Spine Surgery

A Clinical Practice Guideline for Perioperative Nursing Care

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Introduction

The population of patients who require spine surgery for fracture,[1] metastatic cancer,[2] degenerative spine disease (DSD),[3] and spinal cord injury (SCI)[4-6] continues to grow.[7] The volume of anterior and posterior cervical spine fusions is predicted to increase, from 153,288 in 2020 to 173,699 in 2040 for anterior fusion and from 29,620 in 2020 to 35,335 in 2040 for posterior fusion.[8] Between 1998 and 2008, US patients 65 years of age and older experienced a 239.2% increase in the number of spinal fusions, the largest growth of any age group.[9] Additionally, from 2000 to 2019, Medicare beneficiaries experienced a 592% increase in the number of anterior lumbar interbody fusion procedures.[3] In the US alone, one in four Americans is predicted to be 65 years old or older by 2060.[10] Globally, the number of people ages 65 years and older is projected to be 1.6 billion in 2050.[11] The debilitating pain and physical impairment from spine disorders can lead to long-term consequences such as frailty, chronic opioid use, and loss of functional autonomy.[12-15] Owing to the aging population, the demand for spine surgery continues to rise.[3] Evidence-based nursing care and best practices are critical to optimal patient outcomes.[16-18]

Evidence-based recommendations developed from the most up-to-date, rigorous literature synthesis are needed to guide nurses in the safe and effective perioperative care of adults undergoing spine surgery.[18] The American Association of Neuroscience Nurses (AANN) formed an author work group with the aim of conducting a systematic literature review for each question posed to evaluate the evidence and determine best practice recommendations for preoperative, intraoperative, and postoperative care of the patient undergoing spine surgery.

Methods

The AANN Clinical Practice Guideline (CPG) Editorial Board (EB) framed the scope of this evidence-based practice guideline based on membership needs. The writing group was selected from a pool of candidates drawn from a call for volunteers to the general AANN membership. The writing group initially held biweekly and then monthly meetings to develop and accomplish working group cohesion and discuss issues, progress, successes, and next steps. All writing group members contributed to the entire process.

Research Question Development

Initial writing group meetings included development of research questions. All writing group members submitted and discussed suggestions. Formatted according to patient/population, intervention, comparison, and outcome (PICO) methodology,[19] 14 questions were identified as most pertinent to bedside care and approved by the CPG EB.

Research Question Literature Search

Each PICO research question (see **Table 1**) was treated as an individual systematic review. Literature searches were completed by two academic librarians, one from the University of Wisconsin–Madison Ebling Library for the Health Sciences and one from the Library of RUSH University Medical Center. Using relevant medical subject headings and keywords, the following databases were searched: PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Scopus, and Cochrane Library. The literature search for postoperative intervention support groups for adults with spinal cord injury included the American Psychological Association PsycINFO. The full search methodology used for each question is available upon request to AANN.

Inclusion and Exclusion Criteria

Inclusion criteria included adult human population (≥18 years of age), written in English, and published in peer-reviewed journals with full text available. Nonexperimental observational studies, qualitative studies, and quality improvement (QI) publications were included in the review because of the overall scarcity of published research relevant to the identified PICO questions and the value of including these methodologies to the goals of this CPG. Inclusion dates ranged from January 1, 2011, to February 28, 2022. Search strategies included (a) population: cervical, thoracic, and/or lumbar spine; inflammatory, infection, metastatic or primary cancer, fracture, or degenerative diagnoses; (b) interventions: nursing interventions; (c) outcomes: hospital length of stay (LOS), postoperative surgical site infection (SSI), postoperative pain, skin breakdown, and mobility. Exclusion criteria were children less than 18 years of age, animal data, and surgery on the coccyx. Inclusion and exclusion criteria used for each question is available upon request to AANN.

Table 1. PICO Research Questions and Recommendations

Preoperative Interventions	Recommendations
In the care of adults undergoing spine surgery, do preoperative nursing interventions improve postoperative outcomes?	**Preoperative Education** *Preoperative education for early ambulation and reduced length of stay* **Recommendation:** There is low-quality evidence[30,31] to support preoperative education to reduce postoperative LOS, hospital readmissions, and 90-day ED returns (strong recommendation). *Preoperative education to reduce anxiety* **Recommendation:** There is moderate-quality[32,33] and high-quality[34] evidence to support preoperative education to reduce postoperative anxiety scores (strong recommendation). *Preoperative education to reduce opioid requirements, length of stay, and readmission rates* **Recommendation:** There are varying levels of quality of evidence[35-39] to support preoperative education as part of ERAS protocols to reduce opioid requirements, LOS, and readmission rates (strong recommendation). **Preoperative Glycemic Control** **Recommendation:** There is low-quality evidence[40] to support preoperative glycemic control as a nursing intervention to improve postoperative glycemic control (strong recommendation). **Preoperative Smoking Cessation** **Recommendation:** There is low-quality evidence[42] that smoking is a modifiable preoperative risk factor predicting readmission and reoperation, thus supporting preoperative smoking cessation (strong recommendation). **Preoperative Stress Reduction** **Recommendation:** There is low-quality[44,45] and moderate-quality[46,47] evidence to support preoperative stress reduction as a nursing intervention to improve stress, anxiety, depression, and physical function (strong recommendation). **Preoperative Risk Assessment for Postoperative Delirium** **Recommendation:** There is moderate-quality evidence[49] to support conducting a preoperative nursing assessment to identify risk factors for postoperative delirium (strong recommendation). **Prehabilitation** **Recommendation:** There is moderate-quality evidence[51] to support exercise therapy as a nursing intervention to decrease LOS and improve physical functioning (weak recommendation). **Surgical Site Infection Prevention Measures** **Recommendations:** There is low-quality[54] and moderate-quality[53] evidence to support the use of preoperative care bundles to reduce the risk of SSI (strong recommendation). There is low-quality evidence[55,57] to support preoperative screening for nasal MRSA colonization or intranasal antiseptic swabs to reduce SSI risk (weak recommendation). **Venous Thromboembolism Prophylaxis** **Recommendation:** There is low-quality evidence[60] supporting perioperative VTE prophylaxis among patients undergoing ALIF, to prevent postoperative VTE (weak recommendation).

Intraoperative Interventions	Recommendations
In the care of adults undergoing spine surgery, do intraoperative nursing measures affect postoperative outcomes?	**Skin Preparation Surgical Solutions to Reduce Infection** **Recommendations:** There is moderate-quality evidence[61] that is equivocal for using ChloraPrep™ (2% CHG and 70% isopropyl alcohol) as opposed to DuraPrep™ (0.7% available iodine and 7.4% isopropyl alcohol) for intraoperative skin preparation to reduce postoperative SSI (strong recommendation). There is moderate-quality evidence[62] supporting application of povidone-iodine 10-minutes prior to starting the operation to reduce postoperative SSI rates (strong recommendation). **Silicone Foam Dressings to Reduce Pressure Injuries** **Recommendation:** There is low-quality evidence[64] to support prophylactic use of silicone foam dressings over pressure points when in prone position, among patients undergoing thoracic or lumbar surgical procedures, to reduce intraoperative-acquired pressure injuries (strong recommendation). **Self-warming Blankets to Prevent Hypothermia** **Recommendation:** There is moderate-quality evidence[65] to support the use of active self-warming blankets in the preoperative, intraoperative, and postoperative acute care unit to decrease postoperative hypothermia and shivering (strong recommendation).
Postoperative Interventions	**Recommendations**
In the care of adults undergoing spine surgery, does the type or timing of incision care and/or dressing care impact surgical site infection development?	**Incision Care and Impact on Surgical Site Infection** **Recommendation:** There is moderate-quality evidence[54] to support the use of a visible occlusive dressing in combination with perioperative surgical site preventative measures to decrease postoperative SSI rates (strong recommendation).
In the care of adults undergoing spine surgery, do nursing interventions of surgical site drains assist in identifying acute changes in the postoperative phase of care?	**Nursing Interventions of Surgical Site Drains** **Recommendations:** There is low-quality[69] and high-quality[67] evidence supporting procedure-related factors, or use of surgical drains, to aid nurses in identifying acute postoperative changes such as epidural hematoma formation and SSI (strong recommendation). There is low-quality evidence[68] supporting use of a perioperative ERAS protocol to improve timing of surgical drain removal, leading to quicker postoperative mobilization and improved pain control (strong recommendation).
In the care of adults undergoing spine surgery, does the timing of inpatient nutrition affect patient outcomes?	**Timing of Inpatient Nutrition** **Recommendation:** There is low-quality evidence[68,70,71] that the use of perioperative ERAS protocols combined with early postoperative inpatient nutrition reduces postoperative complications and prolonged LOS (strong recommendation).
In the care of adults undergoing spine surgery, are there perioperative nursing interventions that decrease or prevent the development of a postoperative ileus?	**Perioperative Nursing Interventions to Decrease or Prevent Postoperative Ileus** **Recommendation:** There is very low–quality evidence[72,73] to support perioperative nursing assessment and interventions such as identifying risk factors to prevent postoperative constipation,[73] chewing gum in the postoperative phase of care,[72] and perioperative ERAS protocol[39] to promote bowel function, recovery, and prevent postoperative ileus (weak recommendation).
In the care of adults undergoing spine surgery, are there perioperative nursing measures that decrease or prevent postoperative urinary retention?	**Perioperative Nursing Measures that Decrease or Prevent Postoperative Urinary Retention** **Recommendations:** There is low-quality[76-78] and moderate-quality[79] evidence to support preoperative nursing assessment including older age, male sex, and comorbidities as risk factors for increased incidence of POUR (strong recommendation). There is low-quality[76-78] and moderate-quality[79] evidence to support intraoperative nursing assessment including increased IV fluid use and longer surgery time as risk factors for increased incidence of POUR (strong recommendation). There is low-quality[39,75,76] and moderate-quality[79] evidence to support implementing perioperative ERAS nursing strategies such as preoperative renal evaluation, intraoperative urinary catheter use, postoperative early ambulation, and a postoperative urinary catheter management protocol to decrease postoperative POUR (strong recommendation).
In the care of adult spinal cord injury patients, does neurogenic bowel and bladder training improve patient recovery?	**Neurogenic Bowel and Bladder Training After Spinal Cord Injury** **Recommendation:** There is very low-quality evidence[80,81] to suggest neurogenic bowel and bladder training in the care of adult SCI patients may improve quality of life (strong recommendation).
In the care of adults undergoing spine surgery, does the timing or distance of mobilization/ambulation impact postoperative outcomes?	**Timing or Distance of Ambulation** **Recommendation:** There is low-quality[39,68,75] and moderate-quality[84] evidence to support timing of early ambulation (within 4 hours after surgery) or distance of ambulation (50 meters) on patient-centered postoperative outcomes including decreased pain, opioid use, complication rate, urinary retention, and LOS (strong recommendation).

In adults who are managed in an external orthosis for spine trauma or after spine fusion surgery, what nursing interventions are used to improve patient outcomes?	**Nursing Interventions for Adults Managed in an External Orthosis** **Recommendation:** There is insufficient evidence to support types of nursing interventions for adults managed in an external orthosis for spine trauma or after spine fusion surgery to improve patient outcomes.
In the care of adults with spinal cord injury, what interventions can be used to prevent autonomic hyperreflexia?	**Prevention of Autonomic Hyperreflexia** **Recommendations:** There is low-quality evidence[91] to support the use of intravesical lidocaine prior to indwelling catheter exchange to decrease the risk of AHR (strong recommendation). There is low-quality[89,92] and moderate-quality[88] evidence to support neurogenic bowel management to prevent AHR (strong recommendation). There is low-quality evidence[87,90,93] to support nursing strategies or protocols, such as bladder or bowel management and pharmacological interventions, to prevent AHR (strong recommendation).
In the care of adults undergoing spine surgery, does nonopioid pain pharmacotherapies or nonpharmaceutical therapies improve postoperative outcomes?	**Nonopioid Pain Pharmacotherapies and Nonpharmaceutical Therapies** *Preoperative and postoperative gabapentin or pregabalin* **Recommendation:** There is high-quality evidence[97,100,101,106,108,110] to support preoperative use of gabapentin and pregabalin to improve postoperative pain control and reduce opioid requirements (strong recommendation). *Multimodal analgesia protocols* **Recommendations:** There are varying levels of quality evidence[95,96,98,99,102-105] to support preemptive multimodal analgesic pathways to reduce postoperative pain scores and opioid consumption (strong recommendation). There is low-quality evidence[39,68] to support multimodal analgesia as part of ERAS protocols to improve postoperative pain control and decrease opioid requirements (strong recommendation). There is low-quality[39,68,98] and moderate-quality[99] evidence to support multimodal analgesic protocols and multimodal analgesia as part of ERAS protocols to increase early ambulation and reduce LOS (strong recommendation). *Nonpharmacologic therapies* **Recommendation:** There is low-quality[109] and moderatequality[94] evidence to support the development of a preoperative comfort goal or introduction of music therapy to reduce postoperative pain scores and opioid requirements (strong recommendation).
In the care of adults undergoing spine surgery, does the nurses' role in antibiotic stewardship improve postoperative outcomes?	**Nursing's Role in Antibiotic Stewardship** **Recommendations:** There is low-quality[114] and moderate-quality[113] evidence supporting prolonged prophylactice use of antibiotics (greater than 24 hours), with placement of surgical drain, to reduce SSI (strong recommendation). There is low-quality evidence[112] supporting surgical antibiotic prophylaxis stewardship programs to improve SSI rates (weak recommendation).
In adults with spinal cord injury, does timing of individual or group support/counseling improve patient and family outcomes?	**Support Groups for Adults with Spinal Cord Injury** **Recommendations:** Among adults with SCI, there is insufficient evidence to support an optimal or specified timing of when to initiate individual or group support or counseling to improve family self-efficacy. There is low-quality[116] and high-quality[115] evidence to support individual and group support and counseling for patients after SCI to improve patient self-efficacy (strong recommendation).

Search Results

The total number of references in the initial search was 22,320. A PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2009 flow diagram (**Appendix I**) summarizes study selection for each PICO question. The librarians provided a research information systems file of the references. Accounting for duplicates, 22,048 references were uploaded to DistillerSR,[20] a systematic review software.

Systematic Review Process

DistillerSR was employed to organize the systematic review process and evaluate the literature. Each author (AS, KA, KC, EG, JR, JZ, LF) was given unique identifying access, and each reference was reviewed independently by a minimum of two authors. Conflicts between authors at any level were discussed until consensus was achieved. If needed, a third author was consulted as arbitrator. The literature review consisted of three levels of review: (a) title and abstract, (b) full text, and (c) risk-of-bias assessment. Based on study design, the risk-of-bias assessment tools used included Cochrane risk of bias,[21] AMSTAR (A MeaSurement Tool to Assess systematic Reviews),[22] and JBI critical appraisal tools including the Case Series,[23] Cohort Study,[24] Qualitative Research,[25] and Quasi-Experimental Studies[26] checklists. Quality improvement articles were not assessed for risk of bias. The quality of the evidence was scored as high, moderate, low, or very low using the Grading of Recommendations, Assessment, Development, and Evaluations methodology.[27]

Data collected from references were transcribed to the appropriate PICO evidence table (see **Appendix II**). This facilitated critical evaluation of each reference. The Grading of Recommendations, Assessment, Development, and Evaluations methodology[27,28] and the above-named risk-of-bias tools guided the determination of quality of evidence and the recommendation statements, which were reviewed and approved by all writing group members. After the evidence was synthesized, the manuscript with recommendations was reviewed by the AANN CPG EB and two external expert reviewers.

Results

The results are organized by PICO question addressing preoperative, intraoperative, and postoperative nursing interventions, with synthesis of relevant literature and recommendation(s) if applicable to each PICO question. Nearly all articles listed physician authors and did not include specific nursing interventions. While we promote multidisciplinary collaboration for optimal patient outcomes, it is vitally important to ask and provide patient care answers from a nursing perspective to operate within the scope of nursing practice. With very few nursing articles investigating nursing interventions, the writing group synthesized care recommendations incorporating physician research.

Preoperative Nursing Interventions

The preoperative phase of care includes nursing assessment of risk factors as well as nursing strategies to prepare the patient for spine surgery and improve postoperative outcomes. Nursing interventions identified in the literature are described below.

In the care of adults undergoing spine surgery, do preoperative nursing interventions improve postoperative outcomes?

Preoperative Education

Patient and family education is a critical part of nursing practice and can be performed using different modalities, including verbal and written instructions, videos or other technologies, or during patient appointments. Preoperative education for patients undergoing spinal surgery has been evaluated by many outcomes including early ambulation and reduced LOS and reduction of self-perceived anxiety, opioid requirements, and readmission rates.

Preoperative Education for Early Ambulation and Reduced Length of Stay

The influence of preoperative education on early postoperative mobility was evaluated in one article. Preoperative nursing education, in a nurse-driven QI protocol,[29] focused on an early mobility goal within 6 hours after surgery. Early mobility resulted in a statisti-

cally significant decrease to a 6.7-hour LOS for lumbar laminectomy patients (95% CI: -12 to -1.5; *P*=.012) and 9.1-hour LOS (95% CI: -13.9 to -4.3; *P*<.001) for multilevel laminectomies (baseline LOS not reported). There was no statistically significant difference in the anterior cervical discectomy and fusion (ACDF), cervical nonfusion, or posterior laminectomy or foraminotomy groups.

Two articles[30,31] examined if preoperative education reduced LOS, disability, and readmissions, and improved quality of life (QOL). Turcotte et al[30] utilized a nurse navigator preoperative intervention consisting of a psychosocial risk factor assessment and preoperative education course. The course emphasized a checklist of tasks to complete prior to surgery; an overview of the surgery and hospital experience; and information regarding physical rehabilitation, pain management, and postoperative care. Course attendees did not demonstrate statistically significant reductions in LOS days (*P*= .2224), discharge to skilled nursing facility (*P* =.900), 30-day emergency department (ED) returns (*P*=.789), or 30-day readmissions (*P*=.721).[30] However, Eastwood and colleagues[31] utilized a single 2-hour multidisciplinary preoperative patient education session that included nursing, physiotherapy, and occupational therapy staff. The session focused on what patients should expect, how to best prepare for surgery, and proper postelective spinal fusion surgery care. Patients who took part in the presurgical education session demonstrated statistically significant reduction in postoperative back pain (*P*=.03) and 90-day ED visits (*P*=.04).[31]

Recommendation: There is low-quality evidence[30,31] to support preoperative education to reduce postoperative LOS, hospital readmissions, and 90-day ED returns (strong recommendation).

Preoperative Education to Reduce Anxiety

Three randomized controlled trials (RCT)[32-34] examined preoperative education to reduce postoperative anxiety. All three studies utilized the Spielberger State-Trait Anxiety Inventory among elective disc herniation surgery, elective spinal stenosis surgery, and other lumbar spine surgery patients to examine level of anxiety before and after intervention at study-dependent time points. Postoperatively, prior to discharge, the intervention group[32,33] had statistically significant reduction in anxiety scores (N=60; *P*=.0001[32] and N=86; *P*<.001[33]). However, there was no difference between intervention and control groups (N=97; *P*=.265) at discharge.[34]

Recommendation: There is moderate-quality[32,33] and high-quality[34] evidence to support preoperative education to reduce postoperative anxiety scores (strong recommendation).

