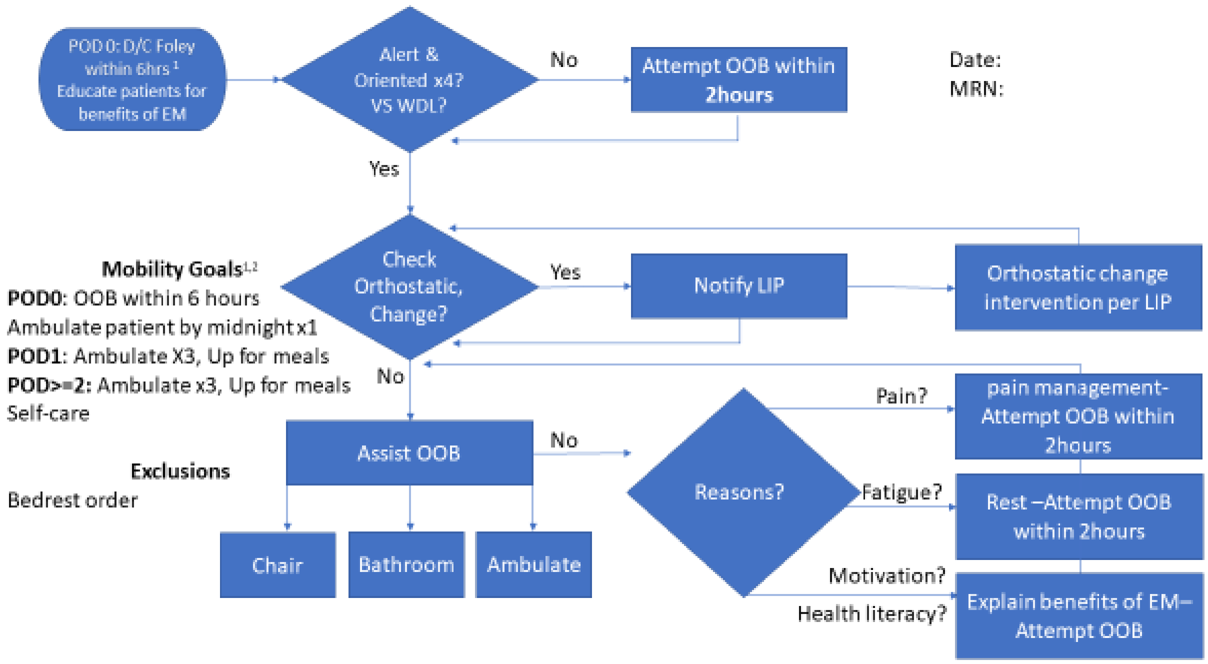
The following changes were made as a result of the PSDA testing: 1. The purpose and target population were added to the protocol as a reminder to all staff. 2. Patients were educated about the benefits of early mobilization in the first step of the protocol. 3. The scale to assess mental status was changed from the Glasgow Coma Scale to an assessment that the patient was alert and oriented. 4. The reasons patients refused to mobilize were added to the worksheet. 5. The stepwise process – out of bed, bathroom, and ambulation – was changed to destination options of chair, bathroom, and ambulation. These modifications resulted in the final protocol as found in Figure 4.

2. **Charge nurses** on the neurosurgery unit were recruited to act as EMP champions. They distributed the EMP worksheet to assigned nursing staff. The EMP champions acted as resource persons and encouraged staff to follow the protocol.
3. **Education of the nursing staff-** The doctoral student educated the nursing staff by distributing email and conducting one-on-one meetings and daily huddles. Information regarding the EMP and its importance in patient care was sent to all nursing staff via email (nursing group mail list, weekly email for two weeks). The email contained the steps and details of the protocol and the importance and benefits of early mobilization. One-on-one education sessions with champions and nursing staff were performed for two weeks. The nurse-driven EMP was presented during the daily huddles times, which occurred three times per week for two weeks. The EMP worksheet was posted on the unit visual management board where daily huddles were performed as well as staff restrooms. Lastly, copies of the nurse-driven EMP worksheet were distributed to all nursing staff on the neurosurgery unit.

4. **Implementing the protocol-** Three PDSA cycles were completed to test and refine the EMP. After the first two weeks of the implementation period, notifying and educating physical therapies (PTs) was needed as PTs could be the first professional other than nursing staff to mobilize patients after spine surgery. Information regarding the EMP and its importance in patient care was sent to all PTs on the neurosurgery unit via email, and PTs were also invited to fill out the early mobility worksheet. All spinal surgery patients were screened for the EMP by a champion. Patients with bedrest orders were excluded. EMP worksheets were stored at the nurse's station and posted on each patient's bedside board. This board was used as a communication board by listing the name of the care team, plan of care, activity goals, diet, and questions. Assigned nurses followed the EMP and documented patient's mobility under "care plan interventions" on the EMR as well as a worksheet. The worksheet (Appendix A) was collected daily by the charge nurses and stored in a locked office. To improve data collection, both the EMR and the worksheet were used. The date and time of the first mobilization were obtained manually from the EMR and the EMP worksheet for each patient. If there was a discrepancy between the EMR and the EMP worksheet, data was obtained from the EMP worksheet. After collection, data were de-identified and organized using Excel, and then the worksheets were disposed.

Figure 4

Nurse-driven Early Mobility Protocol



Note. Final Nurse-driven Early Mobility Protocol.
[1]Adapted from "Enhanced recovery after intraspinal tumor surgery: a single-institutional randomized controlled study," by Liu et al., 2020, World Neurosurgery, https://doi.org/10.1016/j.wneu.2020.01.067.;"Enhanced Recovery After Surgery (ERAS) program for lumbar spine fusion", by Smith et al., 2019, Perioperative Medicine, 1(4), https://doi.org/10.1186/s13741-019-0114-2.
[2] Adapted from "Clinical pathway: spine Enhanced Recovery After Surgery (ERAS)-simple spine pathway", 2019, University of Virginia Health System, https://www.healthsystem.virginia.edu/docs/manuals/guidelines/cpgguidelines/03-clinical-pathways/pathway-eras-simple-spine
[3]Modified based on PDSA cycles from Nurse-driven Early Mobility Protocol Draft. Changes were made by removing "GCS>12, stable VS?", adding "Alert & Oriented x4? and VS WDL?", separating destinations of OOB, and adding more reasons for patient's refusal.

Data Collection and Analysis

Data collection

Data were compared between the two groups. The pre-intervention or early mobilization protocol (EMP) group included patients who underwent spine surgery between October 12th and December 4th, 2019. The intervention or EMP group received the EMP and were tracked from October to December 2020. Data was collected from the EMR for both the pre-EMP and the

EMP group and entered into a database. The data from the EMR included the first time to OOB, discharge disposition, procedure codes, LOS, age, sex, and comorbidities such as hypertension, hyperlipidemia, coronary artery disease, obesity, diabetes mellitus, and obstructive sleep apnea as risks of perioperative complication increase with the number of comorbid factors which may have an impact on LOS (Epstein, 2014; Rupich, 2018). The LOS was calculated as the difference between the patient's admission time to the neurosurgery unit and the minute the discharge order was entered time in the EMR. As the QI project measures not only the outcome but also the process, the use of the EMP in the EMR or the EMP worksheet was used to measure compliance.

Data Analysis/Statistical Methods

Comparisons of patient characteristics and outcomes for the EMP group and the pre-EMP group were performed with t-tests for parametric continuous variables, the Mann-Whitney U test for non-parametric continuous variables, and chi-square tests for categorical variables. Assumptions for the Mann-Whitney U test for the LOS and the first time to OOB were met: 1. the variables of LOS and the first time to OOB were continuous dependent variables. 2. The independent variable of application of the EMP as identified in group membership (pre-EMP or EMP group) was categorical. 3. There was no relationship between the observations. 4. The distribution of LOS had a similar shape of skewness for both groups, and the first time to OOB had a slightly different distribution, although it still allowed to run the Mann-Whitney U test. Therefore, the Mann-Whitney U test was conducted to test the effect of the EMP on LOS and the first time to OOB. The data was analyzed using IBM SPSS software.

Results

Implementation of the EMP

The implementation period was 12 weeks, composed of two weeks of pilot testing, two weeks of educating the nursing staff, and eight weeks of implementing the EMP, from October 12th to December 4th, 2020. Pilot testing was performed using PDSA cycles, and the EMP was modified after these cycles were completed.

Outcomes of the EMP

Fifty-four patients were eligible for this project. Of those 54 patients, four patients did not receive the EMP, translating into a compliance rate with the EMP of 92.6%. Therefore, fifty patients received the EMP. Patient data from 2019 was obtained from a performance improvement coach at the doctoral student's practice site. Fifty-six patients in the 2019 pre-EMP group met the inclusion criteria. Thus, a total of 106 spinal surgery patients met inclusion criteria, 50 in the EMP group and 56 in the pre-EMP group.

Of those 106 patients, the mean age was 59 years, and a majority of the patients were male (54.7%). There were no significant differences in patient demographics of age, gender, comorbidities (hypertension, hyperlipidemia, coronary artery disease, obstructive sleep apnea, diabetes, and obesity), and dispositions before and after implementing the EMP (Table 1).

In the implementation phase of this project, the EMP was used for 50 patients. The LOS decreased from a range of 0.57-8.83 days in the pre-EMP group to a range of 0.06-6.67 days in the EMP group. The mean LOS decreased by 11 hours between the two groups, 46.3 hours to 35.3 hours, a difference of 11 hours, although it was not statistically significant ($U = 1157$, $p = 0.12$, $r = .15$). The first time to OOB was calculated by subtracting from the time when a patient was first mobilized from the patient's admission time to the unit. This measure was significantly decreased from 8.9 hours in the pre-EMP group to 3.9 hours in the EMP group ($U = 620$, $p < .001$, $r = .44$) (Table 2).

The discipline of the staff member who implemented the EMP was also tracked. A majority of patients (54%) were mobilized by the assigned RN, 22% by UAP alone, 8% by the RN and UAP combined, and 14% by physical therapists. The staff member who assisted with mobility was unknown in 2% of the EMP group. First out of bed to ambulate or to the bathroom or to chair was 44%, 40%, and 10%, respectively. There was 82% compliance with documentation of mobilization in the EMR.

Barriers to early mobility were identified by the person documenting on the worksheet as: late admission time (2), pain (1), orthostasis (1), and poor functional status at baseline (1). Two patients did not receive the EMP because of late admission time and poor functional status.

Discharge disposition was measured in both groups. Forty-nine (98%) of patients in the EMP group were discharged to home. Only one patient (2%) in the EMP group was discharged to a rehabilitation facility as compared to four patients (7%) in the pre-EMP group (Table 1).

Discussion

The purpose of this scholarly project was to evaluate the effect of a nurse-driven EMP on the LOS in patients following spine surgery. The aim of this project was to create a nurse-driven protocol to promote early mobilization that would be easy to implement among postoperative spine patients. The overall compliance rate of 92.6% supported the utility of the EMP. Additionally, the patients who received the EMP had a shorter LOS by 11 hours ($U = 1157$, $p = 0.12$, $r = .15$) and earlier first mobilization by 5 hours ($U = 620$, $p < .001$, $r = .44$) when compared to the pre-EMP group.

