CONGRESS OF NEUROLOGICAL SURGEONS SYSTEMATIC REVIEW AND EVIDENCE-BASED GUIDELINES FOR PERIOPERATIVE SPINE: PREOPERATIVE OPIOID EVALUATION

Sponsored by: Congress of Neurological Surgeons (CNS) and the Section on Disorders of the Spine and Peripheral Nerves
Endorsement: Reviewed for evidence-based integrity and endorsed by the American Association of Neurological Surgeons (AANS) and Congress of Neurological Surgeons (CNS)

Authors:

Marjorie C. Wang, MD, MPH[1], James S. Harrop, MD, MSHQS[2], Erica F. Bisson, MD, MPH[3], Sanjay Dhall, MD[4], John Dimar, MD[5], Basma Mohamed, MBChB[6], Praveen V. Mummaneni, MD, MBA[4], Daniel J. Hoh, MD[7]

Departmental and institutional affiliations:

1. Department of Neurosurgery, Medical College of Wisconsin, Wauwatosa, WI, USA
2. Department of Neurological Surgery and Department of Orthopedic Surgery, Thomas Jefferson University, Division of Spine and Peripheral Nerve Surgery, Delaware Valley SCI Center, Philadelphia, PA, USA
3. Clinical Neurosciences Center, University of Utah Health, Salt Lake City, UT, USA
4. Department of Neurosurgery, University of California San Francisco, San Francisco, CA, USA
5. Department of Orthopedics, University of Louisville, Pediatric Orthopedics, Norton Children's Hospital, Norton Leatherman Spine Center, Louisville, KY, USA
6. Department of Anesthesiology, University of Florida College of Medicine, Gainesville, FL, USA
7. Department of Neurosurgery, University of Florida College of Medicine, Gainesville, FL, USA

Corresponding Author contact information:
Marjorie C. Wang, MD, MPH
Department of Neurosurgery
Medical College of Wisconsin
8701 W. Watertown Plank Road
Wauwatosa, WI 53226
414 955-0952
marjorie.wang@gmail.com

Keywords: opioids, elective spine surgery, degenerative spine conditions, outcomes, adverse events

Abbreviations:
ACDF: anterior cervical discectomy and fusion
EQ-5D: EuroQol 5D health-related quality of life survey
MEA: morphine equianalgesic dose

MMEs: morphine milligram equivalents
NASS: North American Spine Society
NDI: Neck Disability Index
ODI: Oswestry Disability Index
PDMP: Prescription Drug Monitoring Program
SF-12: Medical Outcomes Study Survey Short Form 12
SF-36 PCS: Medical Outcomes Study Survey Short Form 36 physical component summary
SRS: Scoliosis Research Society
VAS: Visual Analog Scale

ABSTRACT

Background: Opioid use disorders in the United States have rapidly increased, yet little is known about the relationship between preoperative opioid duration and dose and patient outcomes after spine surgery. Likewise, the utility of preoperative opioid weaning is poorly understood.

Objective: The purpose of this evidence-based clinical practice guideline is to determine if duration and dose of preoperative opioids or preoperative opioid weaning is associated with patient-reported outcomes or adverse events after elective spine surgery for degenerative conditions.

Methods: A systematic review of the literature was performed using the National Library of Medicine/PubMed database and Embase for studies relevant to opioid use among adult patients undergoing spine surgery. Clinical studies evaluating preoperative duration, dose, and opioid weaning and outcomes were selected for review.

Results: Forty-one of 845 studies met the inclusion criteria and none were Level I evidence. The use of any opioids before surgery was associated with longer postoperative opioid use, and longer duration of opioid use was associated with worse outcomes, such as higher complications, longer length of stay, higher costs, and increased utilization of resources. There is insufficient evidence to support the efficacy of opioid weaning on postoperative opioid use, improving outcome, or reducing adverse events after spine surgery.

Conclusion: This evidence-based clinical guideline provides Grade B recommendations that preoperative opioid use and longer duration of preoperative opioid use are associated with chronic postoperative opioid use and worse outcome after spine surgery. Insufficient evidence supports the efficacy of an opioid wean before spine surgery (Grade I).

RECOMMENDATIONS

Question:

1. Does duration of preoperative opioid use impact postoperative opioid use (duration, morphine milligram equivalents), patient-reported outcomes, or adverse events after spine surgery?

Recommendations:

Longer duration of opioid use before spine surgery is associated with worse outcomes (chronic postoperative opioid use, higher complications, increased length of stay, and higher costs and utilization of resources).

Strength of Recommendation: Grade B

Question:

2. Does preoperative morphine milligram equivalents impact postoperative opioid use (duration, morphine milligram equivalents), patient-reported outcomes, or adverse events after spine surgery?

Recommendations:

Preoperative opioid use of any dose (yes/no) is associated with risk of longer duration of postoperative opioid use and worse clinical and patient-reported outcomes.

Strength of Recommendation: Grade B

Question:

3. Does preoperative weaning of opioids impact postoperative opioid use (duration, morphine milligram equivalents), patient-reported outcomes, or adverse events after spine surgery?

Recommendations:

There is insufficient evidence to support the efficacy of opioid weaning on postoperative opioid use, improving outcomes, or reducing adverse events after spine surgery.

Strength of Recommendation: Grade Insufficient

INTRODUCTION

Goals and Rationale

This clinical guideline was created to improve patient care by outlining the appropriate information gathering and decision-making processes involved in the treatment of patients with perioperative spinal disease. Spinal surgical care is provided in many different settings by many different providers. This guideline was created as an educational tool to guide qualified physicians through a series of diagnostic and treatment decisions to improve the quality and efficiency of care.

This guideline should not be construed as including all proper methods of care or excluding methods of care reasonably directed to obtaining the same results. The ultimate judgment regarding any specific procedure or treatment must be made in light of all circumstances presented by the patient and the needs and resources particular to the locality or institution.

Spine surgeries are often performed to treat painful spinal conditions and rates of spine surgery have increased over time.[1,2] From 2005 to 2014, opioid use disorders increased 6.47% annually in the United States and were reported 25% more often between 2010 and 2014 compared with 2005 to 2009 among patients hospitalized for treatment of spinal conditions.[3] In the current opioid crisis, provider prescribing practices and the effects of perioperative opioid use are under intense scrutiny. Despite increasing attention to opioid use, evidence to support best practice regarding preoperative opioid dose and duration in the management of patients with surgical degenerative spine disease is not well known. Likewise, the efficacy of preoperative opioid weaning is poorly understood, although this has been suggested as a potential intervention.

The purpose of this work is to systematically review the literature to form evidence-based guidelines regarding the relationship between duration and dose of preoperative opioids and patient-reported outcomes and adverse events after elective spine surgery for degenerative conditions. We also review the literature regarding the association between preoperative opioid weaning and these outcomes.

METHODS

The guidelines task force initiated a systematic review of the literature and evidence-based guideline relevant to the preoperative treatment of patients with spinal disorders. Through objective evaluation of the evidence and transparency in the process of making recommendations, this evidence-based clinical practice guideline was developed for the diagnosis and treatment of adult patients with various spinal conditions. These guidelines are developed for educational purposes to assist practitioners in their clinical decision-making processes. Additional information about the methods used in this systematic review is provided below.