Preoperative Education to Reduce Opioid Requirements, Length of Stay, and Readmission Rates

One systematic review with meta-analysis,[35] three retrospective studies using historical prior-to-intervention controls,[36-38] and one retrospective study using propensity-matched controlled[39] studies examined patient education as part of enhanced recovery after surgery (ERAS) protocols[35-39]. Enhanced recovery after surgery focuses on multidisciplinary protocols for improving postoperative outcomes such as LOS, morphine milligram equivalent (MME) use, wound complications, readmission rates, and mortality. The forum for education varied, including video recordings, in-person training, and educational pamphlets.[35-39] Opioid requirements were significantly decreased in the post-ERAS groups (N=114; postoperative MME used postoperative day [POD] 0: pre-ERAS 77.0±7.1, post-ERAS 21.9±22.1; *P*<.0001; POD1: pre-ERAS 47.9±63.6, post-ERAS 7.8±16.7; *P*=.004; POD2: pre-ERAS 15.7±44.0, post-ERAS 1.1±3.9; *P*=.007)[39] and MME used POD1 (pre-ERAS 38±36, post-ERAS 16±21; *P*<.0001).[37] Insufficient data were available to complete a meta-analysis on opioid use.[35]

Length of stay was statistically significant between pre- and post-ERAS groups (P=.047),[37] (P<.0001),[39] as well as in a meta-analysis (-1.53 days, 95% CI: -2.89 to -0.16).[35] Readmission rates were equivocal at 30 days when comparing pre- and post-ERAS (*P*=1.0).[39] No statistically significant difference in readmission rates pre- and post-ERAS following anterior lumbar interbody fusion (ALIF), ACDF, and posterior lumbar fusion (PLF) at 90 days (N=361; ALIF: *P*=.9; ACDF: *P*=.36; PLF: *P*=.12)[36] was found. Similarly, among ACDF, posterior cervical decompression and fusion, lumbar microdiscectomy, lumbar decompression, and PLF surgery, no significant difference was found at 30 days readmission (N=243; *P*=.685).[37] Lastly, 30-day and 1-year readmissions (N=140) in the pre-ERAS intervention group were 7 (10%) and 14 (20%), and in the postintervention group 5 (7%) and 12 (17%), respectively.[38]

Recommendation: There are varying levels of quality of evidence[35-39] to support preoperative education as part of ERAS protocols to reduce opioid requirements, LOS, and readmission rates (strong recommendation).

Preoperative Glycemic Control

Although the mechanisms are unclear, there is a robust body of literature linking perioperative hyperglycemia with adverse clinical outcomes across a wide range of neurological, cardiovascular, and other conditions. Glycemic control can be evaluated through blood glucose or glycated hemoglobin (HbA1c) testing, with inpatient care focused on moderate and individualized glycemic targets.

Implementation of a perioperative blood glucose monitoring protocol, including preoperative HbA1c testing, for both diabetic and nondiabetic patients undergoing spinal surgery was investigated.[40] Preoperative HbA1c testing revealed more than 54% of undiagnosed patients with levels consistent with either prediabetes or diabetes. Furthermore, regardless of diagnosis, patients experienced a perioperative increase in blood glucose with levels remaining elevated above preoperative baseline POD1. Study results enable preoperative identification of patients with undiagnosed prediabetes and diabetes, allowing for optimization before elective surgery and establishment of appropriate postoperative follow-up care.[40]

Recommendation: There is low-quality evidence[40] to support preoperative glycemic control as a nursing intervention to improve postoperative glycemic control (strong recommendation).

Preoperative Smoking Cessation

Although there are known risks of lung cancer, pneumonia, and heart disease associated with smoking, in the context of spine surgery, smoking delays healing, increases the risk of clots and infection, and increases inflammation. To reduce the adverse effects of smoking on spinal surgery outcomes, smoking cessation is recommended for at least 4 weeks prior to surgery and 3 months following surgery.[41]

One retrospective review[42] identified risk factors associated with 90-day readmissions and reoperation following posterior cervical decompression and fusion. Badiee et al[42] revealed preoperative smoking was associated with 90-day readmissions (P=.00002) and reoperation (P=.003) in this surgical spine population, emphasizing the importance of education and smoking cessation preoperatively.[42]

Recommendation: There is low-quality evidence[42] that smoking is a modifiable preoperative risk factor predicting readmission and reoperation, thus supporting preoperative smoking cessation (strong recommendation).

Preoperative Stress Reduction

Stress reduction is a cornerstone of ERAS protocols, which aim to mitigate the deleterious effect of surgical stress and improve patient outcomes by controlling key aspects of perioperative care.[43] Perceived stress is addressed in the patient education component of ERAS protocols and can be more specifically targeted with stress reduction methods.

The impact of stress reduction prior to spinal surgery was investigated in four studies.[44-47] Two retrospective studies[44,45] implemented preoperative mindfulness-based stress reduction for patients with lumbar degenerative disc disease (DDD) undergoing one- to four-level decompression and fusion procedures. Yi et al[45] demonstrated a significant decrease in visual analog scale (VAS) pain scores 30-days postoperative (P=.004). In addition, at 12-weeks postoperative, patients had significantly less disability (N=44; P=.032), less pain (P=.025), and significantly higher physical function (P=.002).[44] At 12-months postoperative, patients continued to have significantly less pain (N=34; P=.011) but no significant differences in disability or physical function.[44] Reichart et al[46] investigated a short psychological intervention (SPI) for back pain patients with severe DSD, who had undergone posterior lumbar interbody fusion (PLIF). The SPI was used preoperative and 6-weeks postoperative to measure pain intensity and physical fitness. The intervention group reported a significantly greater reduction in highest pain intensity (P<.001) and better physical fitness (P=.05) compared to the control group (1342).[46] Finally, Strom et al[47] utilized web-based cognitive behavioral therapy (CBT) on patients with symptoms of anxiety and depression preoperative and postoperative, undergoing elective instrumented lumbar spine fusion due to DDD or spondylolisthesis. Outcome results indicated no statistically significant difference within the intervention group regarding changes in the Hospital Anxiety and Depression Scale scores (P=.37). Additionally, there were no statistically significant differences between the intervention and control group in terms of postoperative pain scores, disability, or QOL.

Recommendation: There is low-quality[44,45] and moderate-quality[46,47] evidence to support preoperative stress reduction as a nursing intervention to improve stress, anxiety, depression, and physical function (strong recommendation).

Preoperative Risk Assessment for Postoperative Delirium

Postoperative delirium occurs in more than 50% of older adults and has been shown to increase the risk of cognitive decline.[48] Since the spine surgery population is often older in age, identifying patients at risk for delirium could promote implementation of strategies to prevent or reduce delirium.

Through a meta-analysis, Baek et al[49] sought to identify factors that may place spine surgery patients 65 years of age or older at risk for developing delirium after spine surgery. Risk factors identified include preoperative opioid use, cervical spine surgery, spinal fusion, hypertension (HTN), cerebrovascular disease, pulmonary disease, duration of surgery, and infused intravenous (IV) fluid volume. The pooled incidence rate of postoperative delirium was 13.0%.[49] The authors conclude that nurses who

provide perioperative care for older adult patients undergoing spine surgery should be aware of the potential risk factors of delirium to ensure patient safety. Additional research is required to clearly delineate the risk factors for postoperative delirium in older adults.[49]

Recommendation: There is moderate-quality evidence[49] to support conducting a preoperative nursing assessment to identify risk factors for postoperative delirium (strong recommendation).

Prehabilitation

Defined as "a process of improving the functional capability of a patient prior to a surgical procedure so the patient can withstand any postoperative inactivity and associated decline," prehabilitation aims to increase physical fitness prior to surgery.[50]

One meta-analysis[51] assessed the effectiveness of prehabilitation interventions, including exercise therapy and CBT, on physical functioning, pain, QOL, LOS, and the use of analgesics. Cognitive behavioral therapy interventions were no more effective than usual care for all outcomes. However, a single study focused on exercise therapy and found a significant effect on the length of hospital stay and self-reported physical functioning ($P<.05$).[51]

Recommendation: There is moderate-quality evidence[51] to support exercise therapy as a nursing intervention to decrease LOS and improve physical functioning (weak recommendation).

Surgical Site Infection Prevention Measures

Surgical infections are categorized as a healthcare-associated infection and can be a major complication after spinal surgery.[52] Surgical site infections (SSI) can be superficial or involve tissue under the skin and involve organs or implants, which are often used in fusion surgeries.

Six studies investigated preoperative interventions to decrease the risk of SSI rates among surgical spine patients.[53-58] Interventions included perioperative care bundles, preoperative Methicillin-resistant Staphylococcus aureus (MRSA), and preoperative use of chlorhexidine gluconate (CHG). Two retrospective designs investigated the use of perioperative care bundles to reduce the risk of SSI rates.[53,54] The Bagga et al[53] bundle was investigated irrespective of spinal level and consisted of (a) preoperative glycemic control and CHG bath, (b) intraoperative antibiotic prophylaxis and CHG plus alcohol-based skin preparation, and (c) postoperative five moments of hand hygiene and early mobilization. Study results demonstrated a significant decrease in SSI rate from 3.42% pre implementation to 1.22% post implementation ($P=.0001$). A perioperative care bundle implemented by Castella el al[54] applied to lumbar spine surgery patients consisting of (a) preoperative CHG shower; (b) intraoperative skin antisepsis with CHG and alcohol, and hair removal with clippers if necessary; and (c) postoperative early mobilization. Study results also demonstrated a significant decrease in SSI rates from 19.4% pre implementation to 2.6% post implementation ($P=.001$). A limitation of these retrospective studies is the use of the bundle, which obscures the exact measure that had a positive impact.

Two retrospective design studies[55,57] describe preoperative MRSA screening[55] and use of antiseptic nasal swabs[57] to reduce reoperation for incision and drainage and SSI rates. Xiong et al[55] examined the association between preoperative MRSA nasal testing and incidence of reoperation for incision and drainage in patients undergoing elective primary lumbar instrumented fusion. Preoperative MRSA screening had no impact on decreased incision and drainage rates within 90 days of surgery. Buyuk et al[57] assessed the use of adding preoperative nasal decontamination by antiseptic swab, regardless of preoperative MRSA testing and result, to a current antimicrobial perioperative bundle in patients undergoing thoracolumbar spine surgery. No statistically significant ($P=.68$) decrease in SSI rates was identified.

Finally, two QI studies[56,58] examined the relationship of preoperative CHG use on postoperative SSI rates. One study[56] compared the implementation of 2% CHG cloths to the current practice of bathing with 4% CHG solution. Although postoperative SSI rates decreased, there was no statistically significant difference ($P=.524$) between 2% CHG cloths and 4% CHG solution. Furthermore, Chan et al[58] implemented a preoperative CHG showering protocol for fusion and non-fusion spine surgery. Postoperative SSI rates decreased from 0.7% to 0.2%; however, this was not statistically significant (N=4266; $P=.08$).

Recommendations: There is low-quality[54] and moderate-quality[53] evidence to support the use of preoperative care bundles to reduce the risk of SSI (strong recommendation).

There is low-quality evidence[55,57] to support preoperative screening for nasal MRSA colonization or intranasal antiseptic swabs to reduce SSI risk (weak recommendation).

Venous Thromboembolism Prophylaxis

Venous thromboembolism (VTE) includes deep vein thrombosis and pulmonary embolism, which are rare but potentially lethal complications of spine surgery. However, the benefits of VTE prophylaxis remain a highly controversial topic for elective spine surgery.[59]

Vint et al[60] investigated the efficacy of a proposed perioperative VTE prophylaxis regimen in patients undergoing ALIF (N=200).[60] The VTE prophylaxis intervention

included low-molecular-weight heparin subcutaneously and tinzaparin 4,500 units subcutaneously administered per a protocol of: (a) the night prior to surgery; (b) then daily for 3 to 5 days. Next, acetylsalicylic acid 150 milligrams (mg) daily plus lansoprazole 30 mg daily is taken for 4 weeks after surgery. All patients had intermittent pneumatic compression of their calves and thighs intraoperatively and for 24-hours postoperatively, with early mobilization on POD1 and thromboembolic stockings for 6 weeks. No postoperative VTE were identified in this retrospective review. Limitations included the lack of a baseline VTE risk assessment and surgical sample size, as VTE following ALIF is a rare complication.[60]

Recommendation: There is low-quality evidence[60] supporting perioperative VTE prophylaxis among patients undergoing ALIF, to prevent postoperative VTE (weak recommendation).

Intraoperative Interventions

Intraoperative care includes activities that occur, are carried out, or encountered in the course of surgery. The areas identified in the literature review were skin preparation surgical solutions to reduce SSI, application of a silicone dressing to reduce pressure injuries, and self-warming blankets to prevent hypothermia.

In the care of adults undergoing spine surgery, do intraoperative nursing measures affect postoperative outcomes?

Skin Preparation Surgical Solutions to Reduce Infection

Two RCTs[61,62] evaluated the effectiveness of intraoperative skin preparation surgical solutions to reduce culture occurrence of common bacterial skin flora and SSI rates. Savage et al[61] investigated the use of ChloraPrep™ (2% CHG and 70% isopropyl alcohol) as opposed to DuraPrep™ (0.7% available iodine and 7.4% isopropyl alcohol) on patients undergoing elective lumbar spine surgery (N=100). The overall rate of positive cultures after skin preparation was 0% in the ChloraPrep™ group (N=50) and 6% in the DuraPrep™ group (N=50; *P*=.24). There was an increase in positive cultures after wound closure, but there was no difference between the ChloraPrep™ and the DuraPrep™ groups (*P*=.22). Specific to the surgical site preparation, Yasuda et al[62] evaluated the use of povidone-iodine applied to the surgical site just before starting the operation compared to povidone-iodine applied 10 minutes prior to starting the operation among spine surgery patients (N=89). The rate of positive culture was 6.5% (N=3/46) in the 10-minute dry time group compared to 30.2% (N=13/43) in the non–dry time group, indicating a significant difference in postoperative infection rates (*P*=.004).

A QI study[63] investigated surgical attire, including types of hair covering and sleeve jacket use (N=6548). No difference in postoperative SSI rates (*P*=0.7) among spine procedures with bouffant hats vs traditional skull caps and the use of long-sleeve jackets vs no arm coverings was found.[63]

Recommendations: There is moderate-quality evidence[61] that is equivocal for using ChloraPrep™ (2% CHG and 70% isopropyl alcohol) as opposed to DuraPrep™ (0.7% available iodine and 7.4% isopropyl alcohol) for intraoperative skin preparation to reduce postoperative SSI (strong recommendation).

There is moderate-quality evidence[62] supporting application of povidone-iodine 10-minutes prior to starting the operation to reduce postoperative SSI rates (strong recommendation).

Silicone Foam Dressings to Reduce Pressure Injuries

Yang and colleagues[64] examined the use of a silicone dressing to reduce intraoperatively acquired pressure injuries (IAPI) to the chest and iliac crest pressure point areas for patients in prone position. Study participants included patients undergoing 2.5 hours or longer thoracic or lumbar surgery (N=64). The study found a significant difference in IAPIs between dressed and non-dressed chest areas (*P*=.002) immediately after surgery and between dressed and non-dressed iliac crest areas (*P*=.012) 30 minutes after surgery. One week after surgery (N=13), there were no chest or iliac crest IAPIs in the areas that had been covered by a dressing compared with eight chest (61.5%) and four iliac crest (30.8%) area IAPIs when no dressing had been applied.

Recommendation: There is low-quality evidence[64] to support prophylactic use of silicone foam dressings over pressure points when in prone position, among patients undergoing thoracic or lumbar surgical procedures, to reduce intraoperative-acquired pressure injuries (strong recommendation).

Self-Warming Blankets to Prevent Hypothermia

The efficacy of preoperative, intraoperative, and postoperative use of an active self-warming blanket compared with standard care based on passive insulation techniques in patients scheduled for a clean elective spinal surgery in the prone position with an expected duration of surgery less than 2 hours (N=46) was investigated by Dostalova and colleagues.[65] Findings included axillary temperatures being significantly lower in the control group at the time of departure to the operating theater

(36.0±0.5 vs 36.3±0.4; *P*=.0086). Patients in the self-warming blanket group had higher esophageal temperatures intraoperatively, higher axillary temperatures in the recovery room, and fewer episodes of postoperative shivering (1/46 vs 8/46; *P*=.0352).

Recommendation: There is moderate-quality evidence[65] to support the use of active self-warming blankets in the preoperative, intraoperative, and postoperative acute care unit to decrease postoperative hypothermia and shivering (strong recommendation).

Postoperative Interventions

The postoperative phase after spinal surgery entails coordination of care for wound healing, pain management, and rehabilitation to optimize function. There were 12 PICO questions composed for this section, with the results described below.

In the care of adults undergoing spine surgery, does the type or timing of incision care and/or dressing care impact surgical site infection development?

Incision Care and Impact on Surgical Site Infection

Incision care can vary by the type of surgery, extent of the surgical incision and closure, and surgeon preferences. There is debate on the type of surgical site care, the dressing to use, and how often the dressing should be changed to reduce the risk of infection.

One article[54] addressed the focus of this question. Castella et al[54] used a quasi-experimental design to decrease SSI rates for patients undergoing spinal surgery in the trauma service. The preventative protocol included all three phases of perioperative care. Specific to this PICO question was the use of a visible occlusive dressing that allowed for visualization of the wound without the need to lift or remove the dressing. The dressing was maintained for 5 to 7 days depending on degree of saturation and absence of complications as monitored by infection control nursing. Implementation of a preventative protocol resulted in 14 cases of SSI diagnosed, with a significant decrease in the incidence of SSI from the preintervention period (19.4%) to the postintervention period (2.6%; *P*=.0010). The authors concluded[54] that the use of a transparent and impermeable occlusive dressing allowed the wound to be monitored without need to change the dressing. This nursing strategy limited potential wound contamination.

Recommendation: There is moderate-quality evidence[54] to support the use of a visible occlusive dressing in combination with perioperative surgical site preventative measures to decrease postoperative SSI rates (strong recommendation).

In the care of adults undergoing spine surgery, do nursing interventions of surgical site drains assist in identifying acute changes in the postoperative phase of care?

Nursing Interventions of Surgical Site Drains

Surgical site drains use negative pressure to pull fluid away from the underlying tissue through a catheter placed near the surgical site. The characteristics of the fluid and amount collected should be assessed and documented for potential infection, to identify acute postoperative complications (eg, hemorrhage), and to determine optimal timing of drainage removal.