The mean LOS decreased by 24% from 46.3 hours in the pre-EMP group to 35.3 hours in the EMP group, a difference of 11 hours ($U = 1157$, $p = 0.12$, $r = .15$). Although it was not statistically significant, there was clinical significance in an individual patient due to the benefits of being mobilized earlier in their post-op period. This result is consistent with strong evidence that supports the use of EMPs to decrease the length of stay (Adogwa et al., 2017; Blackburn et al., 2016; Bradywood et al., 2017; Burgess & Wainwright, 2019; Elsarrag et al., 2019; Epstein, 2014; Feng et al., 2019; Kilic et al., 2019; Liu et al., 2020; Rupich et al., 2018; Shield et al., 2017; Sivaganesan et al., 2019; Staartijes et al., 2019; Wainwright et al., 2016; Wang et al., 2017). Reported reduction rates of LOS ranged from 11.9% (Grasu et al., 2018) to 66.9% (Wang et al., 2017).

A study that tested a nurse-driven EMP on a neuroscience unit by Rupich and colleagues showed a significant decrease in LOS by 9.1 hours with patients who underwent lumbar laminectomy, which was estimated a cost-saving of nearly $64,000 (Rupich et al., 2018). If the results of the Rupich study were extrapolated to this project, the reduction of 11 hours in LOS for those patients receiving the EMP suggests cost savings. Also, at the doctoral student's practice site, there was a need to meet the organizational benchmark of the average in-patient LOS from 6.4 days to 6.0 days. As this project showed decreased LOS by 11 hours with the use of the EMP, this nurse-driven project could be an effective addition to reduce LOS.

This QI project demonstrated a significant decreased first time to OOB from 8.9 to 3.9 hours, ($p < .001$). Early mobilization is considered a cornerstone in ERAS pathways for many surgeries (Bugess & Wainwright, 2019) as it is linked to reduced LOSs, reduced costs, reduced surgical site infection rates, and better pain control (Adogwa et al., 2017; Blackburn et al., 2016; Bradywood et al., 2017; Burgess & Wainwright, 2019; Elsarrag et al., 2019; Epstein, 2014; Feng et al., 2019; Kilic et al., 2019; Liu et al., 2020; Rupich et al., 2018; Shield et al., 2017; Sivaganesan et al., 2019; Staartijes et al., 2019; Wainwright et al., 2016; Wang et al., 2017).

Compliance with the protocol was high at 92.6% and was calculated by dividing the number of patients who received the EMP by the total number of patients who met the inclusion criteria during the implementation period. A similar QI project by Rupich and colleagues reported that the average protocol compliance was 87.3% per month when the same calculation method was applied (Rupich et al., 2018). Compliance with bedside standing and assisted walking on POD 1 was 90.4% in a study by Li and colleagues (2018). Another study by Soffin and colleagues reported a compliance rate of 85% to the ERAS program (Soffin et al., 2019). This project demonstrated a higher compliance rate than other studies, which is a strength of this scholarly project and suggests that the protocol was easy to implement among postoperative spine patients and the role of champions most likely supported a higher compliance rate.

The nursing team plays an essential role in promoting the daily mobility of the patient, and nurse-driven mobility programs have shown to increase early ambulation, improve patient functional status and reduce LOS in several studies (Padula et al., 2009; Pashikanti & Von Ah, 2012). Although PTs assisted 14% of patients in this project, the nursing staff mobilized the majority of patients (84%). This suggested that implementation of the EMP by the nursing staff was an effective way to promote early mobilization of post-op spine patients.

The common barriers to early mobilization after spine surgeries identified in the literature were inadequate staffing, high patient turnover, unstable patient status, pain, and a poor functional status (Sepulveda-Pacsi et al., 2016; Rupich et al., 2018). Pain, late admission time, orthostasis, and poor functional status were the four major barriers reported in this project consistent with the literature except for the late admission time (Sepulveda-Pacsi et al., 2016; Rupich et al., 2018). These barriers were identified as factors that prevented patients from receiving the EMP, or delayed patient's first time to out of bed. Rupich and colleagues (2018) reported that the compromised functional level of preoperative patients was the most important barrier to early mobility and demonstrated the use of ceiling lifts for compromised patients, and that severe pain was also a common barrier to ambulation (Rupich et al., 2018). Although only one case of pain was reported in this project, still better pain management is recommended for optimal patient conditions for early mobilization. Late admission time to the unit, such as after 2200, was one of the barriers that prevented patient's early mobility. Although it infrequently occurred, mobilizing patients as early as possible after adequate sleep is still encouraged for the benefits of early mobilization.

PDSA cycles were used to modify the protocol, which provided opportunities to find gaps between the protocol and clinical situations. This ultimately strengthened the EMP. While implementing the EMP, the need to modify the EMP was periodically evaluated. As a result, the EMP was changed. This included, informing and involving PTs in this project based on the need. Furthermore, a high compliance rate (92.6%) to the protocol suggested that the process of this QI project was successful. The role of champions and a daily reminder contributed to a high compliance rate and significantly decreased the first time of mobilization.

At the beginning of the QI project, the early mobility champions were reminded by the doctoral student about the EMP. After the four weeks, utilizing the EMP was observed without a daily reminder. However, after the completion of implementing the project, it is uncertain whether nurses were still following the EMP. Decreased compliance was also reported by Rupich and colleagues' study in 2018, which required providing refreshers at morning huddles, staff meetings, and in one-to-one education sessions to maintain the sustainability of the QI project (Rupich et al., 2018). The use of a designated person as an early mobility champion is also suggested for long-term sustainability.

Sharing the results of this QI project can be an effective way to sustain the positive outcomes of this project and use of the EMP. The development and implementation of this project can contribute to a positive culture change at the practice site. Blackburn and colleagues experienced a positive culture change after implementing an enhanced recovery program for elective spinal surgery patients as the team took ownership of the project by observing the impact of their work on improving the quality of patient care (Blackburn et al., 2016). The results of this QI project were distributed to the nursing staff and a new early mobility champion was recruited for the sustainability of the EMP.

Conclusion

In conclusion, the implementation of a nurse-driven EMP was successful in reduced LOS and promoting early mobilization, as shown by the significant decrease in the first time to OOB after spinal surgery. This intervention was feasible, demonstrated by high compliance with the use of the EMP. It also showed an impact of a nurse-driven protocol by changing the process of care, designed by utilizing the Donabedian framework and PDSA cycles. Finally, the high compliance rate of this protocol and the positive effect of the first time to OOB will require a focused effort on this unit. If this effort is sustained, this project should be considered and evaluated for potential implementation in other specialty settings.

References

Adogwa, O., Elsamadicy, A. A., Fialkoff, J. D., Cheng, J. S., Khalid, S. I., Karikari, I. O., & Bagley, C. A. (2017). Early ambulation decreases length of hospital stay, perioperative complications, and improves functional outcomes in elderly patients undergoing surgery for correction of adult degenerative scoliosis. *The Spine Journal*, 17(10), 111-112. http://doi.org/10.1016/j.spinee.2017.07.182

Allen, C., Glasziou, P., & Del Mar, C. (1999). Bed rest: a potentially harmful treatment needing more careful evaluation. *Lancet*, 354(9186), 1229–1233. http://doi.org/10.1016/s0140-6736(98)10063-6

Blackburn, J. M., Leung, P., Leung, Y., & Walburn, M. (2016). An enhanced recovery program for elective spinal surgery patients. *Journal of Clinical Outcomes Management*, 23(10), 462-469. https://www.mdedge.com/jcomjournal/article/146082/surgery/enhanced-recovery-program-elective-spinal-surgery-patients/page/0/3

Bradywood, A., Farrokhi, F., Williams, B., Kowalczyk, M., & Blackmore, C.C. (2017). Reduction of inpatient hospital length of stay in lumbar fusion patients with implementation of evidence-based clinical care pathway. *Spine*, 42(3), 169-176. http://doi.org/10.1097/BRS.0000000000001703

Braga, M., Pecorelli, N., Ariotti, R., Capretti, G., Greco,M., Balzano, G., Castoldi, R., & Beretta, L. (2014). Enhanced recovery after surgery pathway in patients undergoing pancreaticoduodenectomy. *World J. Surg*, 38(11), 2960–2966. http://doi.org /10.1007/s00268-014-2653-5.

Burgess, L. C., & Wainwright, T. W. (2019). What is the evidence for early mobilisation in elective spine surgery? A narrative review. *Healthcare*, 7(3), 92. http://doi.org/10.3390/healthcare7030092

Calotta, N. A., Coon, D., Bos, T., Ostrander, B. T., Scott, A. V., Grant, M. C., Efton, J. E., & Sacks, J. M. (2019). Early ambulation after colorectal oncologic resection with perineal reconstruction is safe and effective. *Am J Surg*, 218(1),125-130. http://doi.org/ 10.1016/j.amjsurg.2018.10.005

Castella, L., Sopena, N., Rodriguez-Montserrat, D., Alonso-Fernandez, S., Cavanilles, J. M., Iborra, M., Ciercoles, A., Pulido, A., Gimenez, M., Hermoso, J. A. H., & Casas, I. (2019). Intervention to reduce the incidence of surgical site infection in spine surgery. *Journal of Infection Control*, 48(5), 550-554. https://doi.org/10.1016/j.ajic.2019.09.007

Chakravarthy, V. B., Yokoi, H., Coughlin, D. J., Manlapaz, M. R., & Krishnaney, A.A. (2019). Development and implementation of a comprehensive spine surgery enhanced recovery after surgery protocol: the Cleveland clinic experience. *Neurosurg Focus*, 46(4). http://doi.org/10.3171/2019.1.FOCUS18696.

Chen, C. Y., Chang, C. W., Lee, S. T., Chen, Y. C., Tang, S. F. T., Cheng, C. H., & Lin, Y. H. (2015). Is rehabilitation intervention during hospitalization enough for functional improvements in patients undergoing lumbar decompression surgery? A prospective randomized controlled study. *Clinical Neurology and Neurosurgery*, 129(1), 41-46. http://doi.org/ 10.1016/S0303-8467(15)30011-1

De Almeida, E. P. M., De Almeida, J. P., Landoni, G., Galas, F. R. B. G., Fukushima, J. T., Fominsky, E., De Brito, C. M. M., Cavichio, L. B. L., De Almeida, L. A. A., Ribeiro-Jr, U., Osawa, E. A., Diz, M. P., Cecatto, R. B., Battistella, L. R., & Hajjar, L. A. (2017).