Literature Search

Task force members identified search terms/parameters and a medical librarian implemented the literature search, consistent with the literature search protocol (see Supplemental Digital Content 1), using the National Library of Medicine/PubMed database and Embase for the period from 1946 to September 20, 2019 using the search strategies provided in Supplemental Digital Content 1.

Inclusion/Exclusion Criteria

Articles were retrieved and included only if they met specific inclusion/exclusion criteria (Supplemental Digital Content 2). These criteria were also applied to articles provided by guideline task force members who supplemented the electronic database searches with articles from their own files. To reduce bias, these criteria were specified before conducting the literature searches.

Rating Quality of Diagnostic Evidence

The guideline task force used a modified version of the North American Spine Society's (NASS) evidence-based guideline development methodology. The NASS methodology uses standardized levels of evidence (Supplemental Digital Content 3) and grades of recommendation (Supplemental Digital Content 4) to assist practitioners in easily understanding the strength of the evidence and recommendations within the guidelines. The levels of evidence range from Level I (high-quality randomized controlled trial) to Level IV (case series). Grades of recommendation indicate the strength of the recommendations made in the guideline based on the quality of the literature. Levels of evidence have specific criteria and are assigned to studies before developing recommendations. Recommendations are then graded based upon the level of evidence. To better understand how levels of evidence inform the grades of recommendation and the standard nomenclature used within the recommendations see Supplemental Digital Content 4.

Guideline recommendations were written using a standard language that indicates the strength of the recommendation. "A" recommendations indicate a test or intervention is "recommended"; "B" recommendations "suggest" a test or intervention and "C" recommendations indicate a test or intervention or "is an option." "I" or "Insufficient Evidence" statements clearly indicate that "there is insufficient evidence to make a recommendation for or against" a test or intervention. Task force consensus statements clearly state that "in the absence of reliable evidence, it is the task force's opinion that" a test or intervention may be appropriate.

In evaluating studies as to levels of evidence for this guideline, the study design was interpreted as establishing only a potential level of evidence. For example, a therapeutic study designed as a randomized controlled trial would be considered a potential Level I study. The study would then be further analyzed as to how well the study design was implemented and significant shortcomings in the execution of the study would be used to downgrade the levels of evidence for the study's conclusions (see Supplemental Digital Content 5 for additional information and criteria).

Revision Plans

In accordance with the Institute of Medicine's standards for developing clinical practice guidelines, the task force will monitor related publications after the release of this document and will revise the entire document and/or specific sections "if new evidence shows that a recommended intervention causes previously unknown substantial harm; that a new intervention is significantly superior to a previously recommended intervention from an efficacy or harms perspective; or that a recommendation can be applied to new populations."[4] In addition, the task force will confirm within 5 years from the date of publication that the content reflects current clinical practice and the available technologies for the evaluation and treatment for patients with perioperative spinal disease.

RESULTS

The literature search encompassed terms relevant to all chapters in this guideline series and yielded 6812 abstracts (5689 after duplicates were deleted). After a double-blind review, 845 abstracts were identified as relevant to the PICO (patient/population, intervention, comparison, and outcomes) question(s). Task force members reviewed all abstracts yielded from the literature search and identified the literature for full text review and extraction, addressing the clinical questions, in accordance with the literature search protocol (Supplemental Digital Content 1). Task force members identified the best research evidence available to answer the targeted clinical questions. When Level I, II, and/or III literature was available to answer specific questions, the task force did not review Level IV studies.

The task force selected 78 full-text articles for full text review. Of these, 37 were rejected for not meeting the inclusion criteria or for being off-topic. Forty-one articles were selected for systematic review (Supplemental Digital Content 6).

DISCUSSION

Question

Does duration of preoperative opioid use impact postoperative opioid use (duration, morphine milligram equivalents), patient reported outcomes or adverse events after spine surgery?

Recommendation

Longer duration of opioid use before spine surgery is associated with worse outcomes (chronic postoperative opioid use, higher complications, increased length of stay, and higher costs and utilization of resources).

Strength of Recommendation: Grade B

Most studies met the criteria for Level II evidence and no studies met the criteria for Level I evidence. Preoperative opioid use was associated with postoperative opioid use after cervical fusion surgery,[5,6] lumbar discectomy,[7] and lumbar fusion surgery.[7-9] While the literature varied on the definition of chronic opioid use, studies were similar in finding a significant association between duration of pre- and postoperative opioid use.

Level II Evidence

Cervical Fusion Surgery

In patients undergoing cervical spine surgery, chronic opioid use before surgery was associated with chronic opioid use after surgery, although definitions of "chronic opioid use" varied by study. Harris et al[6] defined chronic postoperative opioid use as ≥120 days of filled opioid prescriptions or ≥10 opioid prescriptions filled between 3 and 12 months after surgery. Among patients undergoing elective one or two level ACDF for degenerative diagnoses, they found that preoperative opioid use was strongly associated with chronic postoperative opioid use (odds ratio [OR] 5.7 [95% CI 5.3-6.2], $P < .001$). A history of drug abuse, depression, anxiety, and surgery in the western United States were also associated with chronic postoperative opioid use. Likewise, Karhade et al[5] performed a chart review among patients undergoing ACDF at two academic medical centers and found that duration of preoperative opioid use of >180 days, antidepressant use, tobacco use, and Medicaid insurance were significant predictors of prolonged postoperative opioid use for at least 90 to 180 days after surgery. In the Humana database, Pugely et al[10] also found that nearly half of preoperative opioid users continued to fill opioid prescriptions 1 year after anterior or posterior cervical fusions. Duration of preoperative opioid use was also associated with lower rates of return to work status, disability, and higher costs in a workers' compensation population undergoing single-level cervical fusions. Short-term opioid users, defined as patients who received opioids for <3 months, were more likely to return to work in the first year after surgery compared with intermediate (3-6 months) and long-term (>6 months) preoperative opioid users.[11] Finally, Jain et al[12] used the Humana commercial insurance database to study patients with opioid prescriptions for >6 months before cervical fusion surgery and outcomes. They found higher risk of 90-day wound complications, emergency department visits, and pain-related emergency department visits among patients with chronic preoperative opioid use. They also noted that patients with preoperative chronic use were more likely to have chronic longer-term opioid use (defined as opioid use ≤1 year after surgery), repeat cervical fusion surgery, and epidural or facet joint injections within the year after surgery.