Four articles met inclusion criteria.[66-69] Of the four studies, three were retrospective designs[66,68,69] and one was a meta-analysis.[67] Koutsoumbelis et al[66] investigated patient- and procedure-related factors that may contribute to SSIs in patients undergoing PLIF. Specific to this PICO question, we focused on procedure-related factors, or the use of surgical drains and risk of SSI. The study[66] found no statistically significant association between the number of drains and the overall rate of infection (N=3,218; *P*<.703). Two studies[67,69] evaluated the use of surgical drains and complication rates. Davidoff et al[67] completed a systematic review and meta-analysis to determine whether the practice of wound drains used in lumbar decompression surgery helps to prevent symptomatic epidural hematoma formations or infection. The authors[67] concluded the use of wound drains does not increase the rate of postoperative epidural hematomas (N=5,327; *P*=.28) or SSIs (N=5,327; *P*=.91). Additionally, Buser et al[69] investigated use and length of drain placement following elective spinal surgery. The overall infection rate was 5.7%, with 6.22% of infections among patients with a drain compared to 4.91% in patients without a drain. The length of drain placement was a variable significantly associated with infection (N=671; *P*<.05).[69]

The use of a perioperative ERAS protocol to decrease postoperative hospitalization and risk of complications was reported by Li et al.[68] The application of the ERAS protocol showed significant improvements in the timing of drain removal (48.85±10.10 to 43.92±7.14 h; *P*<.001) in patients after cervical laminoplasty (N=224), allowing for

reduced time to mobilization (30.79±14.45 vs 65.24±25.34 h; *P*<.001) and improved pain control (*P*<.001).

Recommendations: There is low-quality[69] and high-quality[67] evidence supporting procedure-related factors, or use of surgical drains, to aid nurses in identifying acute postoperative changes such as epidural hematoma formation and SSI (strong recommendation).

There is low-quality evidence[68] supporting use of a perioperative ERAS protocol to improve timing of surgical drain removal, leading to quicker postoperative mobilization and improved pain control (strong recommendation).

In the care of adults undergoing spine surgery, does the timing of inpatient nutrition affect patient outcomes?

Timing of Inpatient Nutrition

The timing of nutrition intake after surgery is pertinent for all types of surgery and will depend on the extent of surgery, duration of anesthesia, and return of bowel function. Specific to spinal surgery, there is debate on whether early nutritional intake after surgery can reduce complications and influence LOS.

Three observational studies[68,70,71] matched the focus of this PICO question. The patient surgical procedure samples varied, including PLF,[70] elective lumbar spine surgery,[71] and cervical laminoplasty.[68] All three papers incorporated ERAS protocols to determine if timing of inpatient nutrition affected postoperative patient outcomes. The first ERAS protocol included early postoperative oral nutrition for patients undergoing lumbar fusion surgery.[70] Early oral nutrition predicted postoperative complications in multivariate analysis (N=260; *P*=.026). In an ERAS protocol following cervical laminoplasty,[68] the ERAS group had significantly shorter postoperative early nutrition, hospital stay, and reduced first time of assisted walking (N=224; *P*<.001), compared to the historical control group. Finally, an ERAS protocol following lumbar spine surgery[71] initiated postoperative early nutrition (solids and fluids). A subgroup analysis assessed the trends in the average hospital LOS over the 5-year study duration. The trend in LOS decreased from 2.4±1.2 days to 1.5±0.3 days (N=2,592; *P*<.001).[71] Because timing of inpatient nutrition was embedded in complex multifaceted ERAS protocols,[68,70,71] conclusion limitations are inherent when determining if timing of inpatient nutrition is associated with outcomes.

Recommendation: There is low-quality evidence[68,70,71] that the use of perioperative ERAS protocols combined with early postoperative inpatient nutrition reduces postoperative complications and prolonged LOS (strong recommendation).

In the care of adults undergoing spine surgery, are there perioperative nursing interventions that decrease or prevent the development of a postoperative ileus?

Perioperative Nursing Interventions to Decrease or Prevent Postoperative Ileus

Postoperative ileus can occur after surgery, as evidenced by prolonged absence of bowel motility, abdominal distension, and intolerance of oral intake. Delayed colonic motility over 72 hours is typically considered pathologic, and evaluation for bowel obstruction should be undertaken. Measures to prevent postoperative ileus and return to normal bowel function in spine surgery patients were a focus of the review.

Three retrospective articles[39,72,73] matched the focus of this PICO question. Of these, two studies were limited to patients with PLF[39,72] and one study included thoracolumbar fusion.[73] Stienen et al[73] identified significant contributing factors associated with the impedance of normal bowel function in patients undergoing thoracic or lumbar fusion surgery including longer mean operation times (N=99; *P*=.012), higher estimated blood loss (*P*<.001), and higher mean morphine dosages in the intraoperative phase (*P*=0.286) as well as during POD1 (*P*=.041) and POD2 (*P*=.028). In addition, the authors[73] noted that the use of laxatives on POD3 was significantly more frequent in those with constipation as opposed to those without constipation (*P*=.011). Du et al[72] investigated if chewing gum in the postoperative phase of care can promote bowel function recovery in elderly patients undergoing PLF. Time to first flatus, first bowel sounds heard, and first defecation were all significantly accelerated in the chewing gum group compared with the control group (*P*<.001). An ERAS protocol for patients undergoing one- or two-level transforaminal lumbar interbody fusion (TLIF) included[39] a postoperative standard bowel regimen and diet order on POD0.[39] The first day of bowel movement occurred significantly earlier in the ERAS group as compared to control (3.0 days vs 2.2 days; *P*=.008). However, 35% (N=20) in the ERAS group compared to 25% (N=14) in the pre-ERAS group (*P*=.302) were discharged without having had a bowel movement.[39] Lastly, 1.8%

(N=1) developed an ileus in the ERAS group, and 3.5% (N=2) in the pre-ERAS group (*P*=1.0).

Recommendation: There is very low–quality evidence[72,73] to support perioperative nursing assessment and interventions such as identifying risk factors to prevent postoperative constipation,[73] chewing gum in the postoperative phase of care,[72] and perioperative ERAS protocol[39] to promote bowel function, recovery, and prevent postoperative ileus (weak recommendation).

In the care of adults undergoing spine surgery, are there perioperative nursing measures that decrease or prevent postoperative urinary retention?

Perioperative Nursing Measures that Decrease or Prevent Postoperative Urinary Retention

Impaired voiding after surgery can cause patient discomfort and lead to prolonged LOS. A voiding volume less than 100 milliliters (mL) or voiding volume ratio less than 50% (calculated as the voiding volume divided by the total volume) has been used to identify postoperative urinary retention (POUR).[52] After spinal surgery, up to 60% of patients experience POUR, which is typically managed with intermittent or indwelling catheterization.[74]

Five observational studies[39,75-78] and one meta-analysis[79] met inclusion criteria of this PICO question. Of these, four studies included lumbar spine surgery,[39,75,77,78] one involved cervical and lumbar surgeries,[76] and the meta-analysis included cervical, thoracic, and lumbar surgeries.[79] Study interventions included assessment of risk factors and nursing strategies to decrease POUR.

Four studies[76-79] assessed risk factors for POUR. A meta-analysis (N=31,251) conducted by Chang and colleagues[79] identified older age (WMD, 7.33; 95% CI, 4.59-9.76), male sex (OR, 1.31; 95% CI, 1.04-1.64), and the following comorbidities associated with increased risk of POUR: benign prostatic hypertrophy (OR, 3.79; 95% CI, 1.89-7.62), diabetes mellitus (OR, 1.50; 95% CI, 1.17-1.93), coronary artery disease (OR, 1.34; 95% CI,1.06-1.6), and history of urinary tract infection (UTI) (OR,1.70; 95% CI,1.28-2.24).[79] Furthermore, longer operative time (WMD, 19.88; 95% CI, 5.01-34.75) and intraoperative increased IV fluid use (SMD, 0.37; 95% CI, 0.23-0.52) was found in patients with POUR.[79] In contrast, less surgical level (OR, 0.75; 95% CI: 0.65-0.86) and ambulation POD0 (OR, 0.65; 95% CI, 0.52-0.81) was associated with decreased risk of POUR.[79] Aiyer et al[77] was included in this meta-analysis, so a separate entry was not indicated. In addition, Leitner et al[76] found among elective spine surgery patients with intraoperative urethral catheter-free management that length of surgery was also associated with POUR (*P*<.05). However, Bowman et al[78] investigated perioperative risk factors for POUR among patients undergoing combined lumbar decompression and fusion procedure. Surgical factors such as preoperative catheterization (POUR: 47%; non-POUR: 63%, *P*=.28) and mean operative time (POUR: 143 min; non-POUR: 126 min, *P*=.35) did not significantly correlate with the development of POUR.

Four studies[39,75,76,79] assessed nursing strategies to decrease the risk of POUR. Huang and colleagues[75] found early ambulation (ambulation within 4 hours after surgery) in participants aged 60 years and older undergoing single segment lumbar decompression and fusion (N=86) led to significantly less (*P*<.03) urinary retention than regular ambulation participants (ambulated at a minimum of 24 hours postoperatively). The time before the first time to ambulation was 4±0.5 hours in the early ambulation group and 28±4.5 hours in the regular ambulation group. Furthermore, Chang et al[79] found that ambulation the same day of surgery among elective spine surgery patients was associated with decreased risk of POUR (OR, 0.65; 95% CI, 0.52-0.81). A perioperative ERAS protocol including patients undergoing one- or two-level TLIF procedures was implemented by Porche and colleagues.[39] Interventions included preoperative renal evaluation and postoperative nursing measures. Nursing measures included initiation of physical and occupational therapy evaluations, out of bed to chair for dinner, and implementing a urinary catheter management protocol on POD0. On POD1, nursing interventions included out of bed to chair for all meals and ambulation with assistance at minimum three times daily.[39] The perioperative multifactorial ERAS protocol significantly decreased time to first void: 0.8 days earlier (1.1 days vs 0.3 days; *P*<.001). Finally, Leitner and colleagues[76] investigated bladder care delivery between intraoperative urethral catheter-free (N=54) management and those with preoperatively placed catheters (N=46) in elective cervical and lumbar spine surgery patients. Postoperative urinary retention developed in 30% (N=16) of the urethral catheter-free management group. Of those, POUR was associated with surgery duration (*P*=.01) and volume of IV fluid administration (*P*=.04). Indwelling catheter-free management did not increase postoperative urologic complications (OR, 2.09; 95% CI, 0.69-6.33; *P*=.193). In the preoperatively placed catheter group, the mean catheterization time was 2±1 day, and recatheterization was required by 13% (N=6).[76]

The definition of POUR varied. The following definitions were found: 350 mL[76]; urinary retention not defined[75]; a strict definition for POUR was prospectively defined as meeting any or all of the three criteria: (a) bladder volume post void more than 300 mL (determined by ultrasound bladder scan within 90 minutes of voiding; (b) unassisted inability to void more than 8 hours

postoperative or post catheter removal with a bladder volume at that time of 300 mL or more; and (c) urological consult or diagnosis postoperatively before discharge resulting in a finding consistent with urinary retention.[78]

Recommendations: There is low-quality[76-78] and moderate-quality[79] evidence to support preoperative nursing assessment including older age, male sex, and comorbidities as risk factors for increased incidence of POUR (strong recommendation).

There is low-quality[76-78] and moderate-quality[79] evidence to support intraoperative nursing assessment including increased IV fluid use and longer surgery time as risk factors for increased incidence of POUR (strong recommendation).

There is low-quality[39,75,76] and moderate-quality[79] evidence to support implementing perioperative ERAS nursing strategies such as preoperative renal evaluation, intraoperative urinary catheter use, postoperative early ambulation, and a postoperative urinary catheter management protocol to decrease postoperative POUR (strong recommendation).

In the care of adult spinal cord injury patients, does neurogenic bowel and bladder training improve patient recovery?

Neurogenic Bowel and Bladder Training After Spinal Cord Injury

Spinal cord injury is a potential complication of spinal surgery and can result in temporary or permanent injury to the nerve fibers. When the nerves controlling bowel or bladder function are injured, it can result in neurogenic bowel and bladder characterized as loss of bowel or bladder control, constipation or inability to empty the bladder, and bowel or bladder frequency.

Three studies met inclusion criteria.[80-82] Of these, two studies were observational[80,81] and one was qualitative.[82] The sample population included patients with SCI. Interventions included neurogenic bowel and bladder management to improve QOL among SCI patients.

Using a cross-sectional study, Gong and colleagues[80] aimed to determine aspects of excretory dysfunction most influential in determining QOL among traumatic and nontraumatic SCI patients (N=101). A poorer QOL for people with SCI was associated with those who experienced bladder (P=.010) or bowel (P=.001) accidents and those with more than one bladder (P<.001) or bowel (P=.036) complication. Furthermore, patients who could void normally had better QOL self-perceptions.[80] Adult SCI participants living with neurogenic bladder or bowel dysfunction (N=12) were participants in a qualitative investigation,[82] with the aim to develop a neurogenic bladder and bowel dysfunction goal menu to facilitate goal attainment, scaling, uptake, and use (a technique used to demonstrate the extent to which goals have been met). Participants' goal domains were impact on life, treatment and management, and symptoms and complications. A total of 25 goals were developed, with the top three goals being emotional well-being, exercise, and financial concerns. The study reinforces the need for nursing to involve personalized measures to improve patient-centered clinical outcomes and QOL among SCI patients, particularly with challenges posed by incontinence and limitations on everyday life.[82]

Joshi and colleagues[81] used a prospective case study approach to investigate the duration of clean intermittent catheterization (CIC) once those with SCI were discharged from inpatient rehabilitation. Post discharge, 68.89% (N=31/45) continued CIC and 31.11% (N=14/45) stopped. In addition, among those continuing CIC, 25 patients (80.64%) were completing the procedure themselves, and 6 patients had the procedure carried out by a caregiver. The mean duration was 3.5 months for those who continued CIC; 31.11% transitioned from CIC to other methods, and 11.11% transitioned to an indwelling catheter. Participants noted unavailability of toilets, UTI, procedural difficulties, and pain as reasons for stopping CIC. The following complications were present in patients continuing CIC: UTI (17.78%), pressure injury (8.89%), renal calculi (4.44%), and urethral injury (2.22%). Quality of life for SCI patients who perform CIC was not measured.

Recommendation: There is very low-quality evidence[80,81] to suggest neurogenic bowel and bladder training in the care of adult SCI patients may improve quality of life (strong recommendation).

In the care of adults undergoing spine surgery, does the timing or distance of mobilization/ambulation impact postoperative outcomes?

Timing or Distance of Ambulation

Early ambulation is a priority for most types of surgery because of the beneficial effects in reducing respiratory complications and thromboembolic events as well as improving functional capacity. However, no formal guidelines for early ambulation exist in spinal surgery, and the timing could vary based on the type of spinal surgery.[83]

Five articles addressed this PICO question[29,39,68,75,84]. Heterogeneity existed in the definitions of mobilization, ambulation, and early mobilization/ambulation. There was no data to support optimal timing of mobilization or ambulation. A prospective design study[75] with older

adults undergoing lumbar decompression and fusion investigated if early ambulation improves postoperative outcomes (N=86). The early ambulation group was defined as ambulated within 4 hours after surgery and the control group was ambulated a minimum of 24 hours after surgery. Outcome measures included pain, functional scores, postoperative complications, 90-day readmission rates, and length of index hospital stay. Early ambulation had a shorter duration of a wound drainage catheter (early ambulation, 68 hours vs control group, 78 hours; *P*=.001), less pain (*P*=.002), shorter length of index hospital stay (early ambulation, 4 days vs control group, 5 days; *P*<.001), less urinary retention (early ambulation, 3 cases vs control group, 12 cases; *P*=.030), and less ileus (early ambulation, 0 cases vs control group, 6 cases; *P*=.030). The rate of developing at least one complication was significantly lower in the early ambulation group (early ambulation, 9 vs control group, 22; *P*=.022). There was no difference between groups in 90-day readmission.

One pilot RCT[84] of patients undergoing lumbar discectomy investigated the feasibility and safety of patient mobilization, starting from the postanesthesia care unit (PACU). Outcome measures were postoperative complications and length of hospital stay. The intervention group, in the PACU, were mobilized to sit, stand, and walk to a bathroom at least 1 hour after surgery. Patients in the intervention group also walked 50 meters using a walker, porter, nurse, or standby wheelchair assist to transfer to the general care floor. The control group remained in bed, were not allowed out of bed to the restroom, and remained in bed for transport to the inpatient room. The authors did not report statistical significance. During the first 24 hours postoperative, total opioid use by the intervention group was 10.5 mg vs 25.5 mg by the control group.

ERAS protocols were investigated with a retrospective propensity-matched[39] design (N=114) and a quasi-experimental pre-/postdesign[68] study (N=234). The populations differed between one- or two-level TLIF[39] and cervical laminoplasty.[68] Outcomes included length of hospital stay, pain, opioid use, and complications. The ambulation intervention within the ERAS protocols were early ambulation[39] defined as on-bed movement POD0 and bedside sitting and assisted walking on POD1.[68] Time to early ambulation was significant in both studies: (pre-ERAS group, 1.3±0.1 minutes; ERAS group, 0.6±0.5 minutes; *P*<.001[39] and (pre-ERAS group, 65.34±25.34 minutes; ERAS group, 30.79±14.45 minutes; *P*<.001).[68] Because ERAS protocols involve multiple simultaneous interventions, the contribution of ambulation on overall outcomes could not be determined.

A nursing QI initiative[29] aimed to develop a nurse practitioner–led early mobility protocol to reduce uncomplicated postsurgical spine patients' (N=715) LOS and eliminate the variability of postoperative care. The early mobility protocol included the diagnoses of cervical laminectomies and foraminotomies; ACDF; and lumbar laminectomy, foraminotomies, and discectomies. The goals for POD0 were to (a) mobilize within 6 hours of admission to the inpatient unit following surgery; (b) complete light activity in the room; (c) be out of bed to the bathroom (no urinal/commode); and (d) out of bed for dinner. For posterior cervical fusion and lumbar fusion, the difference was that the patient may mobilize based on clinical judgement. On POD1, goals included (a) patient-controlled analgesia (PCA) and IV fluid discontinued at 0600; (b) indwelling catheter removed at 0500 for lumbar fusion; and (c) increased mobility, such as out of bed to bathroom, chair for all meals, mobilize with registered nurse, and no wait for physical therapy. Exclusion criteria and considerations for nursing are included in the protocol.[29] The QI nursing initiative reduced LOS by 9 hours (*P*<.001) per spine patient hospitalization. The authors[29] also noted nurse autonomy to ambulate the patient, not dependent on other disciplines.

Recommendation: There is low-quality[39,68,75] and moderate-quality[84] evidence to support timing of early ambulation (within 4 hours after surgery) or distance of ambulation (50 meters) on patient-centered postoperative outcomes including decreased pain, opioid use, complication rate, urinary retention, and LOS (strong recommendation).

In adults who are managed in an external orthosis for spine trauma or after spine fusion surgery, what nursing interventions are used to improve patient outcomes?

Nursing Interventions for Adults Managed in an External Orthosis

External orthosis, or a rigid brace fitted around the neck or torso for use in mobility after spinal surgery, has been used to reduce gross body motion and motion segments, enhance fusion rate, and improve pain and functional outcomes. However, the use of external orthosis remains questionable, as it may not improve outcomes, even after more extensive spinal fusions.[85,86]

The literature search yielded no studies to answer this question.