Early mobilization programme improves functional capacity after major abdominal cancer surgery: a randomized controlled trial. *British Journal of Anaesthesia*, 119(5), 900-907. http://doi.org/10.1093/bja/aex250

Debono, B., Corniola, M. V., Pietton, R., Sabatier, P., Hamel, O. & Tessitore, E. (2019). Benefits of Enhanced Recovery After Surgery for fusion in degenerative spine surgery: impact on outcome, length of stay, and patient satisfaction. *Journal of Neurosurgery*, 46(4). http://doi.org/10.3171/2019.1.FOCUS18669

Dieleman, J. L., Baral, R., Birger, M., Bui, A. L., Bulchis, A., Chapin, A., Hamavid, H., Horst, C., Johnson, E. K., Joseph, J., Lavado, R., Lomsadze, L., Reynolds, A., Squires, E., Campbell, M., DeCenso, B., Dicker, D., Flaxman, A. D., Gabert, R., … Murray, C. J. L. (2016). US spending on personal health care and public health, 1996-2013. *JAMA*. 316(24), 2627-2646. http://doi.org/10.1001/jama.2016.16885

Doherty-King, B., Yoon, J. Y., Pecanac, K., Brown, R., & Mahoney, J. (2014). Frequency and duration of nursing care related to older patient mobility. *Journal of Nursing Scholarship*, 46(1), 20–27. http://doi.org/10.1111/jnu.12047

Donabedian A. (1988). The quality of care. How can it be assessed? *JAMA*, *260*(12), 1743–1748. https://doi-org.proxy01.its.virginia.edu/10.1001/jama.260.12.1743

Elsarrag, M., Soldozy, S., Patel, P., Norat, P., Sokolowski, J., Park, M., Tvrdik, P., Yashar, M., & Kalani, M. Y. S. (2019). Enhanced recovery after spine surgery: a systematic review. *Neurosurgical Focus*, 46(4). http://doi.org/10.3171/2019.1.FOCUS18700

Epstein, N. E. (2014). A review article on the benefits of early mobilization following spinal surgery and other medical/surgical procedures. *Surgical Neurology International*, 5, 66-73. http://doi.org/10.4103/2152-7806.130674

Feng, C., Zhang, Y., Chong, F., Yang, M., Liu, C., Liu, L., Huang, C., Huang, C., Xiaoqing, F., Wang, X., Chu, T., Zhou, Y., & Huang, B. (2019). Establishment and implementation of an Enhanced Recovery After Surgery (ERAS) pathway tailored for minimally invasive transforaminal lumbar interbody fusion surgery. *World Neurosurgery*, 129, 317-323. http://doi.org/10.1016/j.wneu.2019.05.139

Freeman, W. J., Weiss A. J., & Heslin, K. C. Agency for Healthcare Research and Quality (2018). *Overview of U.S. Hospital Stays in 2016: Variation by Geographic Region: Statistical Brief #246*

Grasu, R. M., Cata, J. P., Dang, A. Q., Tatsui, C. E., Rhines, L. D., Hagan, K. B., Bhavsar, S., Raty, S. R., Arunkumar, R., Potylchansky, Y., Lipski, I., Arnold, B. A., McHugh, T. M., Bird, J. E., Rodriguez-Restrepo, A., Hernandez, M., & Popat, K. U. (2018). Implementation of an enhanced recovery after spine surgery program at a large cancer center: a preliminary analysis. *Journal of Neurosurgery: Spine*, 29(5), 588–598. http://doi.org/10.3171/2018.4.spine171317

Kalisch, B. J., Lee, S., & Dabney, B. W. (2013). Outcomes of inpatient mobilization: a literature review. *Journal of Clinical Nursing*, 23(11-12), 1486-1501. http://doi.org/10.1111/jocn.12315

Kalisch, B. J., Tschannen, D., Lee, H., & Friese, C. R. (2011). Hospital variation in missed nursing care. *American Journal of Medical Quality*, 26(4), 291-299. http://doi.org/10.1177/1062860610395929.

Kehlet, H. (1997). Multimodal approach to control postoperative pathophysiology and rehabilitation. *British Journal of Anaesthesia*, 78(5), 606–617. http://doi.org/10.1093/bja/78.5.606

Kılıç, E. T., Demirbilek, T., & Naderi, S. (2019). Does an enhanced recovery after surgery protocol change costs and outcomes of single-level lumbar microdiscectomy? *Neurosurgical Focus*, 46(4). http://doi.org/10.3171/2019.1.focus18665

Langley, G. L., Nolan, K. M., Nolan, T. W., Norman, C. L., Provost, L. P. (2009). *The improvement guide: a practical approach to enhancing organizational performance* (2nd ed.). San Francisco: Jossey-Bass Publishers

Li, J., Li, H., Xv, Z. K., Wang, J., Yu, Q. F., Chen, Li, F. C., Ren, Y., & Chen, Q. X. (2018). Enhanced recovery care versus traditional care following laminoplasty. A retrospective case-cohort study. *Medicine*, 97(48). http://doi.org/10.1097/MD.0000000000013195

Liu, B., Liu, S., Wang, Y., Zhao, L., Zheng, T., Chen, L., Zhang, Y., Xue, Y., Lu, D., M, T., Zhao, B., Gao, G., Qu, Y., & He, S. (2020). Enhanced recovery after intraspinal tumor surgery: a single-institutional randomized controlled study. *World Neurosurgery*, 136, 542-552. https://doi.org/10.1016/j.wneu.2020.01.067

Martin, B., Mirza, S. K., Spina, N., Spiker, W. R., Lawrence, B., & Brodke, D. S. (2019). Trends in lumbar fusion procedure rates and associated hospital costs for degenerative spinal diseases in the United States, 2004 to 2015. *Spine*, 44(5), 369-376. http://doi.org/10.1097/BRS.0000000000002822.

McDonald, K. M., Sundaram, V., Bravata, D. M., Lewis, R., Lin, N., Kraft, S. A., McKinnon, M., Paguntalan, H., & Owens, D. K. Agency for Healthcare Research and Quality (2007). *Closing the quality gap: a critical analysis of quality improvement strategies (Vol. 7: Care Coordination).*

National Institute of Neurological Disorders and Stroke. (2020, April 24). *Low Back Pain Fact Sheet*. https://www.ninds.nih.gov/disorders/patient-caregiver-education/fact-sheets/low-back-pain-fact-sheet#3102_7

Nielsen, P. R., Jørgensen, L. D., Dahl, B., Pedersen, T., & Tønnesen, H. (2010). Prehabilitation and early rehabilitation after spinal surgery: randomized clinical trial. *Clinical Rehabilitation*, 24(2), 137–148. http://doi.org/10.1177/0269215509347432

Ostelo, R. W., Costa, L. O., Maher, C. G., de Vet, H. C., & van Tulder, M. W. (2009). Rehabilitation after lumbar disc surgery: an update Cochrane review. *Spine*. 34(17), 1839-1848. http://doi.org/10.1097/BRS.0b013e3181abbfdf

Padula, C. A., Hughes, C., & Baumhover, L. (2009). Impact of a nurse-driven mobility protocol on functional decline in hospitalized older adults. *Journal of Nursing Care Quality*, 24(4), 325-331. http://doi.org/10.1097/NCQ.0b013e3181a4f79b

Pashikanti, L., & Von Ah, D. (2012). Impact of early mobilization protocol on the medical-surgical inpatient population. *Clinical Nurse Specialist*, 26(2), 87–94. http://doi.org/ 10.1097/nur.0b013e31824590e6

Pitter, F. T., Lindberg-Larsen, M., Pedersen, A. B., Dahl, B., & Gehrchen, M. (2019). Readmissions, length of stay, and mortality after primary surgery for adult spinal deformity. *Spine*, 44(2), 107-116. http://doi.org/10.1097/brs.0000000000002782

Qvarfordh P., Olsen, K. S., Bendix, T., & Esbensen, B. A. (2014). Should patients walk from the postanesthesia care unit to the general ward After a lumbar discectomy? A randomized study. *Journal of PeriAnesthesia Nursing*, 29(5), 377-384. http://doi.org/10.1016/j.jopan.2013.10.006

Rubin, D. I. (2007). Epidemiology and risk factors for spine pain. *Neurologic Clinics*, 25(2), 353-371. http://doi.org/10.1016/j.ncl.2007.01.004

Rupich, K., Missimer, E., O'Brien, D., Shafer, G., Wilensky, E. M., Pierce, J. T., Kerr, M., Kallan, M. J., Dolce, D., & Welch, W. C. (2018). The benefits of implementing an early mobility protocol in postoperative neurosurgical spine patients. *American Journal of Nursing*, 118(6), 46–53. http://doi.org/10.1097/01.naj.0000534851.58255.41

Sarosiek, B. (2019). *Clinical pathway for Enhanced Recovery After Surgery (ERAS) simple spine; accompanies related ERAS simple spine protocol.* https://www.healthsystem.virginia.edu/docs/manuals/guidelines/cpgguidelines/03-clinical-pathways/pathway-eras-simple-spine

Sepulveda-Pacsi, A., Soderman, M., & Kertesz, L. (2016). Nurses' perceptions of their knowledge and barriers to ambulating hospitalized patients in acute settings. *Applied Nursing Research*, 32, 117-121. http://doi.org/10.1016/j.apnr.2016.06.001

Shields, L. B. E., Clark, L., Glassman, S. D., & Shields, C. B. (2017). Decreasing hospital length of stay following lumbar fusion utilizing multidisciplinary committee meetings involving surgeons and other caretakers. *Surgical Neurology International*, 8(5). http://doi.org/10.4103/2152-7806.198732

Sivaganesan, Al., Wick, J. B., Chotai, S., Cherkesky, C., Stephens, B. F., & Devin, C. J. (2019). Perioperative protocol for elective spine surgery is associated with reduced length of stay and complications. *American Academy of Orthopaedic Surgeons*, 27(5), 183-189. http://doi.org/10.5435/JAAOS-D-17-00274

Smith, J., Probst, S., Calandra, C., Davis, R., Sugimoto, K., Nie, L., Gan, T. J., & Bennett-Guerrero, E. (2019). Enhanced Recovery after Surgery (ERAS) program for lumbar spine fusion." *Perioperative Medicine*, 8(4). https://doi.org/10.1186/s13741-019-0114-2

Soffin, E. M., Vaishnav, A. S., Wetmore, D. S., Barber, L., Hill, P., Gang, C. H., Beckman, J. D., Albert, T. J., & Qureshi, S. A. (2019). Design and implementation of an Enhanced Recovery After Surgery (ERAS) program for minimally invasive lumbar decompression spine surgery. *Spine*, 44(9), 561-570. http://doi.org/10.1097/brs.0000000000002905

Spine-health. (2020, June 9). *Back Surgery Definition*. https://www.spine-health.com/glossary/back-surgery

Staartjes, V. E., Wispelaere, M. P. D., & Schröder, M. L. (2019). Improving recovery after elective degenerative spine surgery: 5-year experience with an enhanced recovery after surgery (ERAS) protocol. *Neurosurgical Focus*, 46(4). http://doi.org/10.3171/2019.1.focus18646

U.S. Department of Health and Human Services Health Resources and Services Administration. (2011). *Quality Improvement.* https://www.hrsa.gov/sites/default/files/quality/toolbox/508pdfs/qualityimprovement.pdf

Wainwright, T. W., Immins, T., & Middleton, R. G. (2016). Enhanced recovery after surgery (ERAS) and its applicability for major spine surgery. *Best Practice & Research Clinical Anaesthesiology*, 30(1), 91-102. http://doi.org/10.1016/j.bpa.2015.11.001.

Wang, M. Y., Chang, PY., & Grossman, J. (2017). Development of an Enhanced Recovery After Surgery (ERAS) approach for lumbar spinal fusion. *Journal Neurosurg Spine*, 26(4), 411-418. http://doi.org/10.3171/2016.9.SPINE16375.

Zakaria, H. M., Bazydlo, M., Schultz, L., Abdulhak, M., Nerenz, D. R., Chang, V., & Schwalb, J. M. (2019a). Ambulation on postoperative day #0 is associated with decreased morbidity and adverse events after elective lumbar spine surgery: analysis from the michigan spine surgery improvement collaborative (MSSIC). *Neurosurgery,* 0(0), 1-9. https://doi.org/10.1093/neuros/nyz501

Zakaria, H. M., Bazydlo, M.., Schultz, L., Pahuta, M. A., Schwalb, J. M., Park, P., Aleem, I., Nerenz, D. R., & Chang, V. (2019b). Adverse events and their risk factors 90 days after cervical spine surgery: analysis from the Michigan spine surgery improvement collaborative. *Journal of Neurosurgery Spine*., 30, 1–13. https://doi.org/10.3171/2018.10.SPINE18666.