Lumbar Surgery

In patients undergoing lumbar spine surgery, chronic opioid use before surgery was associated with chronic opioid use after surgery. Again, definitions of "chronic opioid use" were not standardized across studies. Karhade et al[7] performed a chart review among patients undergoing surgery for lumbar disc herniation at five medical centers. The predictors of sustained postoperative opioids for 90 to 180 days after surgery included use of instrumentation, duration of preoperative opioid prescription of >180 days, and diagnosis of depression. Qureshi et al[13] reported similar findings using the PearlDiver database. Preoperative opioid prescriptions were associated with long-term postoperative opioid prescriptions, defined as >3 months after lumbar discectomy (OR 3.4). Comorbidities, such as fibromyalgia, migraine disorder, depression, and smoking, were also associated with an increased odds of postoperative long-term opioid

prescriptions. In a retrospective single-center study, Hockley et al[14] compared minimally invasive and open transforaminal lumbar interbody fusion patients and found those undergoing minimally invasive surgery were less likely to report postoperative opioid use at the 3-month follow-up. Anderson et al[8] studied chronic opioid therapy after lumbar fusion surgery among patients with Workman's Compensation claims. In this Ohio claims database study, they found that chronic opioid use before surgery, defined as opioids analgesics supplied for >120 days during the year before lumbar fusion, was associated with chronic opioid use. Chronic postoperative use was defined as opioid prescriptions supplied for >1 year after the immediate 6-weeks after surgery.

Tank et al[15] used the Nationwide Inpatient Sample to study patients with a diagnosis of opioid dependence (*International Classification of Diseases, 9th revision, Clinical Modification* codes 304.0 for opioid-type dependence and 304.7 for combinations of opioid-type drug with any other) and duration of stay, costs, and surgical complications after elective primary or revision 1- or 2-level lumbar fusions. Opioid dependence was associated with a higher odds of prolonged duration of stay of ≥5 days, surgical complications, and higher costs. Kalakoti et al[16] in the Humana claims database between 2007 and 2015, found that duration of preoperative opioid prescriptions within 3 months before surgery was significantly associated with opioid use 1 year after anterior or posterior lumbar fusions. Jain et al[17] used the Humana claims database from 2007 to 2016 and found that patients with a preoperative opioid prescription of >6 months had a higher risk of 90-day emergency department visits and readmissions, wound dehiscence and infection, and revision surgery within 1 year after posterior lumbar fusions. Finally, Connolly et al,[9] using an Optum commercial health insurance claims database, also found that duration of preoperative opioid use, indication for refusion, and diagnosis of depression were associated with increased risks of long-term opioid use after lumbar fusion, defined as postoperative long-term use for ≥365 days after surgery. The preoperative use of opioids for ≥250 days before surgery was associated with an increased odds of postoperative long-term opioid use (OR 220 [95% CI 149-326], $P < .001$).

Level III Evidence

Two Level III studies reported an association between duration of preoperative opioid use and postoperative outcomes. Rosenthal et al[18] found that patients with opioid prescriptions 3 and 6 months before spine surgery had a significantly increased risk of continued opioid use compared with patients with opioid prescriptions at 3 months before surgery or with no opioid prescriptions before surgery. Oleisky et al[19] studied chronic opioid use in a degenerative cervical and lumbar elective spine surgery population and found that the Edlund and the Schoenfeld definitions of chronic opioid use had the highest predictive ability for postoperative opioid use. The Edlund definition accounts for duration and usage of opioids and the Schoenfeld definition accounts for duration; both were associated with postoperative opioid use, patient satisfaction, and patient-reported disability and pain.

Question

Does preoperative morphine milligram equivalents impact postoperative opioid use (duration, morphine milligram equivalents), patient-reported outcomes or adverse events after spine surgery?

Recommendations
Preoperative opioid use of any dose (yes/no) is associated with risk of longer duration of postoperative opioid use and worse clinical and patient-reported outcomes.
Strength of Recommendation: Grade B

The overall goal of this section was to evaluate the association between preoperative opioid dose and postoperative opioid use, patient-reported outcomes, or adverse events after spine surgery. However, most studies evaluated the relationship between clinical outcome and any preoperative opioid use versus none, did not delineate by preoperative morphine milligram equivalents (MME), or used nonstandardized dosing descriptions such as "weak" and "strong" opioids.

Most studies met the criteria for Level II evidence and no studies met the criteria for Level I evidence. The association between higher preoperative MME or weak versus strong opioid use before surgery and postoperative opioid use was inconsistent. In a Level II analysis of lumbar fusion surgery patients, Deyo et al[20] linked the Oregon PDMP and the statewide hospital discharge registry and studied long-term postoperative opioid use. The cumulative opioid dose in the 7 months before surgery was the strongest predictor of long-term postoperative use, defined as ≥4 opioid fills in the 7 months after the index hospitalization with at least 3 of those more than 30 days after hospitalization. Long-term preoperative use was associated with long-term postoperative use (OR 10.8 [95% CI 8.2-13.2]). The odds of long-term opioid use also increased with increasing preoperative dose, with an OR of 15.47 (95% CI 8.53-28.06) for a preoperative mean daily dose of >39 MMEs. In a Level II subanalysis of the control ACDF group for two randomized studies of cervical arthrodesis, Anderson et al[21] found weak opioid use was significantly associated with lower odds of achieving a composite success score including NDI at 24 months after surgery (presumably compared with no opioid use, although this was not directly stated). However, in a later and larger study by Kelly et al,[22] no significant association was found between preoperative opioid strength and outcomes. Opioid use was self-reported on a patient questionnaire. "Weak" opioid use was defined as codeine, propoxyphene, and hydrocodone. "Strong" opioid use was defined as oxycodone, morphine, and meperidine.

In a Level III analysis of patients undergoing cervical or lumbar surgery, Ahn et al[23] reported no persistent postoperative opioid use difference between patients with any preoperative opioid use (yes/no) at either the first or second postoperative visits, 4 to 6 weeks or 8 to 12 weeks, after cervical or lumbar surgeries. However, patients with any preoperative opioid use reported significantly higher inpatient opioid consumption. All other studies consistently showed a significant association between any preoperative opioid use (yes/no) and postoperative opioid use and outcomes and are presented in the following sections.

Level II Evidence
Cervical Fusion Surgery
Reid et al[24] studied 1- to 3-level patients undergoing ACDF and found that opioid-tolerant patients, defined as patients who filled an opioid prescription within the 30-day preoperative period, were more likely to have chronic postoperative opioid use >90 days after surgery (OR 4.42 [95% CI 2.02-9.63], $P < .001$). Lawrence et al[25] reported a similar association between chronic preoperative opioid use (yes/no) and 2-year poor outcome as assessed using a modification of the Robinson criteria. Chronic preoperative opioid use was defined as patients

using daily opioid pain medication for 6 months before surgery. Preoperative opioid use was also associated with increased iliac crest donor site pain at 1 and 2 weeks after ACDF.[26]

Among a workers' compensation population in Ohio who underwent single level anterior or posterior fusion surgeries, Faour et al[11] reported an association between prolonged preoperative opioid use and a lower likelihood of return to work. Kalakoti et al[27] used the Humana dataset to study preoperative chronic opioid use, defined as an active opioid prescription within 3 months of surgery, among patients undergoing anterior cervical, posterior cervical or C1-2 fusions. Preoperative chronic opioid use (yes/no) was significantly associated with 2-year reoperations, ED visits, epidural steroid and facet joint injections, and adverse events, including constipation, venous thromboembolism, acute renal failure, wound complications, infections, and neurologic complications. Preoperative chronic opioid use was also associated with prolonged postoperative opioid use at 2 years after surgery (OR 5.75 [95% CI 5.21-6.36], $P < .001$).