Recommendation: There is insufficient evidence to support types of nursing interventions for adults managed in an external orthosis for spine trauma or after spine fusion surgery to improve patient outcomes.

In the care of adults with spinal cord injury, what interventions can be used to prevent autonomic hyperreflexia?

Prevention of Autonomic Hyperreflexia

Patients who have undergone spinal surgery for an SCI, usually at or above the sixth thoracic vertebra (T6), or individuals who sustain an SCI during surgery are susceptible to autonomic hyperreflexia (AHR). It is most often triggered by painful sensory input involving the skin, bladder, or bowels, and presents as HTN with headache but may also include excessive sweating, bradycardia, and skin flushing. As a life-threatening condition, prevention of AHR is critical.

Seven articles matched the focus of this PICO question.[87-93] Study aims included bladder care,[91] bowel care,[88,89,92] and AHR management in SCI.[87,90,91,93] Solinsky and Linsenmeyer[91] completed a prospective observational cohort study with the primary outcome of incidence and magnitude of AHR as determined by systolic blood pressure following urinary or suprapubic catheter change in treatment vs control groups. The authors found intravesical lidocaine given 4 to 6 minutes prior to catheter exchange statistically significantly decreased (*P*=.014) incidence and magnitude of AHR. Neurogenic bowel management and its relationship to AHR was investigated in three articles.[88,89,92] Through an RCT, Lucci et al[88] investigated lidocaine lubricant during bowel care of patients with SCI above T6. The authors found that the use of lidocaine worsened the severity of AHR during bowel care. The authors suggested the finding was related to the greater stimuli required to produce a bowel movement, thereby exacerbating AHR. Inskip et al[89] and Ozisler et al[92] investigated bowel management outcomes and QOL. Inskip and colleagues[89] completed a retrospective design study, using community SCI participant survey data with the aim of describing the relationships between bowel care, AHR, and QOL. Seventy-four percent of participants reported at least one symptom of AHR during their routine bowel care. The most common symptoms of AHR during bowel care were goosebumps (52%), spasticity (51%), flushing (49%), sweating (49%), general unwellness (43%), and headache (38%). Additionally, symptoms of cardiac arrhythmia during bowel care were noted by 32% of participants with SCI at or above T7. More severe symptoms of AHR were associated with younger participants (*P*=.0009), complex bowel care routine (*P*<.0001), longer time to complete bowel care (*P*=.0018), greater frequency of fecal incontinence (*P*<.0075), and poorer QOL (*P*<.001). Ozisler et al[92] conducted a prospective cohort study among individuals with SCI. Participants with gastrointestinal-induced AHR had symptoms such as sweating following rectal distension or anal manipulation, headache, flushing, nasal congestion, blurred vision, or sudden blood pressure increase. Following initiation of a bowel program, mean neurogenic bowel dysfunction (NBD) score was significantly decreased in both patients with motor complete (*P*=.000) and incomplete (*P*=.018) SCI, indicating improvement in NBD.[92]

Furusawa et al[90] employed a retrospective design and divided bowel and bladder management strategies into categories to investigate the incidence of AHR with each strategy (N=571). Methods for bladder management were spontaneous voiding, intermittent catheterization, indwelling catheterizations, reflex voiding, and others. The lowest incidence of symptomatic AHR was with continent spontaneous voiding, followed by intermittent catheterization. The highest incidence of AHR was found with reflex voiding.[90] Methods of bowel management were continent spontaneous defecation, rectal medications, manual removal of stool, and others. The lowest incidence of AHR was seen with continent spontaneous defecation (N=13/164) and the highest with manual removal of stool (N=67/170).[90]

Tadeu de Andrade et al[87] and Solinsky et al[93] investigated nurse-driven protocols for AHR reduction. Of these, one protocol[93] was created in 1999, published in 2016, and provided the best evidence-based practice at the time. This study empowered nurses to employ a treatment algorithm utilizing both conservative and pharmacological interventions. The algorithm included quickly identifying the source of AHR and removing the stimulus. If this was not effective, oral antihypertensives were used prior to provider notification of the event. Tadeu de Andrade et al[87] employed a retrospective case series among individuals with SCI at T7 or above, considered at risk for AHR. The authors concluded the most frequent risk factors for AHR included bladder distention (89.3%), pain (5.8%), rectal distention (3.9%), pressure ulcer (0.7%), urinary infection (0.7%), and musculoskeletal conditions (0.7%), highlighting the importance of early recognition of AHR in patients with SCI by utilizing nursing diagnoses to increase nursing awareness.[87]

Recommendations: There is low-quality evidence[91] to support the use of intravesical lidocaine prior to indwelling catheter exchange to decrease the risk of AHR (strong recommendation).

There is low-quality[89,92] and moderate-quality[88] evidence to support neurogenic bowel management to prevent AHR (strong recommendation).

There is low-quality evidence[87,90,93] to support nursing strategies or protocols, such as bladder or bowel management and pharmacological interventions, to prevent AHR (strong recommendation).

In the care of adults undergoing spine surgery, does nonopioid pain pharmacotherapies or nonpharmaceutical therapies improve postoperative outcomes?

Nonopioid Pain Pharmacotherapies and Nonpharmaceutical Therapies

Pain management is a priority after spinal surgery and can include regional or neuroaxial anesthetic techniques, infusions, oral medications, nonpharmacologic therapy, or multimodal approaches. This section is broken down into the areas of preoperative and postoperative gabapentin or pregabalin, multimodal analgesia protocols including ERAS, and nonpharmacological interventions.

Nineteen articles matched the focus of this PICO question.[39,68,94-110] Of these, nine study populations were solely PLF[39,96,98,99,101-103,105,109] and seven study populations comprised lumbar discectomy, fusion, laminectomy, and cervical laminoplasty.[68,95,97,100,104,108,110] The remaining three study populations were irrespective of spine surgery location.[94,106,107]

Preoperative and Postoperative Gabapentin or Pregabalin

Three articles investigated the use of gabapentin to reduce postoperative opioid consumption.[100,106,108] Khan et al[100] assessed the analgesic efficacy of a milligram range of a single dose of gabapentin pre and post incision.[100] Preincision or postincision gabapentin 900 mg and 1200 mg significantly reduced the severity of pain (P<.001), decreased morphine sulfate consumption 24 hours after surgery (P<.05), and increased time to first demand for analgesia after surgery (P<.05) in patients after single-level lumbar laminectomy (N=175).[100] Gabapentin 600 mg compared to placebo was more effective in pain control and significantly reduced morphine consumption.[100] However, gabapentin 600 mg was not as effective as gabapentin 900 mg and 1200 mg.[100] The remaining two studies, both of which were meta-analyses (N=1673; N=581) of RCTs,[106,108] evaluated the use of preoperative gabapentin and its impact on postoperative opioid consumption. A significant reduction was observed in cumulative morphine following spine surgery.[106,108] In addition, high-dose (≥900mg/day) gabapentin was superior to low-dose (<900mg/day) gabapentin (N=581).[108]

Three articles investigated the use of pregabalin to reduce postoperative opioid consumption.[97,101,110] Kim et al[101] evaluated the effects of two different doses of perioperative pregabalin administration on acute postoperative pain after lumbar spinal fusion.[101] Perioperative pregabalin 150 mg significantly reduced opioid consumption (24hr; P=.025 and 48hr; P=.028) and use of rescue analgesics compared to pregabalin 75 mg, exerting similar efficacy as placebo.[101] The remaining two studies, both of which were meta-analyses of RCTs,[97,110] evaluated pregabalin for reducing pain intensity[97,110] and 24-hour accumulative morphine equivalent (ME) consumption following lumbar spine surgery.[101] Pregabalin was associated with reduced pain scores at rest 2 hours (P=.001) post surgery[97] and at 12 hours, 24 hours, and 48 hours.[110] For pain scores with mobilization, no clinically relevant reductions in pain scores were associated with using pregabalin at any time point.[110] Furthermore, a significant reduction was observed in cumulative ME consumption following lumbar spine surgery.[97,110] The dosage and interval of pregabalin administration were different in each study in both meta-analyses, resulting in large heterogeneity.

Recommendation: There is high-quality evidence[97,100,101,106,108,110] to support preoperative use of gabapentin and pregabalin to improve postoperative pain control and reduce opioid requirements (strong recommendation).

Multimodal Analgesia Protocols

The reviewed papers comprised five observational studies,[96,98,99,102,105] three RCTs,[95,103,104] and one meta-analysis of RCTs.[107] A prospective observational study (N=240)[105] investigated postoperative pain and QOL in adults after having had spine surgery using a self-administered pain questionnaire completed by the patient the night of surgery and 1-, 2-, 3-, 7-, and 14-days postoperative. Quality of life was assessed with the EQ-5D-5L questionnaire the day before surgery, POD14, and 3 months after surgery. Postoperative pain was managed by multimodal preoperative and postoperative therapy, along with combinations of PCA, nonsteroidal anti-inflammatory drugs (NSAIDs), cyclooxygenase-2 inhibitors, and opioids. Self-reported levels of pain were not significantly different among multiple postoperative modalities of pain management but differed significantly from preemptive pain (N=363) management regimens (P<.05).[105] Usual activity, depression and anxiety, and self-care improved significantly in the preemptive pain management group at 2-weeks postoperative (P<.05). A retrospective cohort study[96] investigated the impact of removing benzodiazepines and long-acting opioids on postoperative pain in single-level TLIF patients (N=111).[96] The negative benzodiazepine cohort (N=34) experienced a faster rate of ME reduction, discharged earlier, and was less likely to receive opioid refills at 2-weeks (P=.021) and 6-months (P=.039) postoperative.[96]

Three observational studies[98,99,102] implemented standardized multimodal analgesia protocols in the PLF population. Compared to historical controls, the protocols reduced pain scores (N=220, average pain score in first 24hr, P<.001[98]; N=83, P=.015, POD1 pain control[102]) and

opioid consumption (*P*=.02, 72hr postoperative opioid consumption[98]; N=85; *P*=.024 POD1 and *P*=.048 POD2[99]; N=101, *P*=.007 POD1 opioid requirements[102]). Furthermore, patients treated according to the new protocol were mobilized earlier from bed (*P*=.003)[99] and there was an observed reduction in hospital LOS (*P*=.03).[98] In addition, three RCTs[95,103,104] evaluated various multimodal analgesic approaches on postoperative pain control after multilevel posterior spine surgery, lumbar fusion surgery, and a one- or two-level lumbar laminectomy. Two preemptive multimodal analgesia protocols[103,104] demonstrated less total postoperative IV morphine requirements (N=22; *P*=.01 at 24hr postoperative)[104] and decreased VAS pain scores (N=80, P=.000[103]; N=22, P=.01 at 24 hr postoperative[104]). However, an analgesic pathway based on preoperative acetaminophen and gabapentin, combined with intraoperative infusions of lidocaine and ketamine, did not show significant change in postoperative opioid use or pain scores.[95] Finally, a meta-analysis[107] of 86 RCTs reviewed 20 pharmacological and 10 regional intervention analgesic pathways for adult spine surgery. The most effective intervention to reduce cumulative morphine consumption and VAS pain scores 24 hours postoperative included triple-drug therapy consisting of paracetamol, NSAID drugs, and either adjunct or gabapentinoid. The mean difference of MEs and pain scores at 24 hours postoperative between paracetamol and NSAID with adjunct and control were -26 (95% CI: -39 to -12) mg and -2.3 (95% CI: -3.1 to -1.4) mg. Adjuncts consisted of duloxetine, epidural clonidine, lidocaine infusion, dexamethasone, and magnesium infusion. The mean difference of MEs and pain scores at 24 hours postoperative between paracetamol, NSAID, and gabapentinoid and placebo were 28 (95% CI: -53 to -4) and -1.4 (95% CI: -2.3 to -0.6). The meta-analysis also concluded a graded analgesic effect in which analgesic efficacy increased with the number of multimodal drugs used.[107]

Finally, two studies,[39,68] both retrospective cohorts, reported on the use of multimodal analgesia as part of ERAS protocols to reduce postoperative MME, pain scores, LOS, and timing to ambulation. Both studies included all three perioperative phases of care. Porche et al[39] focused on one- or two-level open TLIF procedures for DDD[39] and applied nonopioid medication interventions in both preoperative and postoperative phases of care consisting of scheduled oral acetaminophen, duloxetine, and gabapentin. In the ERAS cohort, LOS (*P*<.001), first day of ambulation (*P*<.001), total daily IV morphine MME (*P*<.001) and total 72-hour MME consumption (*P*<.001) was significantly lower.[39] Li et al[68] focused on cervical laminoplasty for degenerative multilevel spine compression and spinal canal stenosis,[68] applying an NSAID-based comprehensive analgesic regimen that consisted of IV NSAID for 3 days after surgery and then sequential oral administration of celecoxib twice daily. The ERAS cohort demonstrated significant reduction in postoperative hospital stay (*P*<.001), first time of assisted walking (*P*<.001), postoperative mean VAS pain scores (*P*<.001), and maximum VAS pain scores (*P*<.001) 3 days after surgery compared to the traditional care group.[43] Limitations of both studies include retrospective review over two time periods, leading to confounding factors such as surgeon experience and hospital safety improvement protocols.[39,68]

Recommendations: There are varying levels of quality evidence[95,96,98,99,102-105] to support preemptive multimodal analgesic pathways to reduce postoperative pain scores and opioid consumption (strong recommendation).

There is low-quality evidence[39,68] to support multimodal analgesia as part of ERAS protocols to improve postoperative pain control and decrease opioid requirements (strong recommendation).

There is low-quality[39,68,98] and moderate-quality[99] evidence to support multimodal analgesic protocols and multimodal analgesia as part of ERAS protocols to increase early ambulation and reduce LOS (strong recommendation).

Nonpharmacologic Therapies

Two articles[94,109] investigated the effectiveness of nonpharmacologic therapies on postoperative pain. One prospective, nonrandomized study (N=60)[109] attempted to determine the impact of establishing a comfort function goal preoperatively on postoperative pain scores and opioid requirements in lumbar fusion patients. The study intervention established a comfort function goal during a routine preoperative patient education class and found no significant difference in pain score POD1 morning (*P*=.58), POD1 evening (*P*=.54), during physical therapy (*P*=.68), at discharge (*P*=.75), or with opiate utilization (*P*=.99).[109] Another study[94] evaluated the effects of music therapy on postoperative pain (N=60). The intervention group listened to music, starting from the evening of the day prior to surgery to POD2. Pain was measured with VAS. Pain was significantly improved in the intervention group compared to control at baseline before surgery (*P*<.001), the day of surgery (*P*<.001), POD1 (*P*<.001), and POD2 (*P*<.001).[94]

Recommendation: There is low-quality[109] and moderate-quality[94] evidence to support the development of a preoperative comfort goal or introduction of music therapy to reduce postoperative pain scores and opioid requirements (strong recommendation).

In the care of adults undergoing spine surgery, does the nurses' role in antibiotic stewardship improve postoperative outcomes?

Nursing's Role in Antibiotic Stewardship

Antibiotic stewardship is defined by the Centers for Disease Control and Prevention as "the effort to measure and improve how antibiotics are prescribed by clinicians and used by patients."[111] These efforts are essential for effectively treating infections, preventing harm from unnecessary antibiotic use, and combatting antibiotic resistance.

Three articles met inclusion criteria for this PICO question.[112-114] Urquhart and colleagues[113] conducted a prospective RCT to compare the rate of complicated SSI after open posterior thoracolumbar spine procedures followed by the placement of a closed-suction drain between patients treated with postoperative antibiotics for 24 and 72 hours. The authors found that the extension of postoperative antibiotics for 72 hours was not associated with a statistically significant (*P*=.714) reduction in the rate of complicated SSI. In addition, a retrospective chart review[114] compared prolonged prophylactic systemic antibiotics (PPSA) to a group that was administered antibiotics for 24 hours or less postoperatively (non-PPSA) following posterior spinal surgery with placement of a subfascial surgical drain (N=336). Prolonged antibiotic use was defined as greater than 24 hours. The author's[114] findings were a twofold reduction of SSIs with the implementation of PPSA (non-PPSA group, 7.14% vs PPSA group, 3.57%; *P*=.146). A retrospective cross-sectional study[112] aimed to investigate the level of compliance with surgical antibiotic prophylaxis (SAP) guidelines in neurosurgery (N=9) operations in participating hospitals. Full compliance with the SAP guidelines occurred in 10% of the 973 assessed procedures. Full compliance with SAP guidelines was associated with weekly hours of infection control personnel per ICU bed (95% CI, 0.2-0.1; *P*=.048), hospital-wide dissemination of SAP guidelines, (95% CI, 1.2-25.3; *P*=.035), monitoring of compliance with the guidelines (95% CI, 2.4-25.2; *P*=.024), and feedback to the surgical team and stakeholders about measuring guideline compliance (95% CI, 2.8-25.2; *P*=.015).

Recommendations: There is low-quality[114] and moderate-quality[113] evidence supporting prolonged prophylactic use of antibiotics (greater than 24 hours), with placement of surgical drain, to reduce SSI (strong recommendation).

There is low-quality evidence[112] supporting surgical antibiotic prophylaxis stewardship programs to improve SSI rates (weak recommendation).

In adults with spinal cord injury, does timing of individual or group support/counseling improve patient and family outcomes?

Support Groups for Adults with Spinal Cord Injury

For patients who suffer from iatrogenic SCI after spinal surgery, support groups can offer a source of social assistance, peer mentorship, and advice for problem solving.

Two articles matched the focus of this PICO question.[115,116] The sample populations were community-dwelling people with SCI within 1 year of injury.[115,116] One study[115] investigated a 30-week group therapy intervention. The other[116] investigated a 52-week, individualized mentor-to-mentee intervention. The study participant inclusion criteria was a history of either traumatic or nontraumatic SCI at any level (excluding cancer-related SCI), who were at least 18 years of age.

An RCT[115] aimed to compare SCI-specific self-efficacy after participating in the Re-Inventing Yourself after SCI intervention, as compared to controls (N=81). The intervention consisted of 6-week facilitator-led sessions lasting for 2 hours. The primary outcome variable for this study, self- efficacy, was measured with the Moorong Self-Efficacy Scale (MSES). Measures were taken at baseline, 6-, 14-, 22-, and 30-weeks post intervention. Individuals in the treatment group had greater increases in MSES scores (4.68 vs 0.82; *P*=.0341) or greater self-efficacy from baseline to 6-weeks post intervention, but that difference did not remain significant after controlling for multiple comparisons. In addition, the treatment group showed significant improvement from baseline to 6-weeks post intervention in the following secondary outcomes: General Self-Efficacy Scale (*P*=.0075), Patient Health Questionnaire–9 for depression (*P*=.0226), and General Anxiety Disorder 7–item scale (*P*=.0322); however, this effect was not sustained past 6-weeks post intervention with any measure.