Table 1. *Demographic characteristics of the pre-EMP and EMP groups*

	Total **N = 106**	**Pre- EMP** **N = 56**	**EMP** **N = 50**	**P value**
Age				
Mean, Standard Deviation	58.94 (12.91)	58.85 (12.88)	59.04 (13.07)	0.94
Gender				0.52
Male	58 (54.7%)	29 (51.8%)	29 (58%)	
Female	48 (45.3%)	27 (48.2%)	21 (42%)	
Disposition				0.21
Home	101 (95.3 %)	52 (93%)	49 (98%)	
Rehab Facility	3 (2.8%)	2 (3.5%)	1 (2%)	
SNF	2 (1.9%)	2 (3.5%)	0 (0%)	
Comorbidities				
HTN	56 (52.8%)	29 (51.8%)	27 (54%)	0.82
HLD	38 (35.8%)	17 (30.3%)	21 (42%)	0.21
CAD	10 (9.4%)	5 (8.9 %)	5 (10%)	0.85
OSA	27 (25.5%)	14 (25%)	13 (26%)	0.91
DM	17 (16%)	10 (17.9%)	7 (14%)	0.59
Obesity	6 (5.7%)	3 (5.3%)	3 (6%)	0.87

Table 2. *Length of stay and first time to out of bed*

	Total **N = 106**	**Pre- EMP** **N = 56**	**EMP** **N = 50**	**P value**
LOS				
Days (Mean, SD[1])	1.71 (1.44)	1.93 (1.64)	1.47 (1.16)	
Hours (Mean, SD)	41.1 (34.6)	46.3 (39.3)	35.3 (27.8)	
Hours (Median, IQR[2])	31.3 (24.61)	39.33 (45.66)	21.72 (23.32)	0.12
First time to out of bed				
Hours (Mean, SD)	6.4 (6.5)	8.9 (6.8)	3.9 (5.1)	
Hours (Median, IQR)	3.47 (9.32)	6.3 (13.73)	2.0 (3.48)	< 0.001

[1]SD: Standard Deviation; [2]IQR: interquartile range

Table 3. *Studies of effects of early mobility protocol*

Citation	Study Design & Purpose	Sample size	Intervention	Outcome Measures	Findings
Adogwa, O., Elsamadicy, A. A., Fialkoff, J. D., Cheng, J. S., Khalid, S. I., Karikari, I. O., & Bagley, C. A. (2017)	Ambispective cohort review to examine the effects of early mobilization on patient outcomes, complications profile, and 30-day readmission rates	Sample of 125 elderly patients (>65 years) undergoing elective spinal surgery for correction of adult degenerative scoliosis	Patients in the early ambulators and late ambulators	Complications rates, duration of hospital stay and 30-day readmission rates	Early ambulation after spinal surgery was associated with decreased perioperative complications (30% vs. 54%, P=0.06), reduced length of stay (5.33 days vs. 8.11 days, p=0.01), and improved functional status. The majority of patients in the early ambulation group discharged to home after spinal surgery than the late ambulation group (71.2% vs. 22.0%, p=0.01).
Blackburn, J. M., Leung, P., Leung, Y., & Walburn, M. (2016)	Retrospective analysis (pre/post ERAS implementation) to describe the clinical pathway for patients undergoing elective spine surgery to improve quality of care and reduce length of stay	Patients with elective spinal surgery, sample size not mentioned	ERAS protocol with "Bums off Beds" implementation	LOS, patient satisfaction, readmission rate	Length of stay was reduced by 52%, improved from 5.7 days to 2.7 days. High patient satisfaction was also reported. ERAS protocol improved reliability of care and a significant financial benefit by reduced length of stay by 52%.
Bradywood, A., Farrokhi, F., Williams, B., Kowalczyk, M., & Blackmore, C.C. (2017)	Retrospective analysis (pre/post evidence based clinical care pathway implementation adaption of "Lean") to improve lumbar spine postoperative care and quality outcomes using a series of Lean quality improvement	A total of 458 patients with non-complex lumbar fusion (less than six levels), 244 (ERAS) vs. 214 (non-ERAS)	ERAS protocol with mobilization protocol	LOS, patient disposition, pain and falls	LOS decreased from 3.9 to 3.4 days, (CI 0.3, 0.8, P<0.001). 75% of patients were discharged to home (75% vs. 64%, P=0.002) although patient satisfaction scores were not significantly changed. Lean methods to produce standardized clinical pathways was effective in improving quality and reduce waste for lumbar spine fusion patients.
Burgess, & Wainwright. (2019)	Narrative review to evaluate the effect of early mobilization following elective spinal surgery on LOS, postoperative complications, performance-based	14 Research articles, all designs	Early mobilization protocol, enhanced recovery (also termed "rapid recovery or fast-track")	LOS, post-op complication rate, patient disposition, readmission rate, performance-based function, patient-reported	Goal-directed early mobilization reduced LOS and complication rate. Early mobilization was also associated with improved performance-based functional tests and patient-reported outcome measures.

	function and patient-reported outcomes		program inclusive of an early mobilization intervention	outcome measure, intervention adherence	
Castella, L., Sopena, N., Rodriguez-Montserrat, D., Alonso-Fernandez, S., Cavanilles, J. M., Iborra, M., Ciercoles, A., Pulido, A., Gimenez, M., Hermoso, J. A. H., Casas, I. (2019)	Quasi-experimental pre-test/post-test study to examine the incidence, characteristics, and risk factors of surgical site infections after spine surgery and evaluates the efficacy of a preventive intervention	139 patients undergoing spinal surgery in an orthopedic surgery department from December 2014 to November 2016	Preventative protocol with modification of wound dressing, staff training, and feedback	Incidence of surgical site infection	Fourteen cases of surgical site infection (SSI) were found out of the 139 patients, with a significant decrease in the incidence of SSIs from the pre-intervention period to the post-intervention period (19.4% vs 2.6%; P = .001). Statistical analysis suggested early ambulation was one of the risk factors for preventing SSI.
Chakravarthy, V. B., Yokoi, H., Coughlin, D. J., Manlapaz, M. R., & Krishnaney, A. A. (2019)	Retrospective analysis (pre/post ERAS implementation) to determine the effectiveness of ERAS protocols for spine surgery	A total of 1770 patients underwent multilevel lumbar or thoracolumbar spinal fusion, 799 (ERAS) vs. 971(non-ERAS)	ERAS protocols including early mobilization protocol	Infection prevention, blood management	Forty surgical site infections were reported in the pre-intervention group (4.12% vs. 2.00%; RR 0.48, 95% CI:0.27-0.86, P=0.01). After implementing the intervention, perioperative transfusion rates decreased from 20.1% to 7.7%(p=0.004). There were no significant changes in morbidity or mortality rates.
Chen, C.-Y., Chang, C.-W., Lee, S.-T., Chen, Y.-C., Tang, S. F.-T., Cheng, C.-H., & Lin, Y.-H. (2015)	RCT to examine outcomes of perioperative rehabilitation intervention for patients who underwent lumbar decompression surgery	60 patients aged 18-65 years old who received rehabilitation intervention during hospitalization for lumbar decompression surgery	Early perioperative rehabilitation intervention	Pain, functional capacity, Roland-Morris Disability Questionnaire (RMDQ), and Short-Form Health Survey (SF-12)	Patients with early perioperative rehabilitation intervention demonstrated significant pain relief, improvement of disability, and quality of life, but functional improvements were not significant.

Elsarrag, M., Soldozy, S., Patel, P., Norat, P., Sokolowski, J., Park, M., … Kalani, M. Y. S. (2019)	Systematic Review to examine studies investigating the application of formal ERAS programs to patients undergoing spine surgery	20 research articles, all designs	ERAS pathway including early mobilization	LOS, readmission rate, complications	Twenty full-text articles were reviewed, and the majority of studies were retrospective reviews. After implementing an ERAS pathway, most studies demonstrated reduced lengths of stay and no increase in rates of readmissions or complications. This suggested ERAS protocols for spine procedures can promote functional status, and reduce LOS, postoperative pain and costs.
Epstein, N. E. (2014)	Systematic Review to examine the effectiveness of early mobilization and other adjunctive measures on morbidity and LOS in both medical and/or surgical series, and report their treatment strategies for spinal patients	18 research articles, all designs	Early mobilization protocol	Complications/ morbidity, LOS	Early mobilization protocols reduced the incidence of complications such as respiratory decompensation/pneumonias, deep venous thrombosis/pulmonary embolism, urinary tract infections, sepsis or infection), along with the average LOS.
Feng, C., Zhang, Y., Chong, F., Yang, M., Liu, C., Liu, L., … & Huang, B. (2019)	Retrospective analysis (pre/post ERAS implementation) to examine the effects of implementation of the ERAS pathway for minimally invasive surgery (MIS) transforaminal lumbar interbody fusion (TLIF)	Patients with MIS TLIF, 44 (ERAS) vs. 30 (pre-ERAS)	ERAS Pathway with mobilization protocol (get out of bed on POD 1)	Compliance with ERAS components, LOS, 30-day readmission rate, 30-day reoperation rate, and financial cost	Patients with the ERAS pathway demonstrated reduced LOS and cost compared to pre-ERAS group, but there were no significant differences in complication rate, 30-day readmission and reoperation rate.
Grasu, R. M., Cata, J. P., Dang, A. Q., Tatsui, C. E., Rhines, L. D., Hagan, K. B., … Popat, K. U. (2018)	Retrospective analysis (pre/post ERSS implementation) to evaluate the effect of an Enhanced Recovery After Spine Surgery (ERSS) programs in a US academic cancer center	Patients with spine surgery for metastatic tumors, 41 (ERSS) vs. 56 (non-ERSS)	ERSS protocol with early mobilization (out of bed on POD1, 3 times daily, bed to chair, chair to bed at minimum assist level. By discharge: ambulate at minimum assist	Pain, LOS, readmission rate and postoperative complications	Patients with an ERSS program showed better pain scores and decreased opioid consumption compared with the pre-ERSS group, but there were no significant differences in LOS, 30-day readmission rate, or 30-day complication rate.