Cervical and Lumbar Surgery
Amraghani et al[28] found patients reporting any preoperative opioid use had a lower odds of being independent from self-reported opioid use at 12 months after cervical or lumbar spine surgery compared with patients with no preoperative opioid use.

Lumbar Surgery
Six Level II studies focused on lumbar surgery and outcome. Any preoperative opioid use was consistently associated with higher risk of long-term opioid use after lumbar surgery. Lall et al[29] and Adogwa et al[30] similarly reported that preoperative opioid use (dichotomized yes/no preoperative use) significantly predicted weeks to opioid cessation after lumbar fusion. Adogwa et al[31] also reported any preoperative prescription for opioids in the 6 months before lumbar decompression and fusion surgery was associated with prolonged opioid use for >1 year after surgery.

Villavicencio et al[32] found patients with any preoperative opioid use before undergoing transforaminal lumbar interbody fusion surgery for degenerative conditions were significantly more likely than nonusers to report higher pain scores (visual analog scale) for low back, greater disability, and lower Medical Outcomes Study Survey Short Form 36 physical component summary scores 1 year after surgery. O'Donnell et al[33] also reported preoperative opioid use was a significant predictor of lower return to work rates after lumbar discectomies among Ohio workers' compensation patients.

In the single study evaluating tramadol use, Hassan et al[34] evaluated patients undergoing lumbar discectomy and found that preoperative tramadol abuse (meeting ≥1 *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* criteria for substance use disorders within a 12-month period) was associated with worse postoperative visual analog scale scores for the low back and lower limb, worse Prolo functional rating scale, and higher complications during the follow-period than the nonuser control group. The tramadol group had a longer length of stay and was more likely to be using tramadol up to a year after surgery.

Level III Evidence
Cervical and Lumbar Surgery

Any preoperative opioid use was associated with higher early postoperative patient-controlled analgesia morphine consumption in the first 3 days after lumbar spine surgery for degenerative changes.[35] Five other Level III studies evaluated patients after cervical or lumbar spine surgeries. Armaghani et al[36] reported that any preoperative opioid use was associated with worse 2-year outcomes (higher ODI or NDI scores, lower SF-12 and EQ-5D scores, and higher Numeric Rating Scale scores) compared with no use. Dunn et al[37] reported that preoperative opioid use was associated with chronic postoperative opioid use 1 year after spine surgery.

Hills et al[38] used their institutional spine registry and the state's Prescription Drug Monitoring Program data to study patient-reported outcomes after elective spine surgery. Preoperative chronic opioid use was defined as having an active prescription for opioids for >50% of the month for 3 consecutive months before surgery. Patients with any preoperative chronic opioid use had worse outcome at 1 year after surgery, with a higher odds of not achieving meaningful improvements in pain, function, and quality of life; higher odds of dissatisfaction with surgery; continued opioid use; and 90-day complications compared with patients without preoperative chronic opioid use. High preoperative opioid dosage >30 MMEs was significantly associated with postoperative chronic opioid use. Wick et al[39] also evaluated registry data for patients undergoing cervical or lumbar spine surgery in a single spine center. The odds of achieving a minimum clinically important difference in outcome decreased significantly as morphine equianalgesic dose increased from 47.8 to 90 mg per day (95% CI 29.0-60.0 mg/day).

Lumbar Surgery

Level III studies were also congruent with Level II studies in reporting a significant association between any preoperative opioid use (yes/no) and long-term postoperative opioid use. Compared with patients without preoperative opioid use, Kanaan et al[40] reported that patients with preoperative opioid use were associated with increased postoperative leg pain intensity 2 weeks after lumbar spine surgery. Wright et al[41] defined chronic postoperative opioid use as a consecutive opioid prescription for >90 days within the first year after the lumbar discectomy or laminectomy surgery at a single center and found a significant association between preoperative and chronic postoperative opioid use. Albert et al[42] noted that preoperative opioid use was associated with postoperative use among 37 patients with lumbar pseudoarthrosis. O'Connell et al[43] reported a significant association between preoperative and postoperative opioid use among patients undergoing lumbar fusion surgery.

Deformity Surgery

Two Level III studies evaluated any preoperative opioid use (yes/no) and outcome after deformity surgery. Elsamadicy et al[44] found that preoperative opioid users reported greater first postoperative pain scores but that the reduction in pain score from baseline to discharge was greater in the preoperative opioid users than nonusers. The preoperative opioid use group also had a greater number of first ambulatory steps compared with the nonuser group (103.8 ± 144.4 feet vs 46.4 ± 84.0 feet, $P = .034$). Mesfin et al[45] reported that preoperative opioid users had worse baseline ODI and SRS scores, but the mean improvement in ODI was similar between groups at 24 months of follow-up. In contrast, the mean improvement in SRS pain scores was significantly higher for the preoperative opioid user group at 24 months compared with the non–

opioid user group. Overall mean change in SRS scores, however, was not significantly different between groups.

Question
Does preoperative weaning of opioids decrease postoperative opioids use (duration, MMEs), patient reported outcomes, or adverse events after spine surgery?
Recommendations:
There is insufficient evidence to support the efficacy of opioid weaning on postoperative opioid use, improving outcome, or reducing adverse events after spine surgery.
Strength of Recommendation: Grade Insufficient

There was a single Level II study[17] that met the inclusion criteria for this question, without any additional supporting studies. Patients in this study were taken off opioids for a 3- to 489-month prescription-free "drug holiday" before 1 or 2-level posterior lumbar fusion surgery and had risks of adverse outcomes, defined as emergency department visits, readmissions, and wound dehiscence and infection, that were similar to opioid-naïve patients, and lower than patients who had preoperative opioid prescriptions sustained for >6 months.

Future Research
This systematic review of the literature highlighted areas that need further research. The relationship between differences in preoperative opioid dose and clinical outcome should be clarified. Only 1 study evaluated tramadol, and the relationship between MMEs and outcome remains unclear. More research is needed regarding interventions to reduce postoperative adverse events. The impact of preoperative opioid weaning and a preoperative opioid-free period on clinical outcome and postoperative opioid requirement should also be studied.

Conclusions
Overall, the literature is consistent in reporting an association between preoperative opioid use and duration with chronic postoperative use of opioids and outcome. The definition of pre- and postoperative use and outcome, however, differed between studies. The literature supports higher complications, worse outcome, and lower return to work among patients who use preoperative opioids, and patients who use preoperative opioids for a prolonged period before surgery. In addition, there are limited data to support the efficacy of an opioid wean before spine surgery.

Conflicts of Interest
All Guideline Task Force members were required to disclose all potential COIs before beginning work on the guideline, using the COI disclosure form of the AANS/CNS Joint Guidelines Review Committee. The CNS Guidelines Committee and Guideline Task Force Chair reviewed the disclosures and either approved or disapproved the nomination and participation on the task force. The CNS Guidelines Committee and Guideline Task Force Chair may approve nominations of task force members with possible conflicts and restrict the writing, reviewing, and/or voting privileges of that person to topics that are unrelated to the possible COIs. See below for a complete list of disclosures.