Ljungberg et al[116] completed a quasi-experimental pre-/posttest design study to investigate a 1-year focused peer mentor program (N=37). The authors hypothesized the intervention would reduce avoidable SCI medical complications and enhance general health, self-efficacy, community integration, and self-management. The intervention included five peer mentors diagnosed with SCI who had undergone a successful community reintegration and 24 newly diagnosed SCI mentees. The primary outcome was self-efficacy as measured by the General Self-Efficacy Scale. Secondary outcomes included medical complications, rehospitalizations, and physician visits between month 0 and month 6. The authors[116] found a 67% improvement in the mentees' self-efficacy scores, but

this was not statistically significant (P=.122). There was a significant decrease between 0 and 6 months and 7 and 12 months in medical complications, doctor visits, and positive sentiments from all the mentees reporting better psychosocial adjustment under the guidance of their mentors during the study period. Urinary tract infection (P=.001), pain (P=.001), depression (P=.004), pressure ulcers (P=.046), hospitalizations (P=.002), and ED visits (P=.004) all showed a significant decrease between the two time periods.[116]

Recommendations: Among adults with SCI, there is insufficient evidence to support an optimal or specified timing of when to initiate individual or group support or counseling to improve family self-efficacy.

There is low-quality[116] and high-quality[115] evidence to support individual and group support and counseling for patients after SCI to improve patient self-efficacy (strong recommendation).

Summary

The recommendations contained in this CPG are limited to the adult neuroscience spine population who have undergone spine surgery. It is intended to provide a synthesis of the current evidence and best practice guidance for the 14 PICO questions addressed. The recommendations put forth in this guideline lay a foundation for clinical practice to improve patient outcomes following spine surgery. Critical to our nursing science, this guideline identifies knowledge gaps, reinforcing the imperative need for research scholars to study nursing care interventions to improve outcomes[18] and practice scholars to study the translation of knowledge to real-world settings.[16,17]

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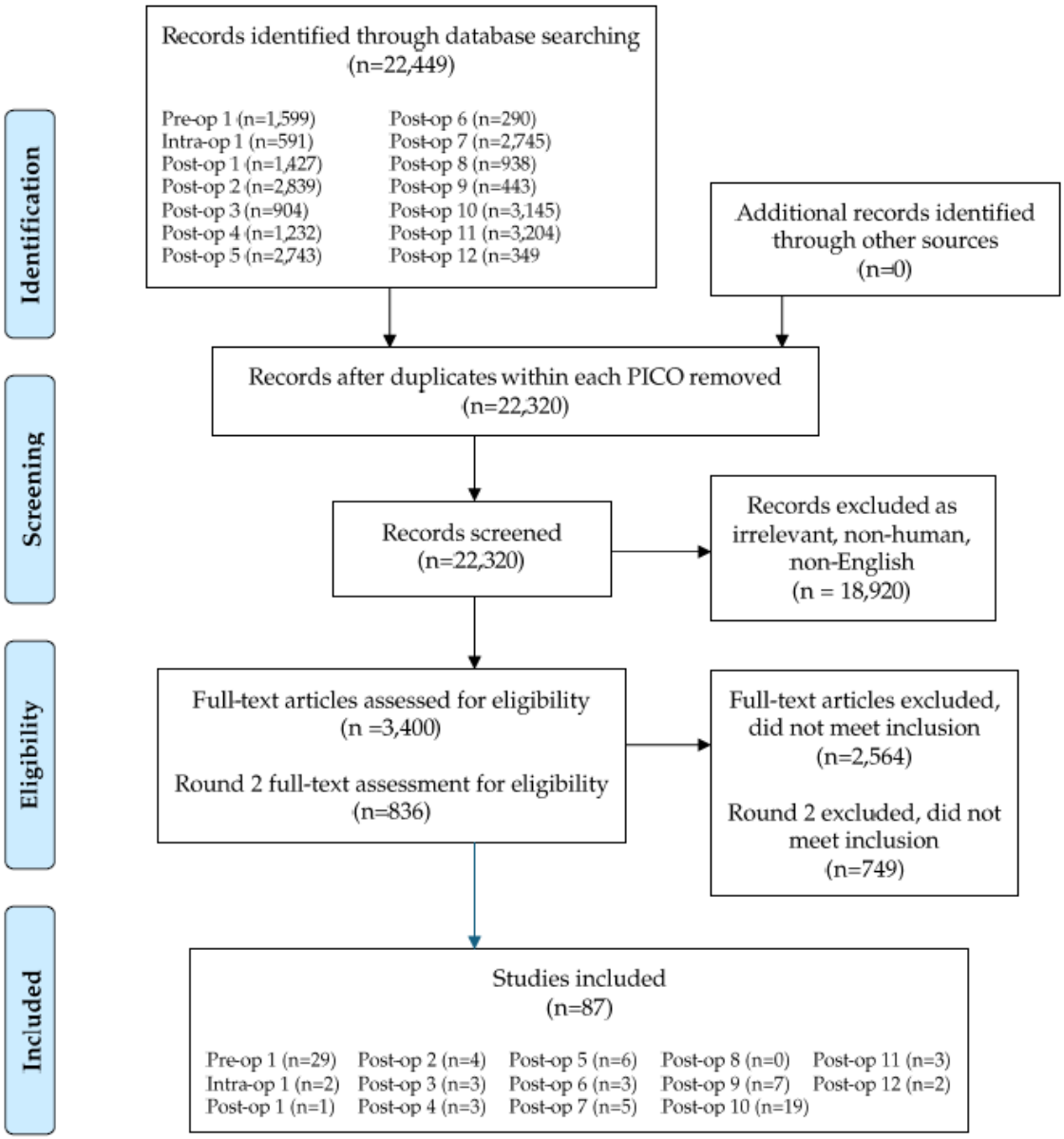
Appendices

Appendix I: PRISMA 2009 Flow Diagram



From: Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med.* 2009;6(7):e1000097. doi:10.1371/journal.pmed1000097.

Appendix II: Summary of Evidence

Preoperative PICO 1. In the care of adults undergoing spine surgery, do preoperative nursing interventions improve postoperative outcomes?

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Debone B, 2019	Pre-/ postobservational; historical controls; consecutive assignment after intervention	N=3,483 (n=1,563 pre-ERAS; n=1,920 post-ERAS)	Elective fusion: cervical and lumbar; exclusion: scoliosis, large deformity	Report initial experience in applying an ERAS program to several degenerative spinal fusion procedures	The pre-ERAS group included 1,563 patients (159 ALIF, 749 ACDF, and 655 posterior fusion), and the post-ERAS group included 1,920 patients (202 ALIF, 612 ACDF, and 1,106 posterior fusion). The mean LOS was significantly shorter in the post-ERAS group than in the pre-ERAS group for all three conditions. It was reduced from 6.06 ± 1.1 to 3.33 ± 0.8 days for the ALIF group (*P*<.001), from 3.08 ± 0.9 to 1.3 ± 0.7 days for the ACDF group (*P*<.001), and from 6.7 ± 4.8 to 4.8 ± 2.3 days for posterior fusion cases (*P*<.001). There was no significant difference in overall complications between the two periods for the ALIF (11.9% pre-ERAS vs 11.4% post-ERAS, *P*=.86) and ACDF (6.0% vs 8.2%, *P*=.12) cases, but they decreased significantly for lumbar fusions (14.8% vs 10.9%, *P*=.02). Regarding satisfaction with overall care among 808 available responses, 699 patients (86.5%) were satisfied or very satisfied, and regarding appreciation of the mobile e-health app in the perceived optimization of care management, 665 patients (82.3%) were satisfied or very satisfied.	Moderate
Rupich K, 2018	Quality improvement	N=715 (n=275 control group; n=440 intervention group)	Patients who had undergone anterior cervical discectomy and fusion, lumbar laminectomy, cervical nonfusion, and posterior laminectomy/ foraminotomy	The goals of this project were to create a nurse-driven protocol to promote early mobility that would be easy to implement among uncomplicated postoperative neurosurgical spine patients and reproduce among other postsurgical patients in the institution.	Analysis of the data demonstrated a statistically significant decrease of 6.7 hours in LOS for the lumbar laminectomy patients in the intervention group compared with the control group. After adjustments for age, sex, diabetes, and number of vertebrae involved (two or more versus one), LOS was decreased by 9.1 hours (*P*<.001) in the intervention group compared with the control group. This is all the more notable given that there were more patients with multilevel laminectomies in the intervention group (64.3%) than in the control group (53.4%). Implementation of the protocol allowed more patients with multilevel laminectomies to have a shorter LOS. There was no statistically significant difference in LOS between the intervention and control groups among the anterior cervical discectomy and fusion, cervical nonfusion, and posterior laminectomy/ foraminotomy procedure types both before and after adjusting for the aforementioned covariates.	Not applicable

Preoperative PICO 1. In the care of adults undergoing spine surgery, do preoperative nursing interventions improve postoperative outcomes? (continued)

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Janssen E, 2021	Systematic review with meta-analysis	15 articles included in systematic review: 12 RCT, 2 lacked controlled trials,1 matched cohort	Mean age from 36 to 63 years; surgery: laminectomy, interlaminar decompression, microdisc, and fusion	Assess short-term (6 mo or less), medium-term (greater than 6 weeks up to 6 mo) and long-term (6 mo or greater) effects of prehabilitation compared to usual care in patients with degenerative disorder of the lumbar spine who were scheduled for spine surgery.	Cognitive behavioral therapy (CBT) interventions were no more effective than usual care for all outcomes. Pooled effect sizes were –2.0 (95% CI: –4.4, 0.4) for physical functioning, –1.9 (95% CI: –5.2, 1.4) for back pain, and –0.4 (95% CI: –4.1, 0.4) for leg pain. Certainty of evidence for CBT ranged from very low to low. Only one study focused on exercise therapy and found a positive effect on short-term outcomes.	Moderate
Wainwright CL, 2020	Postprotocol implementation observational; retrospective	N=100	All patients who underwent spinal surgery; diabetic and nondiabetic but met ADA screening criteria (>45 yrs or a BMI >25, with HTN, HLD, CV disease, physical inactivity); exclusion: <18 yrs, outpatient surgery, nondiabetics that did not meet ADA screening criteria	Monitor stress-induced hyperglycemia during the perioperative period.	Preoperative HbA1c testing identified more than 54% of previously undiagnosed patients with levels consistent with either prediabetes or diabetes according to the ADA criteria for diagnosis. Patients with diabetes and those without diabetes experienced a perioperative increase in blood glucose, with levels remaining elevated above pre-op baseline through post-op day 1.	Low
Bagga RS, 2020	Pre-/ postobservational	N=9,607	Any spinal surgery (cervical, thoracic, lumbar)	Impact of intervention on reducing surgical site infection	Reduction (significant) of SSI secondary to strict bundle adherence and monitored compliance compared to those who did not receive bundle intervention	Moderate
Zarei B, 2018	Randomized clinical trial	N=60; n=30 each group	Elective lumbar disc herniation surgery	To determine the effectiveness of a multimedia-based nursing visit on preoperative anxiety and vital signs in patients undergoing spinal disc herniation surgery	Statistically significant difference between the two groups in terms of the preoperative anxiety, systolic and diastolic BP, pulse, and RR (*P*=.0001).	Moderate
Lee CH, 2018	Randomized control trial	N=86 Intervention group (n=43) and control group (n=43)	Patients undergoing lumbar spinal surgery; inclusion criteria were as follows: (1) age 20 yoa or older, (2) voluntary participation, (3) understand Taiwanese Mandarin Chinese or Taiwanese, and (4) without any hearing or vision impairments after using aides	To determine the effects of preoperative educational intervention on the anxiety and pain of patients undergoing spinal surgery	1. Education can reduce preoperative anxiety and postoperative pain. 2. None of the secondary physical indicator endpoints were significantly different between the intervention and control groups.	Moderate

Preoperative PICO 1. In the care of adults undergoing spine surgery, do preoperative nursing interventions improve postoperative outcomes? (continued)

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Young R, 2021	Pre/post using historical controls (quasi-experimental)	N=243 (n=97 postintervention; n=146 historical controls)	Elective cervical or lumbar surgery	To report the results of ERAS program at a single academic community hospital	Development and implementation of a comprehensive ERAS protocol led to a modest reduction in post-op opiate consumption and LOS in patients undergoing elective cervical or lumbar procedures. Implementation of ERAS may reduce care costs and improve patient outcomes after spine surgery.	Low
Turcotte J, 2021	Cohort/ observational	N=177 (n=104 with pre-op course; n=73 without pre-op course)	Elective posterolateral lumbar fusion	The aim of the study was to quantify the effect of a nurse navigator–led preoperative surgical education course on postoperative resource utilization and patient outcomes.	Patients enrolled in the preoperative course did not demonstrate statistically significant reductions in LOS days (β=–.265, *P*=.224), discharge to SNF (OR=0.939, *P*=.900), 30-day ED returns (OR=0.864, *P*=.789), or 30-day readmissions (OR=1.376, *P*=.721). However, after controlling these factors, patients enrolled in the preoperative course demonstrated a statistically significant reduction in hospital cost (β=–4,143, *P*<.001).	Low
Chavez JL, 2020	Quasi-experimental	N=24	18-80 years of age; lumbar degenerative disease; surgery consisting of at least 1 and up to 4 levels of decompression and/or fusion	Our goal here was to assess 3-month and 12-month postoperative PROs of preoperative MBSR in lumbar spine surgery for degenerative disease.	Participants who underwent a preoperative MBSR course reported improved PROs postoperatively. At 3 months, the intervention group had less disability, higher physical function, and lower pain interference. Furthermore, physical function was significantly higher and pain interference was significantly lower compared with baseline. At 12 months, significantly lower pain interference persisted in the intervention group, and pain interference continued to be significantly lower compared with baseline. MBSR use was a significant predictor of physical function at 3 months and pain interference at 12 months.	Low
Yi JL, 2018	Quasi-experimental	N=48	18-80 years of age; lumbar degenerative disease; surgery consisting of 1-4 levels of decompression and/or fusion	This study assessed whether preoperative MBSR is an effective adjunct to standard postoperative care in adult patients undergoing lumbar spine surgery for degenerative disease.	During hospital admission, no significant dose-response effect of mindfulness techniques was found. At 30 days postoperative, MBSR use was associated with less back pain.	Low

Preoperative PICO 1. In the care of adults undergoing spine surgery, do preoperative nursing interventions improve postoperative outcomes? (continued)

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Eastwood D, 2019	Retrospective cohort	N=206 (n=103, participated in preoperative multidisciplinary education; n=103, opted out of educational session)	Elective spinal fusion for 2-5 levels	The primary objective was to determine if participation in a single preoperative multidisciplinary educational session would result in reduced patient dissatisfaction with surgical expectations. A secondary objective was to determine if participation resulted in improvements in postsurgical pain, disability, and reductions in emergency room visits following surgery.	Patients (n=103) who took part in the presurgical eduction sessions were significantly more satisfied with their surgery compared to the control cohort (*P*=.014). Patients (n=103) who did not participate in the education session failed to have their expectations met in terms of improvement in daily activities (*P*=.03), improvement in walking capacity (*P*=.03), and their expectation of back pain reduction (*P*= .001). There was a statistically significant effect of participation in the educational session reducing postoperative back pain (*P*=.03), although this improvement did not reach a minimally clinically important difference. Number of visits to the emergency room in the 12 weeks following spine surgery was significantly lower (*P*=.04) for patients in the education cohort.	Low
Vint H, 2022	Retrospective review	N=200	ALIF for degenerative conditions	To determine the safety and efficacy of the proposed VTE prophylaxis regime in patients undergoing ALIF surgery	There was no incidence of any symptomatic VTE in any of the 200 patients and no loss to follow-up. There was a 0% incidence of injury to the iliac vessels, symptomatic arterial occlusion, wound hematoma, major intraoperative bleeding, need for transfusion, symptomatic GI bleed, or retroperitoneal hematoma requiring intervention.	Low
Kesanen J, 2017	Randomized control trial	N=100	Spinal stenosis patients	To assess the impact of preoperative knowledge on anxiety, health-related quality of life (HRQoL), disability, and pain in surgically treated spinal stenosis patients	Preoperative anxiety was significantly reduced after an educational intervention based on a knowledge test and an empowering telephone discourse that was shown to increase the patients' knowledge level. In the CG, preoperative anxiety was not relieved until after the surgery.	High
Castella L, 2019	Quasi-experimental, pretest/posttest	N=139	Lumbar spinal surgery in the trauma service	This study examines the incidence, characteristics, and risk factors of SSIs after spine surgery and evaluates the efficacy of a preventive intervention.	The implementation of a multidisciplinary intervention that included revision of the preventive protocol with the modification of wound dressing, staff training, and use of surveillance feedback from results was associated with a 78.1% decrease in the incidence of surgical infection in spinal surgery in the trauma service.	Low
Xiong GX, 2022	Retrospective cohort study, pre-/postintervention	N=1,884	Adult patients undergoing primary instrumented lumbar fusions	The purpose of this study was to determine the impact of nasal MRSA testing and operative debridement rates on surgical site infection after primary lumbar fusion.	MRSA testing, mupirocin prescriptions, perioperative parenteral vancomycin use, and intrawound vancomycin powder use had no impact on I&D rates. The present study demonstrates no impact on surgical I&D rates from the use of preoperative MRSA testing.	Low

Preoperative PICO 1. In the care of adults undergoing spine surgery, do preoperative nursing interventions improve postoperative outcomes? (continued)

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Franker L, 2021	Quality improvement	N=149	18 years of age and older, elective spine fusion procedures	Does cleansing with 2% CHG-impregnated cloths vs current practice of bathing with 4% CHG solution preoperatively reduce SSIs in the elective spine fusion population? The focus of this article is to describe the implementation of 2% CHG-impregnated cloths as a QI preoperative strategy to reduce SSI rates.	Primary: Although there was a decrease in SSI rates, cleansing with 2% CHG-impregnated cloths is not statistically significant compared with bathing with 4% CHG solution (*P*=.524). Zero SSI rate. Secondary: preoperative education class attendance (99.1%), collection of the 2% CHG-impregnated cloth educational handout (96.6%)	QI—not applicable
Baek W, 2020	Meta-analysis	N=645 (5 studies: 2 prospective observations; 3 retrospective observational)	Age 65 yrs or older, underwent spine surgery, postoperative delirium	The purpose of this literature review and meta-analysis was to review the risk factors associated with postoperative delirium after spine surgery in adult patients who were 65 years or older.	Pooled incidence rate of postoperative delirium was 13%. Factors associated with postoperative delirium include preoperative opioid use, cervical spine surgery vs lumbar or thoracic spine surgery, spine fusion vs simple spine surgery, hypertension, cerebrovascular disease, pulmonary disease, duration of surgery, and infused IV fluid volume.	Moderate
Reichart R, 2012	Randomized prospective longitudinal	N=39 (n=19, intervention group; n=20, control group)	Inclusion: minimum age of 18 years and back pain requiring surgery; severe degenerative spinal disease with spinal canal stenosis and instability. The procedure of PLIF was used on all patients.	Study examined the feasibility of an SPI to improve the success of an operative treatment, possibly, by increasing self-efficacy and reducing fear-avoidance beliefs, thus leading to a reduction of the risk of chronic pain	Intervention group reported a significantly greater reduction in the highest pain intensity and a better physical fitness compared to the control group. No significant decrease in fear-avoidance beliefs in the intervention group.	Moderate
Sethi R, 2017	Retrospective cohort	N=140 (n=71 pre protocol, n=69 post protocol)	Complex spinal surgery was defined here as an operation that required either 6 or more levels of vertebral fusion or more than 3 levels of vertebral fusion in a patient with multiple comorbidities. The total possible study population included women and men aged 18–85 years with a primary diagnosis of scoliosis.	Analyze data from complex spine surgeries before and after the implementation of this comprehensive multidisciplinary protocol. The goal of this evaluation was to compare patient complication rates in 2008–2010 (the preintervention period) to complication rates in 2011–2012 (the postintervention period) after full implementation of these system improvements in late 2010.	The most common complication within 30 days after surgery was CSF leak. There were declines in nearly all complications within 30 days after surgery in the postintervention period compared to those in the preintervention period. The most notable reduction was in the 30-day complication rate, primarily because of declines in DVT, PE, wound infection, and return to surgery. There were 4 deaths overall, 3 of which occurred in patients who underwent surgery in the preintervention period.	Low