			level for 50 ft with or without an assistive device; if non-ambulatory, bed to chair, chair to bed transfers at minimum level)		
Kılıç, E. T., Demirbilek, T., & Naderi, S. (2019)	Retrospective analysis (pre/post ERAS implementation) to evaluate the benefits of ERAS in single-level lumbar microdiscectomy	Patients underwent single-level lumbar microdiscectomy, 60 (ERAS) vs. 60 (non-ERAS)	ERAS protocols including early mobilization protocol (sit out of the bed for mobilization within 2 hours)	Time to first mobilization, Postoperative nausea/vomiting (PONV), Preoperative-postoperative VAS pain scores, postoperative analgesic requirement and LOS	Patients in the ERAS group had first oral intake and first mobilization significantly earlier than the non-ERAS group (p =0.001), and the incidence of PONV was less in the ERAS group (p=0.001). Pain scores and postoperative analgesic requirements were significantly less in the ERAS group (p=0.001). LOS was significantly shorter in the ERAS group (30.10 ± 7.80 hours pre-ERAS vs. 26.52 ± 5.16 hours ERAS, p=0.001)
Li, J., Li, H., Xv, Z. K., Wang, J., Yu, Q. F., Chen, Li, F. C., Ren, Y., & Chen, Q. X. (2018)	Retrospective case-cohort study to compare the incidences of complications and LOS after laminoplasty between an ERAS group and a traditional care group	Patients with laminoplasty, 114 (ERAS) vs. 110 (traditional group)	ERAS protocol with early mobilization included on-bed movement on the day of surgery, as well as sitting and assisted walking on the postoperative day 1	Physiological function (early eating, mobilize, postoperative pain (VAS), LOS, postoperative complications, adverse reactions and protocol compliance	The ERAS protocol is safe and feasible and can decrease the LOS without increasing the risk of complications. The first time of ambulation (30.79±14.45 hours ERAS group vs. 65.24±25.34 hours traditional group, P<.001) and oral intake were significantly improved in the ERAS group. LOS was significantly shorter in the ERAS group (5.75±2.46 days ERAS vs. 7.67±3.45day traditional group, P<.001). Pain control was better in the ERAS group than traditional care group in terms of mean VAS score (2.72 ± 0.46 vs. 3.35 ± 0.46, P<.001). The morbidity rate was 21.05% (24 of 114 patients) in the ERAS group and 20.90% (23 of 110 patients) in the control group (P=.75).
Liu, B., Liu, S., Wang, Y., Zhao, L., Zheng, T., Chen, L., Zhang, Y.,	RCT (a single-institutional prospective RCT) to evaluate the safety and efficacy of an enhanced recovery after surgery	Patients with intraspinal tumor surgery, 94 (48 in ERAS vs. 46 control group)	ERAS protocol including in-bed mobilization, 6 hours after surgery early	LOS, postoperative pain score, pain medication use, urinary catheterization,	LOS was significantly reduced in patient with ERAS protocol (5 vs. 8 days; P < 0.001). Better pain scores (1.0±1.3 vs. 1.9±1.3; P=0.007), and decreased use of analgesics (patient controlled analgesia 4.2% vs.19.6%; P (0.020); oral

Xue, Y., Lu, D., M, T., Zhao, B., Gao, G., Qu, Y., & He, S. (2020)	(ERAS) program for intraspinal tumors		ambulation, POD 1	ambulation, mortality, reoperation/readmission rates, complication rates, patient satisfaction, and overall cost	opioid (37.5% vs. 58.7%; P (0.040)) observed in the ERAS group. Early urinary catheter removal (58.3% vs. 6.5%; P < 0.001) and higher satisfaction scores (91.8 ± 4.4 vs. 88.2 ± 6.8; P (0.022)) were reported in the ERAS group. More patients in the ERAS group ambulated on POD 1 than the control group (68.8% vs. 17.4%; P < 0.001). Mortality or 30-day readmission were not reported in both groups, and the postoperative complication rates did not differ between two groups.
Nielsen, P. R., Jørgensen, L. D., Dahl, B., Pedersen, T., & Tønnesen, H. (2010)	RCT to evaluate the outcome of pre-habilitation and early rehabilitation after spinal surgery	Patients underwent for lumbar fusion or decompression followed by inpatient rehabilitation for degenerative lumbar disease, early rehabilitation (28) vs. standard care (32)	Early mobilization protocol with pre-habilitation and early rehabilitation	Postoperative stay, complications, functionality, pain and satisfaction	Improved functional status (p=0.001), shorter LOS (5 vs.7 days, p=0.007), and higher patient satisfaction were observed in the early rehabilitation group. There was no difference in postoperative complications, adverse events, low back pain and radiating pain, timed up and go, sit-to-stand or in life quality.
Pitter, F. T., Lindberg-Larsen, M., Pedersen, A. B., Dahl, B., & Gehrchen, M. (2019)	Cohort study to evaluate outcome after primary surgery for adult spinal deformity (ASD) and investigate risk factors for extended length of stay and readmission within 90 days	892 patients older than 18 years old undergoing primary instrumented surgery for ASD in Denmark in the period 2006 to 2016	Sex, age, comorbidity burden score	LOS, readmissions, and mortality	Median LOS was 8 days, and a total of 175 (28%) patients had extended LOS; 81% was because of complications. Pain and mobilization difficulties was the most common reason (>50%) for extended LOS.
Qvarfordh P., Olsen, K. S., Bendix, T., &	RCT to evaluate the feasibility and safety of mobilizing patient	Patients with lumbar discectomy,	Mobilizing patients to sit, stand and visit	Postoperative complications, pain, patient	Early mobilization, less use of analgesic and oxygen supplement were reported in the interventional group. There were no significant

Esbensen, B. A. (2014)	immediately after lumbar disc surgery	intervention Group n=12 vs. control group n=11	the toilet at least one hour after surgery in PACU	experience, time to mobilization in the general ward and LOS	differences in the LOS and the number of postoperative complications in the two groups during the three weeks after surgery.
Rupich, K., Missimer, E., O'brien, D., Shafer, G., Wilensky, E. M., Pierce, J. T., … Welch, W. C. (2018)	Retrospective analysis to establish an NP-led early mobility protocol to reduce LOS and reduce the variability of postsurgical care. To educate and empower nursing staff to implement the early mobility protocol to improve patient care	Uncomplicated neurosurgery patients who met the inclusion criteria for the early mobility protocol, 715 (275 control group vs. 440 intervention group)	Early mobility protocol	LOS	A nine-hour reduction in LOS of neurosurgical spine patients who underwent lumbar laminectomies was reported after implementing the early mobility protocol. The protocol acted as a catalyst for patient involvement in their postoperative mobility while allowing nurses more autonomy in patient care.
Shields, L. B. E., Clark, L., Glassman, S. D., & Shields, C. B. (2017)	Retrospective analysis (multidisciplinary meetings implementation in 2011, data from 2011-2014) to introduce utilization of multidisciplinary committee meetings between surgeons and other health care providers to decrease LOS following spinal fusion surgery	1978 patients with spine fusion	Multidisciplinary meetings with ambulation protocol (POD 0; Sits on edge of bed; POD1: Physical therapy on two occasions; POD2: Walking in hall and climbing stairs)	LOS and readmission rate	LOS improved over the three years of intervention implementation. There was a statistically significant improvement in cost initially for 2012–2013 vs. 2011–2012 ($P < 0.001$) and for 2013–2014 vs. 2011–2012 ($P = 0.001$).
Sivaganesan, Al., Wick, J. B., Chotai, S,. Cherkesky, C., Stephens, B. F., & Devin, C. J. (2019)	Retrospective analysis (pre/post perioperative protocol) to compare 90-day outcomes and complications before and after implementation of the perioperative elective spine surgery protocol	Patients with elective lumbar or cervical surgery, Pre-protocol n= 1596 vs. post-protocol n= 151	Perioperative protocol with bedrest after durotomy protocol (immediate mobilization if water-tight primary closure achieved; 24hr bedrest only if primary repair	90-day complication rate, EQ-5D, ODI, neck disability index, back and leg pain, patient satisfaction, LOS and discharge disposition	Reduced LOS (p=0.013) and odds of 90-day complications (p=0.009) was reported for post-protocol patients according to multivariate regression analyses. No differences in readmissions, discharge status, or 3-month patient-reported outcomes were observed.

			is poor; patients should lay flat only if symptoms arise) and mobilizing patients on POD 1		
Smith, J., Probst, S., Calandra, C., Davis, R., Sugimoto, K., Nie, L., Gan, T. J., & Bennett-Guerrero, E. (2019)	Retrospective analysis (pre/post ERAS implementation) to test the effectiveness of the ERAS protocol in case cancelations, postoperative nausea and vomiting, length of stay, postoperative pain, and postoperative narcotic use	Patients with lumbar surgery, 230 (pre-ERAS 123 VS. post-ERAS 96)	ERAS protocol including early mobilization (Mobilize out of bed on POD1)	Postoperative nausea and vomiting, length of stay, postoperative pain, and postoperative narcotic use.	There was no significant difference in postoperative pain scores, LOS and the number of short-acting opioids used between two groups, but there was a decrease in the use of long-acting opioids in the post-ERAS group (14.6 to 5.2%, $p = 0.025$). Patients with the ERAS protocol required fewer antiemetic medications in the recovery room (40 to 24%). Although implementing an ERAS bundle for 1–2-level lumbar fusion had minimal effect in reducing LOS, a significant decrease in postoperative opioid and antiemetic use was observed. This study showed mixed results of ERAS bundles due to poor ERAS protocol compliance. Compliance with preoperative and intraoperative medication interventions was relatively good, about 80%, but compliance with postoperative elements such as early physical therapy, early mobilization, and early removal of the urinary catheter was poor.
Soffin, E. M., Vaishnav, A. S., Wetmore, D. S., Barber, L., Hill, P., Gang, C. H., … Qureshi, S. A. (2019)	Retrospective cohort study of prospectively collected data to report the development of enhanced recovery after surgery (ERAS) pathway for lumbar decompression.	61 patients presented for microdiscectomy or lumbar laminotomy/laminectomy	ERAS spine pathway including early mobilization (encourage mobilization and independence; physical therapy/out of bed within 2	LOS, compliance, prevalence of opioid tolerance	The protocol included 15 standard ERAS elements, and the compliance rate was 85.03%. Median LOS was 279 minutes [interquartile range (IQR) 195–398 minutes], 298 minutes (IQR 192–811) for lumbar decompression and 285 minutes (IQR 200–372) for microdiscectomy. No correlation between surgical subtype or duration and LOS was reported. There was no significant effect of baseline opioid use on LOS, or on the total amount of intraoperative or PACU opioid use. Four complications (6.5%) resulted in extended LOS (>23 hours).