Author	Disclosure
Marjorie Wang, MD	Zimmer Biomet, Medtronic

	Abbott ABNS, AANS JNS Spine Editorial Board
James Harrop, MD	Depuy Sysnthesis, Ethician Globus, Stryker
Erica Bisson, MD	PCORI, NREF MiRvs, nView, Stryker, Medtronic MiRvs, nView
Praveen Mumanneni, MD	AO Spine, NREF, ISSS Depuy, Globus, Stryker Spinicity, ISD Depuy,Thieme Publishers, Springer Publishers CNS/NPA
John Dimar, MD	Medtronic, Depuy, Stryker Johnson & Johnson, Pfizer, Glaxo-Smith Kline, Eli Lily, Abbot, Hoffman La Roche, Abbie Pfizer, Norton Hospital Medtronic, Stryker SRS & FOSA (2020) JAAOS, Spine, Spinal Deformity, GSJ (Reviewer)
Sanjay Dhall, MD	Depuy Synthes, Globus Medical Great Circle Technologies
Daniel Hoh, MD	The Spine Journal Editorial Board CNS Officer, CNS Foundation Board, JNS Spine Editorial Board, The Spine Journal Editorial Board

Funding
These evidence-based clinical practice guidelines were funded exclusively by the Congress of Neurological Surgeons and the AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves (through a donation to the CNS Foundation), which received no funding from outside commercial sources to support the development of this document.

Disclaimer of Liability
This clinical, systematic, evidence-based clinical practice guideline was developed by a multi-disciplinary physician volunteer taskforce and is provided as an educational tool based on an assessment of the current scientific and clinical information regarding this guideline topic. These guidelines are disseminated with the understanding that the recommendations by the authors and consultants who have collaborated in their development are not meant to replace the individualized care and treatment advice from a patient's physician(s). If medical advice or assistance is required, the services of a physician should be sought. The proposals contained in these guidelines may not be suitable for use in all circumstances. The choice to implement any particular recommendation contained in these guidelines must be made by a managing physician in light of the situation in each particular patient and on the basis of existing resources.

Acknowledgments
The guidelines task force would like to acknowledge the CNS Guidelines Committee for their contributions throughout the development of the guideline, the AANS/CNS Joint Guidelines Review Committee, the AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves for their donation to the CNS Foundation to support this project, as well as the contributions of Kirsten Aquino, contracted project manager for the CNS, Trish Rehring, MPH, Associate Director for Evidence-Based Practice Initiatives for the CNS, Janet Waters, MLS, BSN, RN, for assistance with the literature searches and Kenneth Probst for the cover illustrations. Throughout the review process, the reviewers and authors were blinded from one another. At this time, the guidelines task force would like to acknowledge the following individual peer reviewers for their contributions: Patricia Raksin, MD, Jason Stacy, MD, Neil Majmunder, MD, Yi Lu, MD, Alex Beier, MD, Andrew Carlson, MD, Brandon Rocque, MD, Robert Whitmore, MD, Jay Turner, MD, Owoicho Adogwa, MD

REFERENCES

1. Deyo RA. Fusion surgery for lumbar degenerative disc disease: still more questions than answers. *The spine journal : official journal of the North American Spine Society.* 2015;15(2):272-274.
2. Rajaee SS, Bae HW, Kanim LE, Delamarter RB. Spinal fusion in the United States: analysis of trends from 1998 to 2008. *Spine.* 2012;37(1):67-76.
3. Lee SW, Shen J, Kim SJ, et al. US Trends of Opioid-use Disorders and Associated Factors Among Hospitalized Patients With Spinal Conditions and Treatment From 2005 to 2014. *Spine.* 2020;45(2):124-133.
4. Ransohoff DF, Pignone M, Sox HC. How to decide whether a clinical practice guideline is trustworthy. *Jama.* 2013;309(2):139-140.
5. Karhade AV, Ogink PT, Thio Q, et al. Machine learning for prediction of sustained opioid prescription after anterior cervical discectomy and fusion. *The spine journal : official journal of the North American Spine Society.* 2019;19(6):976-983.
6. Harris AB, Marrache M, Jami M, et al. Chronic Opioid Use Following Anterior Cervical Discectomy and Fusion Surgery for Degenerative Cervical Pathology. *The spine journal : official journal of the North American Spine Society.* 2019.
7. Karhade AV, Ogink PT, Thio Q, et al. Development of machine learning algorithms for prediction of prolonged opioid prescription after surgery for lumbar disc herniation. *The spine journal : official journal of the North American Spine Society.* 2019.
8. Anderson JT, Haas AR, Percy R, Woods ST, Ahn UM, Ahn NU. Chronic Opioid Therapy After Lumbar Fusion Surgery for Degenerative Disc Disease in a Workers' Compensation Setting. *Spine.* 2015;40(22):1775-1784.
9. r J, 3rd, Javed Z, Raji MA, Chan W, Kuo YF, Baillargeon J. Predictors of Long-term Opioid Use Following Lumbar Fusion Surgery. *Spine.* 2017;42(18):1405-1411.
10. Pugely AJ, Bedard NA, Kalakoti P, et al. Opioid use following cervical spine surgery: trends and factors associated with long-term use. *The spine journal : official journal of the North American Spine Society.* 2018;18(11):1974-1981.
11. Faour M, Anderson JT, Haas AR, et al. Prolonged Preoperative Opioid Therapy Associated With Poor Return to Work Rates After Single-Level Cervical Fusion for Radiculopathy for Patients Receiving Workers' Compensation Benefits. *Spine.*