Preoperative PICO 1. In the care of adults undergoing spine surgery, do preoperative nursing interventions improve postoperative outcomes? (continued)

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Strom J, 2019	Randomized clinical trial	N=114	Inclusion criteria: patients scheduled for first-time elective 1- to 3-level lumbar spine fusion, (that is, instrumented posterolateral fusion [PLF] or transforaminal interbody fusion [TLIF]), attending baseline visit 1 to 5 weeks prior to surgery	To examine the effect of a web-based Spine Platform featuring Interaction and Information by Animation (w-SPIINA) on symptoms of anxiety and depression, pain, disability, and health-related quality of life	Adding w-SPIINA to a usual standard informational regimen did not significantly reduce symptoms of anxiety and depression in the intervention group compared with the control group at 3 months or at any of the predefined time points. Adding w-SPIINA did not further improve achievements in ODI, LBPR, and EQ-5D-5L scores, thereby leaving areas for discussion concerning outcome parameters, setting, population, content, and context.	Moderate
Buyuk AF, 2021	Retrospective, cohort study	N=2,978 (n=1,423 SNA-PI–; n=1,555 SNA-PI+)	Patients older than 18 years who underwent thoracolumbar spinal surgery	Compare SSI rates before and after adding a skin and nasal antiseptic povidone-iodine (SNA-PI) solution to the antimicrobial regimen.	Adding intranasal povidone-iodine (PVP-I) to the infection-prevention regimen did not affect overall infection rates after thoracolumbar spine surgery.	Low
Pennington Z, 2021	Systematic review, meta-analysis	950 articles reviewed, 27 qualitative included, 14 quantitative	ERAS protocol implementation for adult spine surgery	Review the literature on adult spine ERAS protocols, focusing on clinical benefits and cost reductions	The most frequent protocol types were general spine surgery protocols and protocols for lumbar spine surgery patients. The most frequently cited benefits of ERAS protocols were shorter LOS (n=12), lower postoperative pain scores (n=6), and decreased complication rates (n=14). The meta-analysis demonstrated shorter LOS for the general spine surgery and lumbar spine ERAS protocols. Neither general nor lumbar spine protocols led to a significant difference in complication rates. Insufficient data existed to perform a meta-analysis of the differences in costs or postoperative narcotic use.	High
Porche K, 2022	Retrospective cohort	N=114 (n=57 patients in the ERAS cohort; n=57 matched control patients in the pre-ERAS cohort)	Surgery limited to 1- or 2-level TLIF for spondylolisthesis, spinal stenosis, nerve root compression, recurrent disc herniation, pseudoarthrosis, or adjacent segment disease	The aim of this study was to compare length of stay, physiological outcomes, pain scores, and opioid consumptions in patients undergoing open 1- or 2-level TLIF before and after implementing a standardized ERAS protocol.	ERAS was associated with decreased operative time, reduced LOS, decreased IV opioid consumption, and improved physiological outcomes (decreased time to ambulate, bowel movement, void) for open 1- and 2-level TLIF.	Low
Chan AK, 2019	Quality improvement	N=4,266	Adult surgical spine patients: fusion and nonfusion, cervical, thoracic, lumbar	Investigate the efficacy of CHG on lowering the SSI rate after spinal surgery. Assess whether CHG showering affected SSI rates differently depending on whether patients underwent fusion or nonfusion surgeries.	Implementation of preoperative CHG showering protocol decreased the quarterly SSI rates in patients undergoing nonfusion spinal procedures, associated with the most significant lowering of the SSI rate for patients undergoing nonfusion surgery of the lumbar spine, associated with a significant decrease in SSI.	Not applicable

Preoperative PICO 1. In the care of adults undergoing spine surgery, do preoperative nursing interventions improve postoperative outcomes? (continued)

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Badiee RK, 2021	Retrospective review	N=259	The electronic medical records of consecutive patients who underwent PCF were reviewed from 2012 to 2020 at a tertiary academic spine center. Demographic, clinical, radiographic, and surgical variables were collected. Patients were classified as current smokers if they endorsed tobacco use within the month prior to surgery and, if not, were deemed nonsmokers.	To identify risk factors associated with 90-day readmission and reoperation following PCF surgery.	Smoking is a significant predictor of 90-day readmission and reoperation in patients undergoing PCF surgery. Smoking cessation should be strongly considered preoperatively in elective PCF cases to minimize the risk of 90-day readmission and reoperation.	Low

ADA, American Diabetes Association; BMI, body mass index; BP, blood pressure; CSF, cerebrospinal fluid; CT, control group; CV, cardiovascular; DVT, deep vein thrombosis; GI, gastrointestinal; HbA1c, hemoglobin A1c; HLD, hyperlipidemia; HRQoL, health-related quality of life; I&D, incision and drainage; LBPR, low back pain rating; MBSR, mindfulness-based stress reduction; ODI, Oswestry Disability Index; PCF, posterior cervical fusion; PE, pulmonary embolism; PRO, patient-reported outcome; RR, respiration rate; SNF, skilled nursing facility; yoa, years of age.

Intraoperative PICO 1: In the care of adults undergoing spine surgery, do intraoperative nursing measures affect postoperative outcomes?

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Elmously A, 2018	Quality improvement	N=6,548 (n=4,663 before change, n=1,885 after change)	Spine procedures	Assess the relationships among operating room attire, SSIs, and healthcare costs.	Implementation of the AORN guidelines has not decreased SSIs and has increased healthcare costs.	Not applicable
Savage JW, 2012	Prospective randomized controlled trial	N=100 (n=50 ChloraPrep™ group; n=50 DuraPrep™ group)	100 consecutive patients undergoing elective lumbar spine surgery from February to August 2010. All procedures were performed at a single institution by one of four surgeons.	The purposes of this study were to identify the common bacterial flora on the skin overlying the lumbar spine and evaluate the efficacy of readily available skin-preparation solutions in the elimination of bacterial pathogens from the surgical site following skin preparation.	Coagulase-negative Staphylococcus, Propionibacterium acnes, and Corynebacterium were the most commonly isolated organisms prior to skin preparation. The overall rate of positive cultures prior to skin preparation was 82%. The overall rate of positive cultures after skin preparation was 0% (zero of fifty) in the ChloraPrep™ group and 6% (three of fifty) in the DuraPrep™ group (*P*=.24, 95% CI=0.006-0.085). There was an increase in positive cultures after wound closure, but there was no difference between the ChloraPrep™ group (34%, seventeen of fifty) and the DuraPrep™ group (32%, sixteen of fifty) (*P*=.22, 95% CI=0.284-0.483). BMI, duration of surgery, and estimated blood loss did not a show significant association with postclosure positive culture results.	Moderate
Yasuda T, 2015	A prospective, randomized controlled study	N=89 consecutive patients scheduled for spinal surgery were randomly allocated to 2 groups: n=43 in Group A (povidone-iodine was applied to the surgical site just before the skin incision, after the surgeon's hands were scrubbed) and n=46 in group B (povidone-iodine was applied before the surgeon's hands were scrubbed with at least five minutes drying time).	The average patient age was 61.9 years in group A (range, 18–86 years) and 58.1 years in group B (range, 14–82 years). Cervical surgery was performed in 17 patients (39.5%) of group A and 15 patients (32.6%) of group B. Instrumentation surgery was performed in 25 patients (58.1%) of group A and 24 patients (52.2%) of group B.	The objective of this study was to evaluate the effectiveness of two techniques of skin preparation with povidone-iodine: group A (povidone-iodine was applied to the surgical site just before the skin incision, after the surgeon's hands were scrubbed) vs group B (povidone-iodine was applied before the surgeon's hands were scrubbed with at least five minutes drying time).	The authors evaluated the effectiveness of two techniques of skin preparation with povidone-iodine. Because bacteria on the skin appeared significantly reduced by allowing povidone-iodine to dry for 10 minutes prior to surgery, the authors recommend this approach to reduce the incidence of postoperative infections.	Moderate

Intraoperative PICO 1: In the care of adults undergoing spine surgery, do intraoperative nursing measures affect postoperative outcomes? *(continued)*

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Yang T-Y, 2020	Observational, prospective, self-controlled study design	N=64 patients requiring thoracic or lumbar surgery	Surgery to the lumbar or thoracic vertebrae in the prone position	To examine how the use of a soft silicone foam dressing affects the development of intraoperatively acquired pressure injuries (IAPIs) in patients undergoing spinal surgery to obtain baseline data supporting evidence-based nursing care.	Immediately after surgery, 26 IAPIs were observed and there was a significant difference between dressed and nondressed chest areas for the number of IAPIs (4% vs 28%; *P*=.002). After 30 minutes, the total number of IAPIs was 20 and the difference between IAPIs in the iliac crest area was significant between dressed and nondressed areas (0% vs 14%; *P*=.012). After 1 week, there was no chest or iliac crest IAPIs in the areas that had been covered by a dressing; however, 8 chest (61.5%) and 4 iliac crest (30.8%) area IAPIs remained when no dressing had been applied. The majority of IAPIs were stage 1 at all assessment times. After 1 week, 1 IAPI had evolved into a stage 3 injury.	Low
Dostalova V, 2022	Randomized clinical trial	n=46 in intervention group; n=46 in control group	Elective spinal surgery in the prone position (lumbar laminectomy, hemilaminectomy, foraminotomy, or stabilization of lumbar vertebral fractures) with an expected length of surgery <2 hours	The aim of this study was to compare the efficacy of the preoperative, intraoperative, and postoperative use of an active self-warming blanket, with standard care based on passive insulation techniques in patients scheduled for a clean elective spinal surgery in the prone position with an expected duration of surgery of <2 hours.	The axillary body temperatures were not different at baseline but were significantly lower in the control group at the time of departure to the operating theater (36.0 ± 0.5 vs 36.3 ± 0.4; *P*=.0086). Patients in the self-warming blanket group had higher esophageal temperatures intraoperatively, higher axillary temperatures in the recovery room, and fewer episodes of postoperative shivering (1/46 vs 8/46; *P*=.0352). No significant differences were observed in other recorded measures.	Moderate

AORN, Association of periOperative Registered Nurses.

Postoperative PICO 1: In the care of adults undergoing spine surgery, does the type or timing of incision care and/or dressing care impact surgical site infection development?

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Castella L, 2020	Quasi-experimental pre/post	N=139 (n=62 pre-intervention; n=77 post-intervention)	Patients undergoing spine surgery	This study examines the incidence, characteristics, and risk factors of SSIs after spine surgery and evaluates the efficacy of a perioperative preventive intervention.	Of the 139 patients included, 14 cases of SSI were diagnosed, 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).	Moderate

Postoperative PICO 2: In the care of adults undergoing spine surgery, do nursing interventions of surgical site drains assist in identifying acute changes in the postoperative phase of care?

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Koutsoumbelis S, 2011	QI	N=3,218	Posterior lumbar instrumented arthrodesis	The goal of this study was to analyze and identify independent risk factors for surgical site infection among spine patients undergoing posterior lumbar instrumented arthrodesis.	In the final regression model, obesity, estimated intraoperative blood loss, ten or more people in the operating room, a dural tear, history of diabetes, chronic obstructive pulmonary disease, coronary heart disease, and osteoporosis were critical risk factors for the onset of spinal surgical site infection. Obesity and a history of chronic obstructive pulmonary disease were the strongest risk factors for postoperative spinal infection after adjusting for all other variables. The most common pathogen was methicillin-resistant Staphylococcus aureus with a prevalence of 34.5%. This study established a single institution infection rate for posterior lumbar instrumented arthrodesis at 2.6%.	Not applicable
Davidoff CL, 2018	Meta-analysis	N=6,100 (n=5,327 with drain; n=773 no drain)	1. Examined outcomes of LDS or had data for LDS 2. Use of postoperative drains 3. Detailed adverse outcomes including symptomatic epidural hematoma (EDH) or wound infection	To reexamine the literature, applying a refined search strategy focusing exclusively on patients undergoing noninstrumented LDS, directly comparing the use of wound drains to no drainage to identify the risk of postoperative EDH and other adverse outcomes in large patient cohorts	There was no difference between groups in the risk of symptomatic epidural hematoma (RD=0.02; 95% CI=–0.02 to 0.06, *P*=.28) or postoperative infection (RD=0.00; 95% CI=–0.01 to 0.01, *P*= 0.91). In conclusion, symptomatic epidural hematomas and infection are rare following noninstrumented LDS, with incidence rates unaffected by the routine use of wound drainage.	High
Li J, 2018	Retrospective cohort study	N=224 (n=110 traditional care group, n=114 ERAS group)	Patient who underwent cervical laminoplasty for degenerative multilevel spine compression and spinal canal stenosis	The aim of this retrospective study was to compare the incidences of complications and length of postoperative hospitalization after laminoplasty between an ERAS group and a traditional care group.	The mean POPH was significantly shorter in the ERAS group than traditional care group. ERAS protocol significantly promoted postoperative early food-taking and reduced the first time of assisted walking, postoperative time of indwelling urinary catheters, and wound drainage catheters, as compared with the traditional care group. Pain control was better in the ERAS group than traditional care group in terms of mean VAS score and mean maximum VAS score 3 days after surgery.	Low

Postoperative PICO 2: In the care of adults undergoing spine surgery, do nursing interventions of surgical site drains assist in identifying acute changes in the postoperative phase of care? *(continued)*

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Buser Z, 2022	Consecutive case series study	N=671 patients (n=386 with drain and n=285 without the drain)	Patients undergoing elective spinal surgery at a tertiary care center. Cases were identified based on the presence of surgical drain at discharge. Once the drain patients were identified, then a control subset of consecutive patients without a drain was collected.	To characterize if the use of surgical drains or length of drain placement following spine surgery increases the risk of postoperative infection.	The current study shows that the placement of drain does not increase rate of infection, irrespective of levels, length of surgery, or approach. The length of drain placement was a variable to be significantly associated with infection ($P<.05$).	Low

LDS, lumbar decompression surgery; POPH, postoperative hospital stay.

Postoperative PICO 3: In the care of adults undergoing spine surgery, does the timing of inpatient nutrition affect patient outcomes?

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Li ZE, 2020	Retrospective case review study	N=260	Patients older than 65 years who underwent open posterior lumbar fusion surgery with pedicle screw fixation. The main diagnosis was lumbar stenosis with instability, with some accompanied with scoliosis or spondylolisthesis.	The aim of the study was to analyze the effect of compliance with the ERAS program and the relative importance of the individual ERAS program components among elderly patients undergoing lumbar fusion surgery.	Patients with higher compliance had significantly fewer complications (*P*=.031). A multivariate analysis showed that surgical time (*P*=.029), lower compliance (*P*=.034), and early oral feeding (*P*=.026) were predictors of any postoperative complications. On multivariate analysis, the following items remained correlated with prolonged LOS (LOS≥12 days): older age (*P*=.010), lower compliance (*P*<.0001), early ambulation (*P*=.018), and stick to discharge criteria (*P*=.040).	Low
Staartjes VE, 2019	Prospective case series	N=2,592	All patients undergoing elective spine surgery	The aim of this study is to report the results of the 5-year experience with these measures for improved recovery and to identify any trends potentially related to their implementation.	The mean hospital stay was 1.1+/- 1.2 days, with 20 (0.8%) 30-day and 36 (1.4%) 60-day readmissions. Ninety-four percent of patients were discharged after a maximum 1-night hospital stay. Over the 5-year period, a clear trend toward a higher proportion of patients discharged home after a 1-night stay was observed (*P*<.001), with a concomitant decrease in adverse events in the overall cohort (*P*=.025) without increase in readmissions.	Low
Li J, 2018	Retrospective cohort study	N=224 (n=110 traditional care, n=114 ERAS group)	Patients who underwent cervical laminoplasty for degenerative multilevel spine compression and spinal canal stenosis	The aim of this retrospective study was to compare the incidences of complications and length of postoperative hospitalization after laminoplasty between an ERAS group and a traditional care group.	The mean POPH was significantly shorter in the ERAS group than traditional care group. ERAS protocol significantly promoted postoperative early food-taking and reduced the first time of assisted walking, postoperative time of indwelling urinary catheters, and wound drainage catheters, as compared with the traditional care group. Pain control was better in the ERAS group than traditional care group in terms of mean VAS score and mean maximum VAS score in 3 days after surgery.	Low

Postoperative PICO 4: In the care of adults undergoing spine surgery, are there perioperative nursing interventions that decrease or prevent the development of a postoperative ileus?