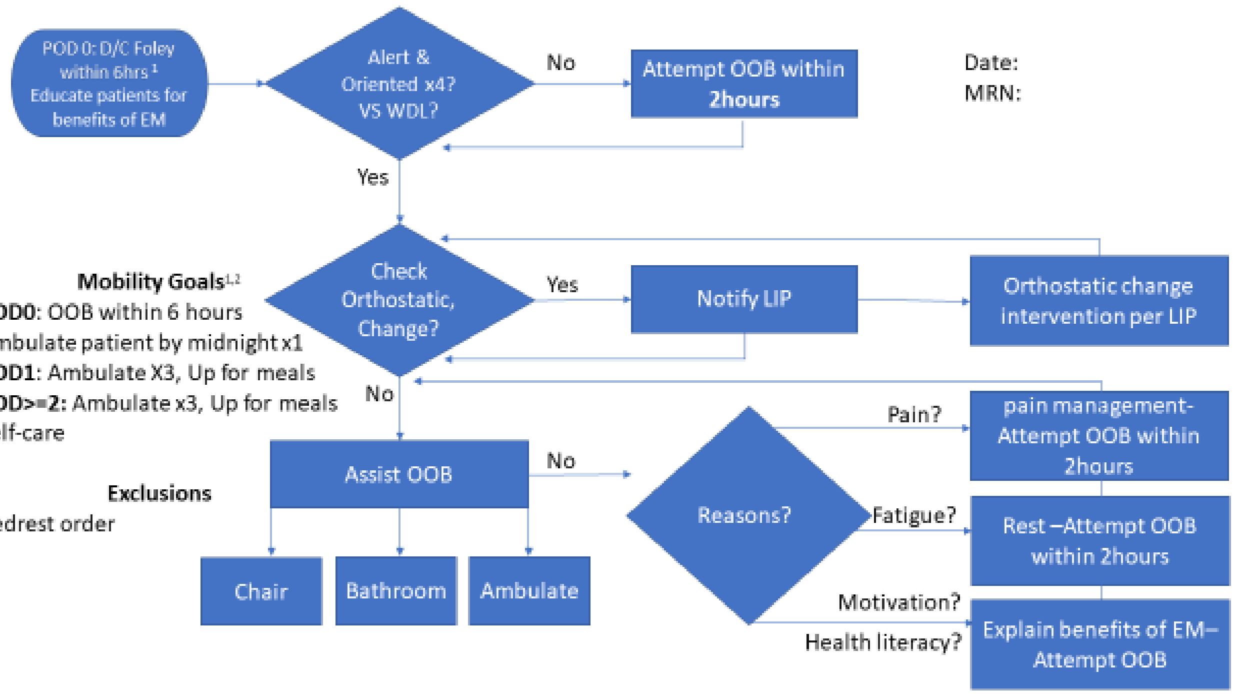
			hours of surgery end		
Staartjes, V. E., Wispelaere, M. P. D., & Schröder, M. L. (2019)	Retrospective analysis (ERAS implementation in 2013, data from 2013-2018) to describe the results of 5-years' experience with ERAS measures and to identify factors affecting implementation	2592 Patients with elective tubular microdiscectomy, mini-open decompression and minimally invasive anterior or posterior lumbar fusion	Early mobilization within 2 hours after operation under guidance of a physiotherapist	LOS, Readmission rate, adverse events, reoperations, PROMs, function (ODI), health-related QOL(EQ-5D), pain (EQ-VAS), leg pain and back pain	The mean LOS was 1.1 ± 1.2 days, with 20 (0.8%) 30-day and 36 (1.4%) 60-day readmissions. Over the 5-year period, there was a trend that majority of patients discharged home after staying one night ($p < 0.001$), with decrease in adverse events ($p = 0.025$) and no increase in readmissions. The average LOS decreased from 2.4 ± 1.2 days to 1.5 ± 0.3 days ($p < 0.001$) with decrease in variance which contributed to an estimated reduction in costs of 46.7% for fusion procedures.
Wainwright, T. W., Immins, T., & Middleton, R. G. (2016)	Systematic Review to evaluate the evidence to support the application of individual ERAS components in major spinal surgery	15 research articles, all designs	ERAS pathway including early mobilization/exercise	LOS, costs	An ERAS pathway contributed patients to recover more quickly and reduce the LOS and hospital costs. Preoperative education, multimodal pain management, strategies to reduce blood loss, early mobilization and post-discharge rehabilitation were important elements of ERAS pathway.
Wang, M. Y., Chang, PY., & Grossman, J. (2017)	prospective case study to review the development and implementation of a "fast track" surgical approach for lumbar fusion	42 patients who underwent TLIF surgery	ERAS protocol including early mobilization (early mobilization using a brace is recommended. No bending or weightlifting for patients who have had fusion surgery)	Oswestry Disability Index (ODI), SF-36, and EQ-5D scores, which were obtained before surgery and at 6 weeks, 3, 6, 12, and 24 months postoperatively	The mean operative time was 94.6 ± 22.4 minutes, the mean intraoperative blood loss was 66 ± 30 ml, and the mean LOS was 1.29 ± 0.9 nights. A significant improvement in the mean ODI score (from 40 ± 13 to 17 ± 11, $p = 0.0001$) was reported in early follow-up.
Zakaria, H. M., Bazydlo, M., Schultz, L., Abdulhak, M., Nerenz, D. R., Chang, V., & Schwalb, J. M. (2019)	Prospective analysis to identify the relationship between ambulation on the day of surgery and 90-day adverse events after lumbar surgery	23295 lumbar surgery patients	Ambulation on POD 0	LOS, Urinary retention, UTI, ileus, readmission, surgical site infection, PE/DVT, and disposition to a rehab facility	Ambulation on POD 0 was associated with a significantly decreased risk for several adverse events after lumbar spine surgery, which suggest significant cost savings. Ambulating on POD 0 should be encouraged and implemented in postoperative care for spine surgery.

Zakaria, H. M., Bazydlo, M.., Schultz, L., Pahuta, M. A., Schwalb, J. M., Park, P., Aleem, I., Nerenz, D. R., & Chang, V. (2019)	Prospective analysis to identify 90-day adverse events and their associated risk factors after cervical spine surgery	8236 patients who had cervical spine surgeries	Risk factors	Adverse events (radicular findings, readmission, dysphagia requiring NPO or feeding tube, urinary retention, surgical site infection, DVT, PE, bowel/bladder dysfunction	A strong association between early ambulation (POD 0) and decreased risk for dysphagia and urinary retention was observed regardless of medical comorbidities, surgical approach or intensity, and preoperative ambulatory status.

Appendix A

Early Mobility Worksheet

Purpose of Project: To Measure the effect of a nurse-driven early mobilization protocol on LOS in patients following spine surgery
Population: post-op spine patients from PACU, follow the protocol on POD 0 or POD 1



Did the patient get out of bed? Yes/ No

Time admitted to 6 West:
Time first ambulated:
Who assisted?

If No, why? What were the barriers? (Circle all that apply)

1) Patient was not stable for OOB (unstable VS, orthostatic, confusion)
2) Patient refused (pain, fatigue, other)
3) I did not have time
4) Staffing
5) Lack of equipment
6) Safety (patient's attitude, too heavy?)
7) Other (comment) ex) Timing (late admission)

Benefits of Early Mobilization

- Decreased length of stay (LOS)
- Better pain control
- Decrease surgical site infection rate
- Decrease post-op complication rate (UTI, wound complications, PE, DVT)
- Better functional status
- Emotional and social well-being

Appendix B

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April 26, 2021

Dear Journal of Neuroscience Nursing,

We wish to submit a quality improvement project paper entitled "Early Mobility Protocol in Postoperative Spine Patients" for consideration by the Journal of Neuroscience Nursing.

We confirm that this work is original and has not been published elsewhere, nor is it currently under consideration for publication elsewhere.

In this paper, we report the effect of a nurse-driven early mobility protocol on the length of stay in patients following spine surgery. Implementing a nurse-driven early mobility protocol decreased the length of stay and first time to out of bed. There was clinical significance in an individual patient due to the benefits of being mobilized earlier in their post-op period. Early mobilization is critical in patients following spine surgery as it is linked to reduced LOSs, reduced costs, reduced surgical site infection rates, and better pain control.
We believe that this manuscript is appropriate for publication by the Journal of Neuroscience Nursing because JNN promotes excellence in patient care outcomes by disseminating evidence-based neuroscience nursing knowledge. This paper showed improvement in postoperative patient care in spine surgery.

We have no conflicts of interest to disclose.

In this paper, Mihwa Ahn is the first author, and Clareen Wiencek and Regina DeGennaro are the senior authors. We have read and approved the submission, and each author has provided intellectual contrition to this paper.

Please address all correspondence concerning this manuscript to me at ma2pb@virginia.edu.

Thank you for your consideration of this manuscript.

Sincerely,

Mihwa Ahn, MSN, MPH, AGACNP-BC

2484 words

Early Mobility Protocol in Postoperative Spine Patients

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Abstract

Background: Early mobilization after surgery has been beneficial to multiple groups of patients, but compliance to mobilization targets has been low.

Purpose: The purpose of this project was to measure the effect of a nurse-driven early mobility protocol (EMP) on the length of stay (LOS) in patients following spine surgery.

Method: This was a quality improvement (QI) project with a before and after study design. The EMP was tested using Plan-Do-Study-Act (PDSA) cycles, modified and then implemented for 8 weeks. Education was provided to the nursing staff. Charge nurses acted as champions. The LOS was calculated from the patient's admission time to the neurosurgery unit to the discharge order entered time in the electronic medical record (EMR). The data and time of first mobilization was obtained manually from the EMR and the EMP worksheet for each patient.

Results: Fifty patients received the EMP, and the results were compared with fifty-six patients in the pre-EMP group. The staff's compliance with the EMP was high at 92.6%. The mean LOS decreased by 11 hours between the two groups, 46.3 hours to 35.3 hours, although it was not statistically significant. The first time to mobilization significantly decreased by 5 hours from 8.9 hours to 3.9 hours ($U = 620$, $p < .001$, $r = .44$).

Conclusion: Implementing a nurse-driven EMP was successful. This intervention was effective as shown by the decreasing LOS and the first time to out of bed. Feasibility was demonstrated by high compliance with the use of the EMP. It also showed an impact of a nurse-driven protocol by changing the process of care, utilizing the Donabedian framework and PDSA cycles. Finally, sustaining a culture change that supports continuing the use of the EMP will depend on the use of champions, engaging nurses and management to ensure sustainability.

Introduction and Background

Back pain and spinal disorders are commonly encountered medical problems in the health care system, and approximately 80% of the population will suffer from lower back pain at some point.[1] A recent analysis estimated that 87.6 billion was spent annually on back pain in the U.S. which accounted for the third-highest amount of health care spending.[2] Spinal procedures, including lumbar spinal fusions, may improve lower back pain and quality of life. Over the last decade, the number of elective lumbar fusions increased by 62.3%, and patients older than 65 years were the majority of this increase.[3]

To achieve positive outcomes after spinal fusion, developing an evidence-based protocol can enhance recovery. Kehlet first introduced a multimodal program called the Enhanced Recovery After Surgery (ERAS), an evidence-based plan to improve care in the perioperative period.[4] Spinal surgery was one of the later specialties to integrate this new multimodal program, which often consist of the preoperative, intraoperative, and postoperative phases, and the postoperative protocol includes early mobilization, pain management, and nutrition.[5]

The benefits of early mobility after surgery include decreased length of stay (LOS), rates of urinary tract infections (UTIs), the incidence of wound complications, pulmonary complications, and thromboembolism.[6] Moreover, early mobilization can improve functional capacity following elective surgery[7] as well as emotional and social well-being.[8,9] In contrast, the traditional practice of bedrest following a surgical procedure has been associated with negative outcomes such as thromboembolism, pneumonia, muscle wasting, and physical deconditioning as reported in a seminal study by Allen et al., in 1999.[10]

Despite the recognized importance of early mobilization after surgery, compliance to mobilization targets has been reported as low,[11,12] which can lead to a higher risk of postoperative (post-op) complications. Currently, at the practice site, there are no standard recommendations on early mobility for postoperative spine patients, and spine surgeries are performed by a neurosurgery team or orthopedic surgery team. Post-operatively, the unit of care and mobility orders depend on the complexity of the surgery and the primary team leading to variability in the times to the first mobilization after spinal surgery.

The average LOS is often used to measure the efficiency of a healthcare facility, and according to the Agency for Healthcare Research and Quality, the national average in-patient LOS was 4.6 days in 2016.[13] At the practice site, the average in-patient LOS was 6.4 days in 2019, and there was a need to reduce to 6 days. Use of an early mobility protocol (EMP) can be beneficial to decrease the average LOS, thus, the purpose of this project was to measure the effect of a nurse-driven early mobility protocol on LOS in patients following spine surgery.

Review of Literature

Strong evidence exists to support the use of early mobilization to decrease the LOS.[6,14-27] In addition, some of these studies showed that the EMP reduced costs and contributed to better pain control as well as reduced surgical site infection rates. However, other outcome measures, such as a post-op complication rate and readmission rate, were varied among studies. Also, outcomes in this population cannot be solely attributed to an EMP as reported by multiple investigators.[5,15-21,26] In addition, there were variations among EMP, so the evidence does not clearly support one standard EMP. This review did not differentiate among different types of surgical procedures, so depending on the surgical procedure, the results of EMP can be different. Lastly, the compliance rate to the protocol was either not reported or varied among studies that could impact the interpretation of these results.