2017;42(2):E104-e110.
12. Jain N, Brock JL, Phillips FM, Weaver T, Khan SN. Chronic preoperative opioid use is a risk factor for increased complications, resource use, and costs after cervical fusion. *The spine journal : official journal of the North American Spine Society.* 2018;18(11):1989-1998.
13. Qureshi R, Werner B, Puvanesarajah V, et al. Factors Affecting Long-Term Postoperative Narcotic Use in Discectomy Patients. *World neurosurgery.* 2018;112:e640-e644.
14. Hockley A, Ge D, Vasquez-Montes D, et al. Minimally Invasive Versus Open Transforaminal Lumbar Interbody Fusion Surgery: An Analysis of Opioids, Nonopioid Analgesics, and Perioperative Characteristics. *Global spine journal.* 2019;9(6):624-629.
15. Tank A, Hobbs J, Ramos E, Rubin DS. Opioid Dependence and Prolonged Length of Stay in Lumbar Fusion: A Retrospective Study Utilizing the National Inpatient Sample 2003-2014. *Spine.* 2018;43(24):1739-1745.
16. Kalakoti P, Hendrickson NR, Bedard NA, Pugely AJ. Opioid Utilization Following Lumbar Arthrodesis: Trends and Factors Associated With Long-term Use. *Spine.* 2018;43(17):1208-1216.
17. Jain N, Brock JL, Malik AT, Phillips FM, Khan SN. Prediction of Complications, Readmission, and Revision Surgery Based on Duration of Preoperative Opioid Use: Analysis of Major Joint Replacement and Lumbar Fusion. *The Journal of bone and joint surgery American volume.* 2019;101(5):384-391.
18. Rosenthal BD, Suleiman LI, Kannan A, Edelstein AI, Hsu WK, Patel AA. Risk Factors for Prolonged Postoperative Opioid Use After Spine Surgery: A Review of Dispensation Trends From a State-run Prescription Monitoring Program. *The Journal of the American Academy of Orthopaedic Surgeons.* 2019;27(1):32-38.
19. Oleisky ER, Pennings JS, Hills J, et al. Comparing different chronic preoperative opioid use definitions on outcomes after spine surgery. *The spine journal : official journal of the North American Spine Society.* 2019;19(6):984-994.
20. Deyo RA, Hallvik SE, Hildebran C, et al. Use of prescription opioids before and after an operation for chronic pain (lumbar fusion surgery). *Pain.* 2018;159(6):1147-1154.
21. Anderson PA, Subach BR, Riew KD. Predictors of outcome after anterior cervical discectomy and fusion: a multivariate analysis. *Spine.* 2009;34(2):161-166.
22. Kelly MP, Anderson PA, Sasso RC, Riew KD. Preoperative opioid strength may not affect outcomes of anterior cervical procedures: a post hoc analysis of 2 prospective, randomized trials. *Journal of neurosurgery Spine.* 2015;23(4):484-489.
23. Ahn J, Bohl DD, Tabaraee E, Aboushaala K, Elboghdady IM, Singh K. Preoperative narcotic utilization: accuracy of patient self-reporting and its association with postoperative narcotic consumption. *Journal of neurosurgery Spine.* 2016;24(1):206-214.
24. Reid DBC, Patel SA, Shah KN, et al. Opioid-Limiting Legislation Associated with Decreased 30-Day Opioid Utilization Following Anterior Cervical Decompression and Fusion. *The spine journal : official journal of the North American Spine Society.* 2019.
25. Lawrence JT, London N, Bohlman HH, Chin KR. Preoperative narcotic use as a predictor of clinical outcome: results following anterior cervical arthrodesis. *Spine.* 2008;33(19):2074-2078.
26. Armaghani SJ, Even JL, Zern EK, Braly BA, Kang JD, Devin CJ. The Evaluation of Donor Site Pain After Harvest of Tricortical Anterior Iliac Crest Bone Graft for Spinal

Surgery: A Prospective Study. *Spine.* 2016;41(4):E191-196.
27. Kalakoti P, Volkmar AJ, Bedard NA, Eisenberg JM, Hendrickson NR, Pugely AJ. Preoperative Chronic Opioid Therapy Negatively Impacts Long-term Outcomes Following Cervical Fusion Surgery. *Spine.* 2019;44(18):1279-1286.
28. Armaghani SJ, Lee DS, Bible JE, et al. Preoperative opioid use and its association with perioperative opioid demand and postoperative opioid independence in patients undergoing spine surgery. *Spine.* 2014;39(25):E1524-1530.
29. Lall MP, Restrepo E. Predictors of Weeks to Opioid Cessation after Lumbar Fusion: A Prospective Cohort Study. *Pain management nursing : official journal of the American Society of Pain Management Nurses.* 2018;19(5):525-534.
30. Adogwa O, Davison MA, Vuong VD, et al. Reduction in Narcotic Use After Lumbar Decompression and Fusion in Patients With Symptomatic Lumbar Stenosis or Spondylolisthesis. *Global spine journal.* 2019;9(6):598-606.
31. Adogwa O, Davison MA, Vuong VD, et al. Regional Variation in Opioid Use After Lumbar Spine Surgery. *World neurosurgery.* 2019;121:e691-e699.
32. Villavicencio AT, Nelson EL, Kantha V, Burneikiene S. Prediction based on preoperative opioid use of clinical outcomes after transforaminal lumbar interbody fusions. *Journal of neurosurgery Spine.* 2017;26(2):144-149.
33. O'Donnell JA, Anderson JT, Haas AR, et al. Preoperative Opioid Use is a Predictor of Poor Return to Work in Workers' Compensation Patients After Lumbar Diskectomy. *Spine.* 2018;43(8):594-602.
34. Hassan Hashisha RK, Ali SM, Awad TE. Impact of tramadol abuse on clinical outcome of lumbar discectomy patients'. *Neurotoxicology.* 2019;75:9-13.
35. Tuna T, Boz S, Van Obbergh L, Lubansu A, Engelman E. Comparison of the Pain Sensitivity Questionnaire and the Pain Catastrophizing Scale in Predicting Postoperative Pain and Pain Chronicization After Spine Surgery. *Clinical spine surgery.* 2018;31(9):E432-e440.
36. Armaghani SJ, Archer KR, Rolfe R, Demaio DN, Devin CJ. Diabetes Is Related to Worse Patient-Reported Outcomes at Two Years Following Spine Surgery. *The Journal of bone and joint surgery American volume.* 2016;98(1):15-22.
37. Dunn LK, Yerra S, Fang S, et al. Incidence and Risk Factors for Chronic Postoperative Opioid Use After Major Spine Surgery: A Cross-Sectional Study With Longitudinal Outcome. *Anesthesia and analgesia.* 2018;127(1):247-254.
38. Hills JM, Pennings JS, Archer KR, et al. Preoperative Opioids and 1-year Patient-reported Outcomes After Spine Surgery. *Spine.* 2019;44(12):887-895.
39. Wick JB, Sivaganesan A, Chotai S, et al. Is There a Preoperative Morphine Equianalgesic Dose that Predicts Ability to Achieve a Clinically Meaningful Improvement Following Spine Surgery? *Neurosurgery.* 2018;83(2):245-251.
40. Kanaan SF, Arnold PM, Burton DC, Yeh HW, Loyd L, Sharma NK. Investigating and predicting early lumbar spine surgery outcomes. *Journal of allied health.* 2015;44(2):83-90.
41. Wright AK, Sikora M, Leveque JC. Characterizing the Risk of Long-Term Opioid Utilization in Patients Undergoing Lumbar Spine Surgery. *Spine.* 2019.
42. Albert TJ, Pinto M, Denis F. Management of symptomatic lumbar pseudarthrosis with anteroposterior fusion. A functional and radiographic outcome study. *Spine.* 2000;25(1):123-129; discussion 130.

43. O'Connell C, Azad TD, Mittal V, et al. Preoperative depression, lumbar fusion, and opioid use: an assessment of postoperative prescription, quality, and economic outcomes. *Neurosurgical focus.* 2018;44(1):E5.
44. Elsamadicy AA, Drysdale N, Adil SM, et al. Association Between Preoperative Narcotic Use with Perioperative Complication Rates, Patient Reported Pain Scores, and Ambulatory Status After Complex Spinal Fusion (>/=5 Levels) for Adult Deformity Correction. *World neurosurgery.* 2019.
45. Mesfin A, Lenke LG, Bridwell KH, et al. Does preoperative narcotic use adversely affect outcomes and complications after spinal deformity surgery? A comparison of nonnarcotic- with narcotic-using groups. *The spine journal : official journal of the North American Spine Society.* 2014;14(12):2819-2825.