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Porche K, 2022	Retrospective cohort	N=114 (n=57 patients in the ERAS cohort, n=57 matched control patients in the pre-ERAS cohort)	Surgery limited to 1- or 2-level TLIF for spondylolisthesis, spinal stenosis, nerve root compression, recurrent disc herniation, pseudoarthrosis, or adjacent segment disease	The aim of this study was to compare LOS, physiological outcomes, pain scores, and opioid consumptions in patients undergoing open 1- or 2-level TLIF before and after implementing a standardized ERAS protocol	ERAS was associated with decreased operative time, reduced LOS, decreased IV opioid consumption, and improved physiological outcomes (decreased time to ambulate, bowel movement, void) for open 1- and 2-level TLIF.	Very Low
Du X, 2021	Retrospective single-center cohort study	N=60 (n=30 with chewing gum, n=30 control group without chewing gum)	Consecutive patients undergoing posterior lumbar fusion surgery for degenerative lumbar disease. The inclusion criteria: (I) patients who were diagnosed with degenerative lumbar diseases, such as lumbar disc herniation (LDH), lumbar spinal stenosis (LSS) or lumbar spondylolisthesis (LS), based on clinical symptoms (eg, low back pain, lower limb pain or numbness) and radiological imaging; (II) patients who were over 60 years old; (III) patients undergoing conservative therapy for at least 3 months without improvement; (IV) patients who received open posterior lumbar fusion surgery, such as posterior lumbar interbody fusion (PLIF) or transforaminal lumbar interbody fusion (TLIF), under general anesthesia.	Determine whether chewing gum facilitates bowel function recovery in elderly patients undergoing lumbar spine surgery.	Compared with control group, the chewing gum group had less time to the first flatus (12.4±2.9 vs 17.8±2.2 h; *P*<.001), first bowel sounds heard (17.3±2.8 vs 25.0±2.5 h; *P*<.001), and first defecation (51.9±5.2 vs 76.1±3.8 h; *P*<.001), but no significant differences were found in the length of hospital stay (11.7±2.1 vs 11.9±2.5 d; *P*=.697) and the postoperative complications (*P*=.501).	Very Low

Postoperative PICO 4: In the care of adults undergoing spine surgery, are there perioperative nursing interventions that decrease or prevent the development of a postoperative ileus? *(continued)*

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Stienen MN, 2014	Retrospective single center study; cohort	N=99 (n=44 constipation; n=55 no constipation)	All patients undergoing thoraco-lumbar fusion surgery for degenerative lumbar spine disease with instability	Determine whether constipation is common amongst patients receiving thoraco-lumbar spinal fusion surgery and if the complexity and length of surgery are important predisposing factors.	The rate of constipation is high in patients undergoing thoraco-lumbar fusion surgery for degenerative spinal instability (44%). Occurrence of constipation was associated with longer mean operation times (*P*=.012), higher EBL (*P*<.001), and higher mean morphine dosages in postoperative days 0-7 (POD#1 *P*=.041 and POD#2 *P*=.028).	Very Low

EBL, estimated blood loss.

Postoperative PICO 5: In the care of adults undergoing spine surgery, are there perioperative nursing measures that decrease or prevent postoperative urinary retention?

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Findings	Quality of Evidence
Huang J, 2021	Prospective cohort study	N=86 (n=39 voluntarily joined the EA group, n=47 joined the RA group)	Patients aged 60 years and older; patients with newly diagnosed LDD; patients requiring single-segment decompression and fusion surgery; and those voluntarily joining in the early ambulation (EA) group or the regular ambulation (RA) group after surgery; patients agreeing to provide access to postoperative outcomes; and patients agreeing to join the current prospective cohort study.	The purpose of the present study is: (i) to evaluate whether early ambulation improves postoperative physical outcomes; (ii) to determine whether early ambulation decreases complications and 90-day readmission rates; and (iii) to assess whether early ambulation shortens the length of postoperative hospital stay.	Early ambulation in elderly patients after lumbar decompression and fusion surgery improved functional status, decreased the incidence of complications, and shortened the length of postoperative hospital stay.	Low
Leitner L, 2021	Prospective cohort study	N=100 (n=46 females, n=54 males)	Elective spine surgery	Evaluated surgical and urological parameters prior to and after spine surgery performing a quality assessment of current clinical practice in bladder management.	Urethral catheter-free management seems to be a valuable option in selected patients undergoing spine surgery since it does not increase the occurrence of PUC, in the case that PVR is monitored postoperatively allowing de novo catheterization as appropriate.	Low
Porche K, 2022	Retrospective cohort	N=114 (n=57 patients in the ERAS cohort, n= 57 pre-ERAS cohort)	Surgery limited to 1- or 2-level TLIF for spondylolisthesis, spinal stenosis, nerve root compression, recurrent disc herniation, pseudoarthrosis, or adjacent segment disease	The aim of this study was to compare LOS, physiological outcomes, pain scores, and opioid consumptions in patients undergoing open 1- or 2-level TLIF before and after implementing a standardized ERAS protocol.	ERAS was associated with decreased operative time, reduced LOS, decreased IV opioid consumption, and improved physiological outcomes (decreased time to ambulate, bowel movement, void) for open 1- and 2-level TLIF.	Low
Aiyer SN, 2017	Prospective cohort study	N=370 (n=91 in the POUR group, n=309 in the control group)	Elective microlumbar discectomy, single- and multiple-level decompressions, and single-level posterior lumbar fusions	Identify the patient- and surgical procedure–related risk factors for the development of POUR in microlumbar discectomy, lumbar decompression, and single-level fusions.	61% of patients developed POUR, with an incidence of 16.48%. Significant risk factors for POUR were older age, higher BMI, surgery duration, intra-op fluid administration, lumbar fusion vs discectomy/decompression, and higher postoperative pain scores (P<.05 for all).	Low

Postoperative PICO 5: In the care of adults undergoing spine surgery, are there perioperative nursing measures that decrease or prevent postoperative urinary retention? *(continued)*

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Findings	Quality of Evidence
Bowman JJ, 2021	Observation; prospective case series	N=200 (n=130 women, n=70 men)	Age 50 or older and underwent a combined lumbar decompression and fusion procedure	The purpose of this study is to evaluate the incidence and risk factors for POUR within a population of patients over 50 years of age undergoing elective lumbar decompression and fusion surgery.	POUR occurred in 19 of 200 patients. Those with POUR were more likely to be male (20% vs 4%). Administration of scopolamine (*P*=.02), neostigmine (*P*=.01), and the total number of levels operated on (*P*=.02) were found to be independent risk factors for the development of POUR. Length of surgery, surgical level, and the performance of an interbody fusion did not have a bearing on the development of POUR (*P*>.05).	Low
Chang Y, 2021	Systematic review and meta-analysis	N=31,251 (11 studies; 2 prospective, 9 retrospective)	Elective spine surgery	This study aimed to review the available literature on risk factors associated with POUR following elective spine surgery.	Patients with POUR were older than those without POUR (WMD, 7.13; 95% CI, 4.50-9.76). Male patients were found to have an increased risk of POUR (OR, 1.31; 95% CI, 1.04-1.64). The following variables were also identified as significant risk factors for POUR: BPH (OR, 3.79; 95% CI, 1.89-7.62), DM (OR, 1.50; 95% CI, 1.17-1.93), and previous UTI (OR, 1.70; 95% CI, 1.28-2.24). Moreover, longer operative time (WMD, 19.88; 95% CI, 5.01-34.75) and increased intraoperative fluid support (SMD, 0.37; 95% CI, 0.23-0.52) were observed in patients with POUR. In contrast, spine surgical procedures involving fewer levels (OR, 0.75; 95% CI, 0.65-0.86), and ambulation on the same day as surgery (OR, 0.65; 95% CI, 0.52-0.81) were associated with a decreased risk of POUR.	Moderate

BPH, benign prostatic hyperplasia; DM, diabetes mellitus; LDD, lumbar disc degeneration; PUC, permanent urinary catheter; PVR, post-void residual; SMD, standardized mean difference; WMD, weighted mean difference.

Postoperative PICO 6: In the care of adult spinal cord injury patients, does neurogenic bowel and bladder training improve patient recovery?

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Gong D, 2020	Cross sectional	N=101	Hospitalized inpatients with traumatic or nontraumatic SCI	To determine the aspects of excretory dysfunction most influential in determining the quality of life of survivors of spinal cord injury.	Only 2 of the 101 subjects professed to be unaffected by excretion dysfunction. Bladder-related dysfunction was the most frequently mentioned type of problem. Quality-of-life impairment was found to be most often associated with bladder accidents, bowel accidents, and having more than one bladder complication.	Very low
Joshi AD, 2022	Prospective case series	N=45 (n=31 patients continued CIC, n=14 patients stopped CIC)	Patients with SCI rehabilitated with CIC for bladder regulation	The objective of the present study was to understand the patient perspectives along with epidemiological and demographic factors associated with the use of CIC for bladder management in patients with SCI after institutional rehabilitation.	68.89% continued CIC. In those who stopped CIC, the median duration of practicing CIC was 3.5 months. The most common difficulty among compliant patients was carrying out CIC in outdoor environments due to the unavailability of toilet facilities. UTI (17.78%) was the most common complication noted. Dependence (20%) was a major procedural difficulty, followed by pain. Adaptations to remain continent in special conditions were diapers and condom catheters. The duration of CIC practiced influenced discontinuation of CIC. With an increase in the duration of CIC practiced after discharge, the risk of discontinuation of CIC decreased with an adjusted odds ratio of 0.773.	Very low
Goldstine J, 2021	Qualitative	N=12	Adults living with neurogenic bladder and/or bowel dysfunction	Our overall objective was to develop a clinically meaningful menu of goal areas applicable to anyone with neurogenic bladder and bowel dysfunction to facilitate the use of GAS in this population.	Of 24 goals identified initially, 2 (8%) were not endorsed and were removed, and 3 goals were added. Most participants listed “Impact on Life” goals among their 5 most important goals. Three main themes emerged: challenges posed by incontinence, limitations on everyday life, and need for personalized care.	Not applicable

GAS, goal attainment scale.

Postoperative PICO 7: In the care of adults undergoing spine surgery, does the timing or distance of mobilization/ambulation impact postoperative outcomes?

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Huang J, 2021	Prospective cohort	N=86 (n=39 voluntarily joined the EA group, n=47 joined the RA group)	Patients aged 60 years and older; patients with newly diagnosed LDD; patients requiring single-segment decompression and fusion surgery; and those voluntarily joining in the early ambulation (EA) group or the regular ambulation (RA) group after surgery; patients agreeing to provide access to postoperative outcomes; and patients agreeing to join the current prospective cohort study.	The purpose of the present study is: (i) to evaluate whether early ambulation improves postoperative physical outcomes; (ii) to determine whether early ambulation decreases complications and 90-day readmission rates; and (iii) to assess whether early ambulation shortens the length of postoperative hospital stay.	Early ambulation in elderly patients after lumbar decompression and fusion surgery improved functional status, decreased the incidence of complications, and shortened the length of postoperative hospital stay.	Low
Porche K, 2022	Retrospective cohort, propensity matched	N=114 (n=57 patients in the ERAS cohort, n=57 matched control patients in the pre-ERAS cohort)	Surgery limited to 1- or 2-level TLIF for spondylolisthesis, spinal stenosis, nerve root compression, recurrent disc herniation, pseudoarthrosis, or adjacent segment disease	The aim of this study was to compare length of stay, physiological outcomes, pain scores, and opioid consumptions in patients undergoing open 1- or 2-level TLIF before and after implementing a standardized ERAS protocol	ERAS was associated with decreased operative time, reduced LOS, decreased IV opioid consumption, and improved physiological outcomes (decreased time to ambulate, bowel movement, void) for open 1- and 2-level TLIF.	Low
Li J, 2018	Retrospective cohort study	N=224 (n=110 traditional care, n=114 ERAS group)	Patients who underwent cervical laminoplasty for degenerative multilevel spine compression and spinal canal stenosis	The aim of this retrospective study was to compare the incidences of complications and length of postoperative hospitalization after laminoplasty between an ERAS group and a traditional care group.	The mean POPH was significantly shorter in the ERAS group than traditional care group. ERAS protocol significantly promoted postoperative early food-taking and reduced the first time of assisted walking, postoperative time of indwelling urinary catheters, and wound drainage catheters, as compared with the traditional care group. Pain control was better in the ERAS group than traditional care group in terms of mean VAS score and mean maximum VAS score in 3 days after surgery.	Low

Postoperative PICO 7: In the care of adults undergoing spine surgery, does the timing or distance of mobilization/ambulation impact postoperative outcomes? *(continued)*

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Rupich K, 2018	QI	N=715 (n=275 control group, n=440 intervention group)	Uncomplicated neurosurgery patients who met the inclusion criteria for the early mobility protocol	The purpose of this quality improvement initiative was to establish an NP-led early mobility protocol to reduce uncomplicated postsurgical spine patients' LOS in the hospital and eliminate the variability of postsurgical care. A secondary objective was to educate and empower nursing staff to initiate the early mobility protocol independently and incorporate it in their practice to improve patient care.	Implementation of the protocol resulted in a 9-hour reduction in LOS per hospitalization in neurosurgical spine patients.	Not applicable
Qvarfordh P, 2014	Prospective, randomized controlled trial, pilot study	N=22	Eligible patients were those scheduled for elective lumbar discectomy. Inclusion criteria were: age older than 18 years, ability to understand Danish, and to walk a minimum of 50 meters without assistance.	The aim of this pilot study was to investigate whether it was feasible and safe to mobilize patients shortly after lumbar disc surgery with the objective of reducing postoperative complications and allowing shorter hospitalization.	22 patients were included, 11 in each group. Owing to the limited number of patients, statistical comparisons were not performed. However, patients in the walking group were mobilized earlier than the controls, and needed fewer painkillers and less oxygen supplement during the first postoperative day. The LOS and the number of postoperative complications were similar in the two groups as tested during the 3 weeks after surgery	Moderate

Postoperative PICO 8: In adults who are managed in an external orthosis for spine trauma or after spine fusion surgery, what nursing interventions are used to improve patient outcomes?

N/A

Postoperative PICO 9: In the care of adults with spinal cord injury, what interventions can be used to prevent autonomic hyperreflexia?

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Taden de Andrade L, 2013	Retrospective case series	N=465	Spinal cord injury	The study looked at patients with nursing diagnosis of risk for autonomic dysreflexia (AD) and assessed the volume of patients who developed AD.	Of 271 at risk for AD, 80 developed AD (96.2% had traumatic pathology). Primary preceding events were bladder distension, pain, rectal distention, and infection/ pressure ulcers. Most common symptom was HTN.	Low
Lucci VEM, 2019	Double-blind placebo-controlled crossover clinical trial	N=13	Eligible participants were individuals aged greater than 18 years of age with chronic (greater than 1 year), traumatic high-level (T6 or above) SCI, who had an established bowel care routine and a prior history of AD.	To determine whether the use of a topical anesthetic lubricant (2% lidocaine) ameliorates cardiovascular complications compared to a placebo lubricant during at-home bowel care. Additional aims included evaluation of the impact of lidocaine on time to complete bowel care, and self-reported symptoms of AD during care.	The use of lidocaine lubricant actually worsened the severity of AD during at-home bowel care. Episodes of AD induced by bowel care provoked abnormal heart rate responses and cardiac arrhythmia, with rate and rhythm disturbances exacerbated during the lidocaine condition, when the AD was more severe and more prolonged. Lidocaine use did not improve symptoms of AD or palpitations, and participant questionnaires revealed that they perceived their care routines to have taken longer and bowel emptying to have been more difficult to complete in the lidocaine condition.	Moderate
Inskip JA, 2018	Care series	N=287	18 years of age and older, those with injury at or above T7 were considered at risk for AD	Describe the relationships between bowel care, AD, and QOL.	Bowel management was a problem for 78%: it interfered with personal relationships (60%) and prevented staying (62%) and working (41%) away from home. The normal bowel care duration was >60 min in 24% and most used digital rectal stimulation (59%); 33% reported bowel incontinence at least monthly. Of those at risk for AD (n=163), 74% had AD symptoms during bowel care; 32% described palpitations. AD interfered with activities of daily living in 51%. Longer durations of bowel care (P<.001) and more severe AD (P= .04) were associated with lower QOL.	Low
Furusawa K, 2011	Retrospective, case series	N=571 patients	1) history of SCI at or above T6; 2) discharge from each hospital after more than 4 months at initial injury; 3) no pressure ulcerations, deep venous thrombolysis, ureteral or renal stones or heterotopic ossification throughout hospitalization	The purpose of the study was to investigate the relationship between the different bowel and bladder management methods and the incidence of AD during hospitalization in patients with SCI.	The highest incidence of symptomatic AD was diagnosed in subjects using reflex voiding and in those using manual removal of stool. The lowest incidence of symptomatic AD was in those on continent spontaneous voiding and continent spontaneous defecation.	Low

Postoperative PICO 9: In the care of adults with spinal cord injury, what interventions can be used to prevent autonomic hyperreflexia? *(continued)*

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Solinsky R, 2019	Prospective cohort	N=50	People with SCI T6 or above who have had autonomic dysreflexia and have an indwelling bladder catheter	To determine whether or not intravesical lidocaine was effective at decreasing AD during catheter changes	The incidence of AD in the lidocaine treatment group was 14.8% vs 47.8% in the control group (*P*=.011). Pretreatment with lidocaine also demonstrated a significantly attenuated rise in SBP immediately after the catheter change (9.5 mmHg vs 26.9 mmHg for posttreatment, *P*=.014) relative to baseline SBP.	Low
Ozisler Z, 2015	Prospective cohort	N=55 (n=42 male, n= 3 female)	Traumatic SCI	Main aim of the present study was to assess the efficacy of bowel program on GIS problems and on reducing the severity of NBD	At least one gastrointestinal problem was identified in 44 (80%) of the 55 patients before bowel program. Constipation (56%, 31/55) and incontinence (42%, 23/55) were the most common gastrointestinal problems. Digital rectal stimulation was the most common method for bowel evacuation, both before (76%, 42/55) and after (73%, 40/55) bowel program. Oral medication, enema, and manual evacuation application rates were significantly decreased and constipation, difficult intestinal evacuation, abdominal distention, and abdominal pain rates were significantly reduced after bowel program. In addition, mean neurogenic bowel dysfunction score was decreased after bowel program.	Low
Solinsky R, 2016	Retrospective chart review	N=78	Male patients with SCI who experienced autonomic dysreflexia while inpatient at the VA hospital over a 3.5 yr period	Primary objective of this study was to evaluate the safety of a nursing-driven protocol utilizing conservative management, nitroglycerin paste and hydralazine to treat AD	There were 445 episodes of autonomic dysreflexia recorded in the study period, with 92% adherence to the protocol. When the protocol was followed, target blood pressure was achieved for 97.6% of all episodes. Twenty-three total adverse events occurred (5.2% of all episodes). All adverse events were due to hypotension and only 0.9% required interventions beyond clinical monitoring. Of each patient's initial autonomic dysreflexia episode, 97.3% resolved using the protocol without need for further escalation of care.	Low

AD, autonomic dysreflexia; GIS, gastrointestinal; SBP, systolic blood pressure.

Postoperative PICO 10: In the care of adults undergoing spine surgery, does nonopioid pain pharmacotherapies or nonpharmaceutical therapies improve postoperative outcomes?