This review summarized the pertinent studies across a variety of spine surgeries and suggests that the EMP was beneficial in terms of the LOS, surgical site infection rate, costs, and pain control but mixed results in other outcome measures, such as postoperative complications, readmission rates, and functional status. The purpose of this scholarly project was to evaluate the effect of a nurse-driven EMP on the LOS in patients following spine surgery. There was sufficient evidence to support early mobilization after surgery, including spinal surgeries, as an essential element of postoperative care. However, there was variability in the type of protocols, including nurse-driven protocols.

Design

Quality Improvement Project

A QI pre and post intervention design was used utilizing Donabedian's framework of structure, process and outcome. This model guided the project to focus on the process of care for the spine surgery patient and how the EMP would fit into that workflow. Planning for revision of the EMP, the Model for Improvement as an implementation framework was used through several Plan-Do-Study-Act (PDSA) cycles. The Institutional Review Board (IRB) at the practice site determined that this project did not require IRB oversight.

Setting and patient population

This project was conducted in the neurosurgery acute care unit (30-bed) in an academic medical center (612-bed) in the southeast, where a monthly average of 40 spine surgeries are performed. At the time of this project, four neurosurgeons performed spinal surgery following the ERAS pathway. Patients were informed of the EMP project during the preadmission clinic visit by nurse coordinators. All patients over age 18 undergoing spinal surgery and admitted postoperatively to the neurosurgery unit were eligible for this project. This QI project excluded patients who had durotomies or cerebral spinal fluid leaks due to total bedrest orders in place in the immediate postoperative period.

Development and Implementation of the EMP

The implementation period was 12 weeks, composed of two weeks of pilot testing, two weeks of educating the nursing staff, and eight weeks of implementing the EMP, from October 12th to December 4th, 2020.

To develop the nurse-driven EMP, input from the expert team of physical therapists (PTs), nurse practitioners, and clinical nurses was obtained. Evidence from the literature and mobility goals of the ERAS spine program were used to develop the original protocol. Pilot testing was performed using PDSA cycles, and the EMP was modified after completing cycles. The EMP worksheet was used to guide the nursing staff to follow the EMP and collect data. The EMP worksheet contained the EMP, benefits of early mobility, admission time, first time to OOB, and lists of barriers to mobilization. Charge nurses were recruited to act as EMP champions to act as resource persons and encouraged staff to follow the EMP and distributed the EMP worksheet to assigned nursing staff. Educating the nursing staff was performed by distributing email, conducting one-on-one meetings, and presenting during daily huddles for two weeks.

All spine surgery patients were screened for the EMP by a champion, and assigned nurses followed the EMP and document patient's mobility in EMR as well as EMP worksheet. Notifying and educating PTs was needed during implementing the EMP as PTs could be the first professional other than nursing staff to mobilize patients after spine surgeries. Information regarding the EMP was sent to all PTs on the neurosurgery unit, and they were invited to participate in the EMP. The EMP worksheet was distributed and collected by champions.

Data Collection and Analysis

Data collection

Data were compared between the two groups. The pre-intervention or pre-EMP group included patients who underwent spine surgery between October 12th and December 4th, 2019. The intervention or EMP group received the EMP and were tracked from October to December 2020. Data was collected from the EMR for both the pre-EMP and the EMP group and entered into a database. The data from the EMR included the first time to OOB, discharge disposition, procedure codes, LOS, age, sex, and comorbidities such as hypertension, hyperlipidemia, coronary artery disease, obesity, diabetes mellitus, and obstructive sleep apnea as risks of perioperative complication increase with the number of comorbid factors.[6,22] The LOS was calculated as the difference between the patient's admission time to the neurosurgery unit and the minute the discharge order was entered in the EMR. As the QI project measures not only the outcome but also the process, the use of the EMP in the EMR or the EMP worksheet was used to measure compliance. To improve data collection, both the EMR and the worksheet were used. The date and time of the first mobilization were obtained manually for each patient. If there was a discrepancy between the EMR and the EMP worksheet, data was obtained from the EMP worksheet. After collection, data was de-identified and organized using Excel, then the worksheets were disposed.

Data Analysis/Statistical Methods

Comparisons of patient characteristics and outcomes for the EMP group and the pre-EMP group were performed with t-tests for parametric continuous variables, the Mann-Whitney U test for non-parametric continuous variables, and chi-square tests for categorical variables. The

Mann-Whitney U test was conducted to test the effect of the EMP on LOS and the first time to OOB. The data was analyzed using IBM SPSS software.

Results

Fifty-four patients were eligible for this project. Of those 54 patients, four patients did not receive the EMP, translating into a compliance rate with the EMP of 92.6%. Therefore, fifty patients received the EMP. Patient data from 2019 was obtained from a performance improvement coach at the practice site. Fifty-six patients in the 2019 pre-EMP group met the inclusion criteria. Thus, a total of 106 spinal surgery patients met inclusion criteria, 50 in the EMP group and 56 in the pre-EMP group.

Of those 106 patients, the mean age was 59 years, and a majority of the patients were male (54.7%). There were no significant differences in patient demographics of age, gender, comorbidities, and dispositions before and after implementing the EMP (Table 1).

In the implementation phase, the EMP was used for 50 patients. The LOS decreased from a range of 0.57-8.83 days in the pre-EMP group to a range of 0.06-6.67 days in the EMP group. The mean LOS decreased by 11 hours between the two groups, 46.3 hours to 35.3 hours, (U = 1157, p = 0.12, r = .15). The first time to OOB was calculated by subtracting from the time when a patient was first mobilized from the patient's admission time to the unit. This measure was significantly decreased from 8.9 hours in the pre-EMP group to 3.9 hours in the EMP group (U = 620, p < .001, r = .44) (Table 2).

The discipline of the staff member who implemented the EMP was tracked. A majority of patients (54%) were mobilized by the assigned RN , 22% by the unlicensed assistive personnel, 8% by the RN and UAP combined, and 14% by physical therapists. First out of bed to ambulate or to the bathroom or to chair was 44%, 40%, and 10%, respectively. There was 82% compliance with documentation of mobilization in the EMR.

Barriers to early mobility were identified by the person documenting on the worksheet as: late admission time (2), pain (1), orthostasis (1), and poor functional status at baseline (1). Two patients did not receive the EMP because of late admission time and poor functional status.

Discharge disposition was measured in both groups. Forty-nine (98%) of patients in the EMP group were discharged to home. Only one patient (2%) in the EMP group was discharged to a rehabilitation facility as compared to four patients (7%) in the pre-EMP group (Table 1).

Discussion

The mean LOS decreased by 24% from 46.3 hours in the pre-EMP group to 35.3 hours in the EMP group, a difference of 11 hours ($U = 1157$, $p = 0.12$, $r = .15$). Although it was not statistically significant, there was clinical significance in an individual patient due to the benefits of being mobilized earlier in their post-op period. This result is consistent with strong evidence that supports the use of EMPs to decrease the length of stay.[6,14-27] Reported reduction rates of LOS ranged from 11.9%[28] to 66.9%.[27]

A study that tested a nurse-driven EMP on a neuroscience unit by Rupich and colleagues showed a significant decrease in LOS by 9.1 hours with patients who underwent lumbar laminectomy, which was estimated a cost-saving of nearly $64,000.[22] If the results of the Rupich study were extrapolated to this project, the reduction of 11 hours in LOS for those patients receiving the EMP suggests cost savings. Also, at the practice site, there was a need to meet the organizational benchmark of the average in-patient LOS from 6.4 days to 6.0 days. This nurse-driven project could be an effective addition to reduce LOS.

This QI project demonstrated a significant decrease in time to OOB from 8.9 to 3.9 hours, ($p < .001$). Early mobilization is considered a cornerstone in ERAS pathways for many surgeries[17] as it is linked to reduced LOSs, reduced costs, reduced surgical site infection rates, and better pain control.[6,14-27]

Compliance with the protocol was high at 92.6% and was calculated by dividing the number of patients who received the EMP by the total number of patients who met the inclusion criteria during the implementation period. Similar studies reported compliance rates of 85% to 90.4%.[22,29] This project demonstrated a higher compliance rate than other studies, which may suggest that the protocol was easy to implement. Additionally, the role of champions most likely supported a higher compliance rate.

The nursing team plays an essential role in promoting the daily mobility of the patient, and nurse-driven mobility programs have shown to increase early ambulation, improve patient functional status and reduce LOS.[9] Although PTs assisted 14% of patients in this project, the nursing staff mobilized the majority of patients (84%).

PDSA cycles were used to modify the protocol, which provided opportunities to find gaps between the protocol and clinical situations. During the implementation phase, the EMP was evaluated and modified. The final EMP is found in Figure 1. Modifications included educating patients in the first step of the protocol, changing mental status assessment, separating destinations of OOB, adding more reasons for patient's refusal, and including PTs in the project.

At the beginning of the QI project, the early mobility champions were reminded by the author about the EMP. After the four weeks, utilizing the EMP was observed without a daily reminder. The use of a designated person as an early mobility champion is also suggested for long-term sustainability.

The results of this QI project were shared with the unit staff. Sustained practice change will depend on the continued role of nurse champions to promote the use of the EMP. In a study by Blackburn et al[15], staff ownership of ERAS outcomes helped to sustain practice change.

Conclusion

In conclusion, the implementation of a nurse-driven EMP reduced LOS and promoted early mobilization, as shown by the significant decrease in the first time to OOB after spinal surgery. This intervention was feasible, demonstrated by a 92% compliance with the protocol. The use of the Donabedian framework and PDSA cycles strengthened the design and implementation of the EMP. Finally, the sustainability of the positive outcomes of this project will depend on the role of the nurse champions and review of patient data. If this effort is sustained, this project should be considered and evaluated for potential implementation in other specialty settings.

References

1. Rubin DI. Epidemiology and risk factors for spine pain. *Neurologic Clinics*. 2007; 25(2):353-371. doi:10.1016/j.ncl.2007.01.004
2. Dieleman JL, Baral R, Birger M, et al. US spending on personal health care and public health, 1996-2013. *JAMA.* 2016;316(24):2627-2646. doi:10.1001/jama.2016.16885
3. Martin B, Mirza SK, Spina N, et al. Trends in lumbar fusion procedure rates and associated hospital costs for degenerative spinal diseases in the United States, 2004 to 2015. *Spine*, 2019;44(5):369-376. doi:10.1097/BRS.0000000000002822.
4. Kehlet H. Multimodal approach to control postoperative pathophysiology and rehabilitation. *British Journal of Anaesthesia.*1997; 78(5):606–617. doi:10.1093/bja/78.5.606
5. Chakravarthy VB, Yokoi H, Coughlin DJ, et al. Development and implementation of a comprehensive spine surgery enhanced recovery after surgery protocol: the Cleveland clinic experience. *Neurosurg Focus*.2019;46(4). doi:10.3171/2019.1.FOCUS18696.
6. Epstein, NE. A review article on the benefits of early mobilization following spinal surgery and other medical/surgical procedures. *Surgical Neurology International*.2014;5:66-73. doi:10.4103/2152-7806.130674
7. De Almeida EPM, De Almeida JP, Landoni G, et al. Early mobilization programme improves functional capacity after major abdominal cancer surgery: a randomized controlled trial. *British Journal of Anaesthesia*.2017;119(5):900-907. doi:10.1093/bja/aex250
8. Kalisch BJ, Lee S, Dabney BW. Outcomes of inpatient mobilization: a literature review. *Journal of Clinical Nursing*.2013;23(11-12);1486-1501. doi:10.1111/jocn.12315