Supplemental Digital Content 1. Literature searches

Search Strategies used for all PICO questions

PUBMED
((((("SPINE/SURGERY"[MESH] OR SPINE SURGER*[TIAB] OR SPINAL SURGER*[TIAB] OR SPINE PROCEDURE*[TIAB] OR "SPINAL FUSION"[MESH] OR SPINAL FUSION*[TIAB] OR SPINE FUSION*[TIAB] OR CERVICAL FUSION*[TIAB] OR THORACIC FUSION*[TIAB] OR SPINE INTERBODY FUSION*[TIAB] OR LUMBAR INTERBODY FUSION*[TIAB] OR VERTEBRAL FUSION*[TIAB] OR THORACOLUMBAR FUSION*[TIAB] OR LUMBAR FUSION*[TIAB] OR TLIF/MITLIF FUSION*[TIAB] OR SPONDYLODES*[TIAB] OR SPONDYLOSYNDES*[TIAB] OR "TOTAL DISC REPLACEMENT"[MESH] OR DISC REPLACEMENT*[TIAB] OR DISK REPLACEMENT*[TIAB] OR DISC ARTHROPLAST*[TIAB] OR DISK ARTHROPLAST*[TIAB] OR "LUMBAR VERTEBRAE/SURGERY"[MESH] OR "THORACIC VERTEBRAE/SURGERY"[MESH] OR "CERVICAL VERTEBRAE/SURGERY"[MESH] OR "FORAMINOTOMY"[MESH] OR FORAMINOTOM*[TIAB] OR "LAMINECTOMY"[MESH] OR LAMINECTOM*[TIAB] OR HEMILAMINECTOM*[TIAB] OR LAMINOTOM*[TIAB] OR "SPINAL CORD COMPRESSION/SURGERY"[MESH] OR SPINAL DECOMPRESSION*[TIAB] OR SPINE DECOMPRESSION*[TIAB] OR SPINAL CORD DECOMPRESSION*[TIAB] OR LUMBAR DECOMPRESSION*[TIAB] OR THORACIC DECOMPRESSION*[TIAB] OR CERVICAL DECOMPRESSION*[TIAB] OR "LAMINOPLASTY"[MESH] OR LAMINOPLAST*[TIAB] OR LAMINAPLAST*[TIAB] OR "DISKECTOMY"[MESH] OR DISKECTOM*[TIAB] OR DISCECTOM*[TIAB] OR ACDF[TIAB] OR "INTERVERTEBRAL DISC/SURGERY"[MESH]) OR ((SPINE STABILIZATION*[TIAB] OR SPINE STABILISATION*[TIAB] OR SPINAL STABILIZATION*[TIAB] OR SPINAL STABILISATION*[TIAB]) AND (SURGERY*[TW] OR SURGERIES*[TW] OR SURGICAL*[TW])) OR (("DECOMPRESSION, SURGICAL"[MH:noexp] OR SURGICAL DECOMPRESSION OR DECOMPRESSION SURGER*[TIAB] OR "NEUROSURGICAL PROCEDURES"[MESH:noexp] OR "ELECTIVE SURGICAL PROCEDURES"[MESH]) AND (SPINE*[TW] OR SPINAL*[TW] OR VERTEBRAE[TW] OR LUMBAR*[TW] OR

CERVICAL*[TW] OR THORACIC*[TW])))) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) AND (ADULT[MESH])))) NOT (EDITORIAL*[PT] OR LETTER*[PT] OR COMMENT*[PT]) AND (hasabstract[text] AND English[lang])) AND ((("NUTRITION THERAPY"[MESH] OR NUTRITION THERAP*[TIAB] OR NUTRITIONAL THERAP*[TIAB] OR NUTRITIONAL SUPPORT[MH] OR NUTRITION SUPPORT*[TIAB] OR NUTRITIONAL SUPPORT*[TIAB]) OR NUTRITION SUPPLEMENT* OR NUTRITIONAL SUPPLEMENT*[TIAB]) OR ("DIET THERAPY"[MESH] OR DIET THERAP*[TIAB] OR "DIET THERAPY"[SUBHEADING] OR "MALNUTRITION/DRUG THERAPY"[MESH] OR "MALNUTRITION/THERAPY"[MESH] OR DIETARY MODIFICATION*[TIAB] OR DIET MODIFICATION*[TIAB] OR DIET INTERVENTION*[TIAB] OR DIETARY INTERVENTION[TIAB])))) OR ((((("SPINE/SURGERY"[MESH] OR SPINE SURGER*[TIAB] OR SPINAL SURGER*[TIAB] OR SPINE PROCEDURE*[TIAB] OR "SPINAL FUSION"[MESH] OR SPINAL FUSION*[TIAB] OR SPINE FUSION*[TIAB] OR CERVICAL FUSION*[TIAB] OR THORACIC FUSION*[TIAB] OR SPINE INTERBODY FUSION*[TIAB] OR LUMBAR INTERBODY FUSION*[TIAB] OR VERTEBRAL FUSION*[TIAB] OR THORACOLUMBAR FUSION*[TIAB] OR LUMBAR FUSION*[TIAB] OR TLIF/MITLIF FUSION*[TIAB] OR SPONDYLODES*[TIAB] OR SPONDYLOSYNDES*[TIAB] OR "TOTAL DISC REPLACEMENT"[MESH] OR DISC REPLACEMENT*[TIAB] OR DISK REPLACEMENT*[TIAB] OR DISC ARTHROPLAST*[TIAB] OR DISK ARTHROPLAST*[TIAB] OR "LUMBAR VERTEBRAE/SURGERY"[MESH] OR "THORACIC VERTEBRAE/SURGERY"[MESH] OR "CERVICAL VERTEBRAE/SURGERY"[MESH] OR "FORAMINOTOMY"[MESH] OR FORAMINOTOM*[TIAB] OR "LAMINECTOMY"[MESH] OR LAMINECTOM*[TIAB] OR HEMILAMINECTOM*[TIAB] OR LAMINOTOM*[TIAB] OR "SPINAL CORD COMPRESSION/SURGERY"[MESH] OR SPINAL DECOMPRESSION*[TIAB] OR SPINE DECOMPRESSION*[TIAB] OR SPINAL CORD DECOMPRESSION*[TIAB] OR LUMBAR DECOMPRESSION*[TIAB] OR THORACIC DECOMPRESSION*[TIAB] OR CERVICAL DECOMPRESSION*[TIAB] OR "LAMINOPLASTY"[MESH] OR LAMINOPLAST*[TIAB] OR LAMINAPLAST*[TIAB] OR "DISKECTOMY"[MESH] OR DISKECTOM*[TIAB] OR DISCECTOM*[TIAB] OR ACDF[TIAB] OR "INTERVERTEBRAL DISC/SURGERY"[MESH]) OR ((SPINE STABILIZATION*[TIAB] OR SPINE STABILISATION*[TIAB] OR SPINAL STABILIZATION*[TIAB] OR SPINAL STABILISATION*[TIAB]) AND (SURGERY*[TW] OR SURGERIES*[TW] OR SURGICAL*[TW])) OR (("DECOMPRESSION, SURGICAL"[MH:noexp] OR SURGICAL DECOMPRESSION OR DECOMPRESSION SURGER*[TIAB] OR "NEUROSURGICAL PROCEDURES"[MESH:noexp] OR "ELECTIVE SURGICAL PROCEDURES"[MESH]) AND (SPINE*[TW] OR SPINAL*[TW] OR VERTEBRAE[TW] OR LUMBAR*[TW] OR CERVICAL*[TW] OR THORACIC*[TW])))) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) AND (ADULT[MESH])))) NOT (EDITORIAL*[PT] OR LETTER*[PT] OR COMMENT*[PT]) AND (hasabstract[text] AND English[lang])) AND (("BLOOD PROTEINS"[MESH] OR BLOOD PROTEIN*[TIAB] OR PLASMA PROTEIN*[TIAB] OR SERUM PROTEIN*[TIAB]) OR ("TRANSFERRIN"[MESH] OR TRANSFERRIN[TIAB] OR TRANSFERRINS[TIAB] OR SEROTRANSFERRIN[TIAB]