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Lin PC, 2011	Quasi-experimental, pretest and posttest design	N=60 (n=30 study, n=30 control)	All patients scheduled for non-emergency spine surgery were eligible to participate in the study. Inclusion criteria were as follows: age >18 years, no mental or cognitive impairment, ability to communicate, and willingness to participate in the study.	The aim of this study was to evaluate the effects of music therapy on anxiety, postoperative pain, and physiological reactions to emotional and physical distress in patients undergoing spinal surgery.	The results of this study as indicated by VAS scores from before surgery to 2 days after surgery show that the level of anxiety was lower in the study group than in the control group. In the study, subjects in the music group had a 16% decrease in anxiety when compared with the pre-intervention level, while the anxiety level of the control group did not change significantly. In this study, in the comparison of pain in the study group after music therapy with that in the control group, a statistically significant difference was found in the VAS pain score. The results showed that 1 hour after surgery, systolic and mean blood pressure in the study group were significantly lower than in the control group; no significant differences were observed in other physiological indices between the two groups. No significant differences were found between the two groups in cortisol, norepinephrine, and epinephrine concentrations in 24-hour urine testing.	Moderate
Maheshwari K, 2020	Double-blinded, placebo-controlled, parallel-group, randomized controlled trial	N=299; allocated to analgesic pathway (n=150), allocated to placebo (n=149)	Multilevel posterior spine elective surgery who were at high risk for postoperative pain	1) Patients given multimodal analgesia consisting of oral gabapentin and acetaminophen combined with infusions of lidocaine and ketamine have superior quality of recovery scores 3 days after multilevel spine surgery. 2) Multimodal analgesia reduces opioid consumption and pain scores during the initial 48 postoperative hours.	Primary outcomes: Use of multimodal analgesic pathway based on preoperative single-dose acetaminophen and gabapentin, and intraoperative infusions of lidocaine and ketamine, did not improve day 3 quality of recovery or reduce pain scores or 48-hour opioid consumption. This combination of four analgesics was not beneficial for patients having multilevel spine surgery. Exploratory outcomes: None including PACU LOS, postoperative nausea and vomiting, patient satisfaction with pain management at discharge from the hospital, quality of recovery score at 1 month, and health-related quality of life EQ-5D at 3 months differed by clinically important amounts.	High
Boulter JH, 2019	A retrospective cohort study	N=111; (positive BZD, n=77; negative BZD, n=34)	Single-level TLIF patients	To evaluate the impact of removing benzodiazepines and LAOs on postoperative pain in single-level TLIF patients.	There was no difference between inpatient pain scores, but the – benzodiazepine cohort experienced a faster rate of morphine equivalent reduction, used less trigger medications, and discharged earlier. As outpatients, the – benzodiazepine cohort was less likely to receive opioid refills at 2 weeks and 6 months postoperatively.	Low

Postoperative PICO 10: In the care of adults undergoing spine surgery, does nonopioid pain pharmacotherapies or nonpharmaceutical therapies improve postoperative outcomes? *(continued)*

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Lam DMH, 2015	Meta-analysis; spine was subanalysis	9 studies; N=623 (n=291 patients taking pregabalin, n=332 patients on the control treatment)	Lumbar lami, disc, fusion	The aim of this meta-analysis was to evaluate the analgesic efficacy of pregabalin in reducing postsurgical pain in terms of 2- and 24-hour postsurgical VAS pain scores and 24-hour accumulative morphine-equivalent consumption, in various surgical categories to provide a useful reference in perioperative care.	Statistically significant difference in pain scores at 2 hours and MME consumption. No significant difference in pain scores at 24 hours	High
Walker CT, 2019	Retrospective cohort	N=220 (n=102 preprotocol implementation, n=118 postprotocol implementation)	Open posterior lumbar fusion for degenerative pathology	Determine whether the implementation of the protocol would decrease pain scores, opioid consumption, OAE, and LOS in patients following posterior lumbar fusion.	A significant improvement in postoperative pain control, the primary outcomes measure, after protocol implementation. This improvement was observed across all the pain metrics evaluated, including average and highest pain scores, in both the first 24 hours and from 24 to 72 hours after surgery. POST patients were also able to achieve satisfactory pain control sooner after surgery then PRE. Improvement in postoperative pain control was accomplished with a 35% reduction in opioid utilization in the first 72 hours after surgery. After protocol implementation, hospital LOS was reduced by nearly 1 full day.	Low
Mathiesen O, 2013	Case control, quasi-experimental	N=85 (n=41 postintervention group, n=44 preintervention group)	Adult patients scheduled for elective posterior instrumented fusion on 3 levels for nonmalignant and non-infectious conditions of the spine were included in the study.	This case–control study investigated if a standardized comprehensive pain and postoperative nausea and vomiting (PONV) treatment protocol would improve pain treatment in this population.	A comprehensive and standardized multimodal pain and PONV protocol significantly reduced opioid consumption, improved postoperative mobilization, and presented concomitant low levels of nausea, sedation, and dizziness.	Moderate
Khan ZH, 2011	Randomized, double-blinded, placebo-controlled trial	N=175 (placebo n=25, group II through VII, n=25 for each group [total n=150])	ASA physical status I presenting for an elective single-level lumbar laminectomy under general anesthesia	The aim of this study was to determine the analgesic efficacy of different doses of gabapentin.	Gabapentin 900 and 1200 mg reduced pain intensity, morphine consumption and increased time to the first demand for analgesia.	High
Kim JC, 2011	Prospective, randomized, controlled, and double-blind trial	N=84 (placebo n=28, P75 group n=28, P150 group n=28)	Male patients (20-65 years) scheduled for elective posterior lumbar spinal fusion	The purpose of this study was to evaluate the effects of 2 different doses of perioperative pregabalin administration, twice on the day of surgery, on acute postoperative pain after spinal surgery.	Pregabalin 300 mg, but not 150 mg, significantly reduced fentanyl consumption of IV PCA and the frequency of additional pain rescue administration than placebo after lumbar spinal fusion surgery. These beneficial effects of pregabalin were not accompanied by increased side effects and were extended into the second postoperative day.	High

Postoperative PICO 10: In the care of adults undergoing spine surgery, does nonopioid pain pharmacotherapies or nonpharmaceutical therapies improve postoperative outcomes? *(continued)*

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Rajpal S, 2020	Prospective observational	N=101 (PMA patient group, n=51; reference group, n=50)	Eligible patients were undergoing 1-level or 2-level open transforaminal lumbar interbody fusion surgeries with instrumentation using intraoperative image guidance and performed by one of 4 surgeons at a single institution.	The main objectives of this study were to determine the impact of preventative multimodal analgesia (PMA) on postoperative opioid requirements and analgesic effectiveness in patients undergoing lumbar fusion surgery.	The differences in opioid requirement and postoperative pain scores were statistically significant on all 4 postoperative days. The effect size varied from –0.54 to –0.99 for the postoperative opioid requirement and from –0.59 to –1.16 for postoperative pain, indicating that these measures were reduced by about 1/2 to 1 SD in the PMA patient group.	Low
Kim S, 2016	Prospective, randomized clinical trial	N=80 (allocated to preemptive multimodal analgesia, n=40; allocated to morphine administration only, n=40)	Participants were required to undergo posterior lumbar interbody fusion (PLIF) surgery for symptomatic lumbar 4-5 stenosis	To assess the efficacy of a novel preemptive multimodal analgesic regimen for reducing postoperative pain and complications after primary lumbar fusion surgery	No differences were observed in the patient demographics, intraoperative blood loss, postoperative Hemovac drain output, or nonunion rate between two groups. The VAS and ODI were lower at all postoperative time points, except the ODI on postoperative day 1 in the patients randomized to receive the preemptive multimodal analgesic regimen. No major identifiable postoperative complications were observed in either treatment group.	Moderate
Garcia RM, 2013	Prospective, randomized	N=22 (n=10 patients randomized to treatment group, n=12 patients randomized to control group)	Any patient who was to undergo a primary 1-motion segment or 2-motion segment lumbar laminectomy for symptomatic spinal stenosis	The objective of this study was to assess the efficacy of a novel multimodal analgesic regimen in reducing postoperative pain and intravenous morphine requirements after primary multilevel lumbar decompression surgery.	Primary outcomes: The combined use of COX-2 inhibitors, pregabalin, and long-acting opioids are an effective analgesic regimen after lumbar laminectomy or spinal stenosis. Patients randomized to multimodal analgesia on a scheduled basis in the postoperative period had lower intravenous morphine requirements at all postoperative time points when compared with patients who were randomized to intravenous morphine alone. There was at least a 41% reduction in the mean intravenous morphine requirement at all postoperative time points with a maximal mean percent reduction of 58% in the entire postoperative hospital course for patients randomized to receive the multimodal treatment regimen. Patients demonstrated lower VAS scores at all time points. Secondary outcomes: Patients randomized to multimodal treatment group required significantly less immediate release oral narcotics once intravenous morphine was discontinued; the average number of oxycodone with Tylenol tablets taken before discharge was less; no significant difference in timing to first liquid oral intake but earlier time to first solid food intake, no significant difference between treatment and control group for average total hospitalization time.	Moderate

Postoperative PICO 10: In the care of adults undergoing spine surgery, does nonopioid pain pharmacotherapies or nonpharmaceutical therapies improve postoperative outcomes? *(continued)*

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Lee BH, 2013	Nonblind multicenter prospective observational clinical series	17 hospitals, N=393 patients	Patients who underwent instrumented lumbar spinal fusion with or without laminectomy for various degenerative conditions, such as intervertebral disc herniation, spinal stenosis, degenerative spondylolisthesis, and degenerative lumbar scoliosis.	The purposes were to survey patterns of perioperative pain management after spinal surgery and to investigate the effects of perioperative pain management, such as preemptive analgesia and multimodal postoperative pain management, on acute postoperative patient satisfaction, pain reduction, and health-related quality of life in patients undergoing spinal surgery.	Self-reported levels of pain were not significantly different among postoperative multiple modalities of pain management, but were different significantly for preemptive pain management regimens (P<.05, independent t test). The number of patients that reported the self-administrative use of PCA was higher in the no preemptive pain management group compared to the preemptive group (P<.05). In regards to EQ-5D usual activity, depression/anxiety and self-care improved significantly in the preemptive pain management group when measured at 2 weeks postoperative (P<.05).	Low
Arumugam S, 2016	Meta-analysis	17 RCTs, 1,793 patients, patient specific to spine not indicated	Spine surgery subanalysis	This meta-analysis examined the use of preoperative gabapentin and its impact of postoperative opioid consumption and opioid use after surgery and the incidence of vomiting, somnolence, and nausea.	A significant reduction was observed in cumulative morphine following spinal surgeries (SMD –2.66, 95% CI: –3.43 to –1.90; P<.001).	High
Bae S, 2022	Meta-analysis and systematic review	5,908 studies screened, 86 RCTs met inclusion, N=6,284 participants	Adults undergoing spine surgery under GA, irrespective of the pathology, location, number of level or complexity.	Compare, rank, and grade all pharmacological and regional interventions used in adult spine surgery.	The most effective intervention was triple-drug therapy, consisting of paracetamol, nonsteroidal anti-inflammatory drugs, and adjunct. The pooled mean reduction in morphine consumption and pain score at postoperative 24 hours were –26 (95% credible interval [CrI]: –39 to –12) mg and –2.3 (95% CrI: –3.1 to –1.4),respectively. Double-drug therapy was less effective, but showed moderate morphine reduction in a range of –15 to –17 mg and pain score reduction in a range of –1 to –1.6. Single-agent interventions were largely ineffective.	High
Peng C, 2017	Meta-analysis and systematic review	7 studies; N=581 patients (n=383, gabapentin group; n=198, control group)	Patients who underwent spine surgery (lumbar fusion, laminectomy, or discectomy)	This meta-analysis aimed to evaluate whether gabapentin can decrease pain intensity, total morphine consumption, and related complications, and whether high-dose gabapentin is superior to low-dose gabapentin.	1. Gabapentin was associated with reduced pain scores at 12 and 24 hours, corresponding to a reduction of 11.18 points at 12 hours and 9.94 points at 24 hours on a 100-point VAS. 2. Gabapentin was associated with a reduction in total morphine consumption. 3. Gabapentin can reduce the occurrence of vomiting, urine retention, and pruritus. There were no significant differences in the occurrence of nausea, dizziness, somnolence, or headache. High dose ≥ 900 mg of gabapentin is more effective than a low dose less than 900 mg.	High

Postoperative PICO 10: In the care of adults undergoing spine surgery, does nonopioid pain pharmacotherapies or nonpharmaceutical therapies improve postoperative outcomes? *(continued)*

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Porche K, 2022	Retrospective cohort	N=114 (57 patients in the ERAS cohort and 57 matched control patients in the pre-ERAS cohort)	Surgery limited to 1- or 2-level TLIF for spondylolisthesis, spinal stenosis, nerve root compression, recurrent disc herniation, pseudoarthrosis, or adjacent segment disease	The aim of this study was to compare length of stay, physiological outcomes, pain scores, and opioid consumption in patients undergoing open 1- or 2-level TLIF before and after implementing a standardized ERAS protocol.	ERAS was associated with decreased operative time, reduced LOS, decreased IV opioid consumption, and improved physiological outcomes (decreased time to ambulate, bowel movement, void) for open 1- and 2-level TLIF.	Low
Li J, 2018	Retrospective cohort study	N=224 (traditional care group n=110, ERAS group n=114)	Patient who underwent cervical laminoplasty for degenerative multilevel spine compression and spinal canal stenosis	The aim of this retrospective study was to compare the incidences of complications and length of postoperative hospitalization after laminoplasty between an ERAS group and a traditional care group.	The mean POPH was significantly shorter in the ERAS group than traditional care group. ERAS protocol significantly promoted postoperative early food-taking, reduced the first time of assisted walking, postoperative time of indwelling urinary catheters, and wound drainage catheters, as compared with the traditional care group. Pain control was better in the ERAS group than traditional care group in terms of mean VAS score and mean maximum VAS score in 3 days after surgery.	Low
Hennessy W, 2015	Prospective, nonrandomized	N=60 (n=30, intervention group; n=30 control group, retrospective chart review)	Elective, lumbar fusion	The purpose of this feasibility study was to determine the impact of establishing a comfort function goal preoperatively on postoperative pain scores and opiate requirements in lumbar fusion patients.	No significant difference in pain score or opiate requirement was found.	Low
Jiang H-J, 2017	Systematic review and meta-analysis	10 clinical; N=535 patients (n= 294 pregabalin group, n=241 control group)	Spine surgery subanalysis	Compare pregabalin vs placebo for reducing pain intensity in spinal surgery.	Pregabalin was associated with reduced pain scores at 12, 24, and 48 hours corresponding to a reduction of 1.91 points (95% CI, –4.07, 0.24) at 12 hours, 2.66 pints (95% CI, –4.51 to –0.81) at 24 hours and 4.33 points (95% CI, –6.38 to –2.99) at 48 hours on a 100 point numeric rating scale. There was no significant difference between VAS scores with mobilization at 12, 24, and 48 hours. Similarly, pregabalin was associated with a reduction in cumulative morphine consumption at 24 hours (–7.07, 95% CI –9.84, –4.30) and 48 hours (–6.52, 95% CI –7.78, –5.25, *P*=0.0000). Furthermore, pregabalin can reduce the occurrence of nausea (RR 0.57, 95% CO 0.41, 0.79, *P*=.001, number needed to treat = 8.4). There were no significant differences in the occurrence of sedation, dizziness, headache, or visual disturbance.	High

ASA, American Society of Anesthesiologists; BZD, benzodiazepines; IV, intravenous; LAO, long-acting opioids; OAE, opioid addiction education; PMA, preventative multimodal analgesia; SD, standard deviation.

Postoperative PICO 11: In the care of adults undergoing spine surgery, does the nurses' role in antibiotic stewardship improve postoperative outcomes?

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Schmitt C, 2017	Cross sectional	9 tertiary care hospitals	Skull or spine surgery performed by neurosurgery; spine surgery–specific analysis (included in findings)	This study aims to determine the index of surgical antibiotic prophylaxis compliance in neurosurgery.	Full compliance was 10% and was associated with weekly hours of infection control personnel per intensive care unit bed (95% CI, 0.2-0.1), hospital-wide dissemination of SAP guidelines (95% CI, 1.2-25.1), monitoring (95% CI, 1.2-25.1), and feedback of compliance rates (95% CI, 3.8-25.2). Daytime procedures had greater compliance regarding drug dose (OR, 3.38; 95% CI, 1.72-6.65) and initial time (OR, 2.30; 95% CI, 1.24-4.25). Spinal procedures achieved greater compliance with initial time (OR, 1.83; 95% CI, 1.12-3.01) and duration (OR, 1.59; 95% CI, 1.7-2.16).	Low
Urquhart JC, 2019	Randomized controlled trial	N=552	Age greater than or equal to 16 years old; elective, open posterior thoracic or lumbar multilevel decompression and/or athrodesis for deformity or degenerative conditions, or large enough magnitude that the insertion of a closed-suction drain would be considered; and ability to provide informed consent.	The purpose of the present study was to compare the rate of complicated surgical site infection after posterior, open thoracolumbar spine procedures followed by the placement of a closed-suction drain between patients treated with postoperative antibiotics for 24 hours and 72 hours.	The extension of postoperative antibiotics for 24 hours after the drain removal is not associated with a reduction in the rate of complicated surgical site infection after posterior thoracolumbar elective spinal surgery.	Moderate

Postoperative PICO 11: In the care of adults undergoing spine surgery, does the nurses' role in antibiotic stewardship improve postoperative outcomes? *(continued)*

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Pivazyan G, 2021	Retrospective cohort study	N=336 (n=168 with non-PPSA, n=168 with PPSA)	Inclusion criteria were patients 18 years of age or older who underwent traditional midline posterior open spine surgery for degenerative conditions. Given that the most prevalent regions of degenerative surgery for spine surgeons are the cervical and lumbar/ lumbosacral, only these regions were included. Indications for surgery were degenerative pathologies (degenerative disk disease, spinal stenosis, spondylolisthesis, adjacent segment disease).	The aim of the current investigation was to evaluate the impact of prolonged prophylactic systemic antibiotics (PPSA) on the development of surgical site infection rate (SSIR) in degenerative spine surgery.	Our series demonstrate a two-fold reduction of SSI with implementation of PPSA regimen. Six patients in the PPSA group and 12 patients in the non-PPSA group developed deep SSI. Similar pattern of infections was found in cervical and lumbar regions, when analyzed separately. PPSA regimen was associated with higher cost and higher *C. difficile* infection rate. Even though the SSI rate was not statistically significant between the PPSA and non-PPSA groups, the clinical implications are relevant.	Low

OR, odds ratio.

Postoperative PICO 12: In adults with spinal cord injury, does timing of individual or group support/ counseling improve patient and family outcomes?

First Author, Year	Study Design	Number of Participants	Population	Study Aim	Study Findings	Quality of Evidence
Coker J, 2019	Parallel-arm 1:1 randomized controlled trial	N=81	History of traumatic or nontraumatic SCI at any level; at least 4 weeks postdischarge from initial inpatient rehabilitation; 18 years of age or older; English speaking	The purpose of the study was to evaluate the efficacy of a specific, replicable group CBT-based education intervention to enhance personal self-efficacy.	Individuals in the treatment group had greater increases in MSES scores from baseline to immediately postintervention (6 weeks) than the control group, but that difference did not remain significant after controlling for multiple comparisons. However, the improvement in the treatment group relative to the control group was not maintained through follow-up at 30 weeks. There was no evidence of an immediate or sustained treatment effect on any of the secondary outcomes.	High
Ljungberg I, 2011	Quasi-experimental; pre-/posttest	N=24	Minimum 18 years of age, admitted to inpatient SCI rehabilitation unit with moderate to severe neurological deficits within one year of their injury	To describe the implementation of a peer mentoring program designed to support this adjustment process for people with SCI/disease and the program's believed impact of self-efficacy and prevention of medical complications	67% showed improved self-efficacy scores between the two time points. Medical complications and doctor visits all decreased significantly between 0-6 months and 7-12 months. Findings indicate that the older an individual is, the lower the likelihood of having urinary tract infections.	Low