9. Pashikanti L, Von Ah D. Impact of early mobilization protocol on the medical-surgical inpatient population. *Clinical Nurse Specialist*. 2012;26(2):87–94. doi: 10.1097/nur.0b013e31824590e6
10. Allen C, Glasziou P. Del Mar C.Bed rest: a potentially harmful treatment needing more careful evaluation. *Lancet*.1999;354(9186):1229–1233. doi:10.1016/s0140-6736(98)10063-6
11. Braga M, Pecorelli N, Ariotti R, et al. Enhanced recovery after surgery pathway in patients undergoing pancreaticoduodenectomy. *World J. Surg*.2014;38(11):2960–2966. doi:10.1007/s00268-014-2653-5.
12. Smith J, Probst S, Calandra C, et al. Enhanced Recovery after Surgery (ERAS) program for lumbar spine fusion.” *Perioperative Medicine*.2019;8(4). doi:10.1186/s13741-019-0114-2
13. Freeman WJ, Weiss AJ, Heslin KC. Overview of U.S. Hospital Stays in 2016: Variation by Geographic Region: Statistical Brief #246. *Healthcare Cost and Utilization Project (HCUP) Statistical Briefs.* Rockville (MD): Agency for Healthcare Research and Quality. Published December 18, 2018. https://pubmed.ncbi.nlm.nih.gov/30720972/
14. Adogwa O, Elsamadicy AA, Fialkoff JD, et al. Early ambulation decreases length of hospital stay, perioperative complications, and improves functional outcomes in elderly patients undergoing surgery for correction of adult degenerative scoliosis. *The Spine Journal*.2017;17(10):111-112. doi:10.1016/j.spinee.2017.07.182
15. Blackburn JM, Leung P, Leung Y, et al. An enhanced recovery program for elective spinal surgery patients. *Journal of Clinical Outcomes Management*.2016;23(10):462-469.

https://www.mdedge.com/jcomjournal/article/146082/surgery/enhanced-recovery-program-elective-spinal-surgery-patients/page/0/3. Accessed April 18, 2020

16. Bradywood A, Farrokhi F, Williams B, et al. Reduction of inpatient hospital length of stay in lumbar fusion patients with implementation of evidence-based clinical care pathway. *Spine*.2017;42(3):169-176. doi:10.1097/BRS.0000000000001703
17. Burgess LC, Wainwright TW. What is the evidence for early mobilisation in elective spine surgery? A narrative review. *Healthcare*.2019;7(3):92. doi:10.3390/healthcare7030092
18. Elsarrag M, Soldozy S, Patel P, et al. Enhanced recovery after spine surgery: a systematic review. *Neurosurgical Focus*.2019;46(4). doi:10.3171/2019.1.FOCUS18700
19. Feng C, Zhang Y, Chong F, et al. Establishment and implementation of an Enhanced Recovery After Surgery (ERAS) pathway tailored for minimally invasive transforaminal lumbar interbody fusion surgery. *World Neurosurgery*.2019;129:317-323. doi:10.1016/j.wneu.2019.05.139
20. Kılıç ET, Demirbilek T, Naderi S. Does an enhanced recovery after surgery protocol change costs and outcomes of single-level lumbar microdiscectomy? *Neurosurgical Focus*.2019;46(4). doi:10.3171/2019.1.focus18665
21. Liu B, Liu S, Wang Y, et al. Enhanced recovery after intraspinal tumor surgery: a single-institutional randomized controlled study. *World Neurosurgery*.2020;136:542-552. doi:10.1016/j.wneu.2020.01.067
22. Rupich K, Missimer E, O'Brien D, et al. The benefits of implementing an early mobility protocol in postoperative neurosurgical spine patients. *American Journal of Nursing*.2018;118(6):46–53. doi:10.1097/01.naj.0000534851.58255.41

23. Shields LBE, Clark L, Glassman SD, et al. Decreasing hospital length of stay following lumbar fusion utilizing multidisciplinary committee meetings involving surgeons and other caretakers. *Surgical Neurology International*.2017;8(5). doi:10.4103/2152-7806.198732

24. Sivaganesan Al, Wick JB, Chotai S, et al. Perioperative protocol for elective spine surgery is associated with reduced length of stay and complications. *American Academy of Orthopaedic Surgeons*.2019;27(5):183-189. doi:10.5435/JAAOS-D-17-00274

25. Staartjes VE, Wispelaere MPD, Schröder ML. Improving recovery after elective degenerative spine surgery: 5-year experience with an enhanced recovery after surgery (ERAS) protocol. *Neurosurgical Focus*.2019;46(4). doi:10.3171/2019.1.focus18646

26. Wainwright TW, Immins T, Middleton RG. Enhanced recovery after surgery (ERAS) and its applicability for major spine surgery. *Best Practice & Research Clinical Anaesthesiology*.2016;30(1):91-102. doi:10.1016/j.bpa.2015.11.001.

27. Wang MY, Chang PY, Grossman J. Development of an Enhanced Recovery After Surgery (ERAS) approach for lumbar spinal fusion. *Journal Neurosurg Spine*.2017;26(4):411-418. doi:10.3171/2016.9.SPINE16375.

28. Grasu RM, Cata JP, Dang AQ, et al. Implementation of an enhanced recovery after spine surgery program at a large cancer center: a preliminary analysis. *Journal of Neurosurgery: Spine*.2018;29(5):588–598. doi:10.3171/2018.4.spine171317

29. Soffin EM, Vaishnav AS, Wetmore DS, et al. Design and implementation of an Enhanced Recovery After Surgery (ERAS) program for minimally invasive lumbar decompression spine surgery. *Spine*.2019;44(9):561-570. doi:10.1097/brs.0000000000002905

30. Sarosiek B. Clinical pathway for Enhanced Recovery After Surgery (ERAS) simple spine; accompanies related ERAS simple spine protocol. https://www.healthsystem.virginia.edu/docs/manuals/guidelines/cpgguidelines/03-clinical-pathways/pathway-eras-simple-spine. Published 2019, Accessed February 14, 2020.

Table 1: Demographic characteristics of the pre-EMP and EMP groups

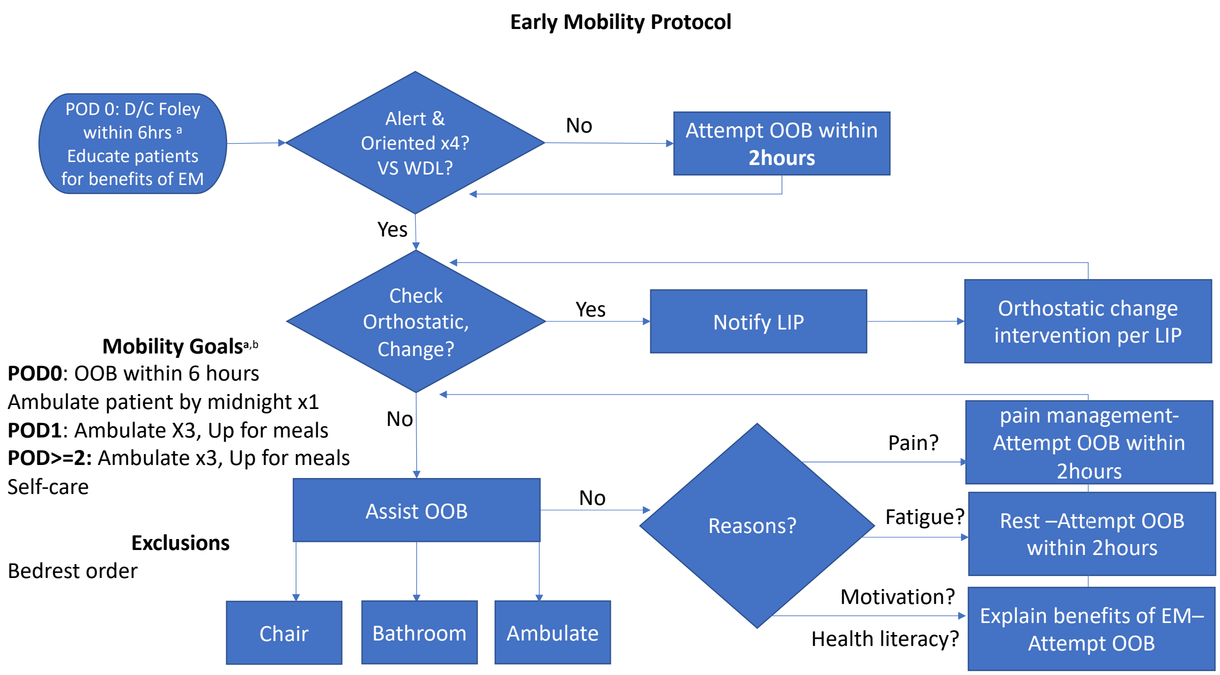
	Total N = 106	**Pre- EMP** N = 56	**EMP** N = 50	**P value**
Age				
Mean, Standard Deviation	58.94 (12.91)	58.85 (12.88)	59.04 (13.07)	0.94
Gender				0.52
Male	58 (54.7%)	29 (51.8%)	29 (58%)	
Female	48 (45.3%)	27 (48.2%)	21 (42%)	
Disposition				0.21
Home	101 (95.3 %)	52 (93%)	49 (98%)	
Rehab Facility	3 (2.8%)	2 (3.5%)	1 (2%)	
SNF	2 (1.9%)	2 (3.5%)	0 (0%)	
Comorbidities				
HTN	56 (52.8%)	29 (51.8%)	27 (54%)	0.82
HLD	38 (35.8%)	17 (30.3%)	21 (42%)	0.21
CAD	10 (9.4%)	5 (8.9 %)	5 (10%)	0.85
OSA	27 (25.5%)	14 (25%)	13 (26%)	0.91
DM	17 (16%)	10 (17.9%)	7 (14%)	0.59
Obesity	6 (5.7%)	3 (5.3%)	3 (6%)	0.87

Table 2: Length of stay and first time to out of bed

	Total N = 106	**Pre- EMP** N = 56	**EMP** N = 50	**P value**
LOS				
Days (Mean, SD[a])	1.71 (1.44)	1.93 (1.64)	1.47 (1.16)	
Hours (Mean, SD)	41.1 (34.6)	46.3 (39.3)	35.3 (27.8)	
Hours (Median, IQR[b])	31.3 (24.61)	39.33 (45.66)	21.72 (23.32)	0.12
First time to out of bed				
Hours (Mean, SD)	6.4 (6.5)	8.9 (6.8)	3.9 (5.1)	
Hours (Median, IQR)	3.47 (9.32)	6.3 (13.73)	2.0 (3.48)	< 0.001

[a]SD: Standard Deviation; [b]IQR: interquartile range

Figure 1: Nurse-driven Early Mobility Protocol



Note. Final Nurse-driven Early Mobility Protocol.
[a]Adapted from Enhanced recovery after intraspinal tumor surgery: a single-institutional randomized controlled study by Liu et al[21], Enhanced Recovery After Surgery (ERAS) program for lumbar spine fusion by Smith et al.[12]
[b] Adapted from Clinical pathway: spine Enhanced Recovery After Surgery (ERAS)-simple spine pathway[30]
Modified based on PDSA cycles from Nurse-driven Early Mobility Protocol Draft. Changes were made by removing "GCS>12, stable VS?", adding "Alert & Oriented x4? and VS WDL?", separating destinations of OOB, and adding more reasons for patient's refusal.