OR SIDEROPHILIN[TIAB] OR "BETA-1 METAL-BINDING GLOBULIN"[TIAB] OR ISOTRANSFERRIN[TIAB]) OR ("PREALBUMIN"[MESH] OR PREALBUMIN*[TIAB] OR "BLOOD CELL COUNT"[MESH] OR BLOOD CELL COUNT*[TIAB] OR COMPLETE BLOOD COUNT*[TIAB] OR BLOOD CELL NUMBER*[TIAB] OR LYMPHOCYTE COUNT*[TW] OR PLATELET COUNT*[TW] OR "HYPOPROTEINEMIA"[MESH] OR HYPOPROTEINEMIA[TIAB] OR "HYPOALBUMINEMIA"[MESH] OR HYPOALBUMIN*[TIAB] OR "MALNUTRITION"[MESH:noexp] OR MALNUTRITION*[TW] OR MALNOURISH*[TIAB] OR UNDERNUTRITION[TIAB] OR PROGNOSTIC NUTRITION INDEX[TIAB] OR "NUTRITION ASSESSMENT"[MESH] OR NUTRITION ASSESSMENT*[TIAB] OR NUTRITION INDEX*[TIAB] OR NUTRITIONAL ASSESSMENT*[TIAB] OR NUTRITIONAL INDEX*[TIAB] OR PROGNOSTIC NUTRITIONAL INDEX[TIAB] OR "NUTRITIONAL STATUS"[MESH] OR NUTRITIONAL STATUS*[TIAB] OR NUTRITION STATUS*[TIAB] OR NUTRITIONAL MANAGEMENT*[TIAB] OR NUTRITION MANAGEMENT*[TIAB] OR NUTRITIONAL STATE*[TIAB] OR NUTRITION STATE*[TIAB] OR "SERUM ALBUMIN"[MESH] OR ALBUMIN[TIAB] OR TRANSTHYRETIN[TIAB] OR PROALBUMIN[TIAB] OR NUTRITIONAL OPTIMIZATION*[TIAB] OR NUTRITIONAL OPTIMISATION*[TIAB] OR NUTRITION OPTIMIZATION*[TIAB] OR NUTRITION OPTIMISATION*[TIAB] OR NUTRITIONAL BIOMARKER*[TIAB] OR "NUTRITION DISORDERS"[MESH:noexp] OR NUTRITION DISORDER*[TIAB] OR NUTRITIONAL DISORDER*[TIAB] OR NUTRITIONAL RISK SCORE*[TIAB] OR (MALNUTRITION SCREENING TOOL[TIAB]) OR (MINI NUTRITIONAL ASSESSMENT[TIAB]) OR (MINI NUTRITIONAL ASSESSMENT) OR (MALNUTRITION UNIVERSAL SCREENING TOOL[TIAB]) OR (NUTRITION RISK SCREENING[TIAB]) OR (SUBJECTIVE GLOBAL ASSESSMENT[TIAB]))))) OR ((("OSTEOPOROSIS/DIET THERAPY"[MESH] OR "OSTEOPOROSIS/DRUG THERAPY"[MESH] OR "OSTEOPOROSIS/THERAPY"[MESH]) OR ((BONE MORPHOGENETIC PROTEIN*[TIAB]) OR (("ANABOLIC AGENTS/THERAPEUTIC USE"[MESH] OR ANABOLIC THERAP*[TIAB] OR ANABOLIC TREATMENT*[TIAB]) OR (ANTI-OSTEOPOROTIC AGENT*[TIAB] OR ANTIOSTEOPOROTIC AGENT*[TIAB]) OR ("ABALOPARATIDE"[SUPPLEMENTARY CONCEPT] OR ABALOPARATIDE[TIAB] OR BA058[TIAB]) OR ("PARATHYROID HORMONE/THERAPEUTIC USE"[MESH] OR PARATHYROID HORMONE THERAP*[TIAB]) OR (("DIPHOSPHONATES"[MESH] OR DIPHOSPHONATE*[TIAB] OR BISPHOSPHONATE*[TIAB]) OR (ALENDRONATE[TW] OR MK-217[TIAB] OR FOSAMAX[TIAB] OR CLODRONIC ACID[TW] OR DICHLOROMETHYLENEBISPHOSPHONATE[TIAB] OR DICHLOROMETHYLENE BIPHOSPHONATE[TIAB] OR CL2MDP[TIAB] OR DICHLOROMETHANEDIPHOSPHONATE[TIAB] OR CLODRONATE[TIAB] OR BONEFOS[TIAB] OR ETIDRONIC ACID[TW] OR HYDROXYETHYLIDENE DIPHOSPHONIC ACID[TIAB] OR ETIDRONATE*[TIAB] OR ETHANEHYDROXYDIPHOSPHONATE[TIAB] OR DICALCIUM EHDP[TIAB] OR XIDIFON[TIAB] OR XYDIPHONE[TIAB] OR XIDIPHON[TIAB] OR DIDRONEL[TIAB] OR IBANDRONIC ACID[TW] OR IBANDRONATE[TIAB] OR BONIVA[TIAB] OR BONVIVA[TIAB] OR RPR 102289A[TIAB] OR BONDRONAT[TIAB] OR BM 21.0955[TIAB] OR BM 210955[TIAB] OR BM-21.0955[TIAB] OR BM21.0955[TIAB] OR BM-210955[TIAB] OR PAMIDRONATE[TW] OR AHPRBP[TIAB] OR

AMINOPROPANEHYDROXYDIPHOSPHONATE[TIAB] OR AMIDRONATE[TIAB] OR PAMIDRONIC ACID[TIAB] OR PAMIDRONATE MONOSODIUM[TIAB] OR PAMIDRONATE CALCIUM[TIAB] OR PAMIDRONATE DISODIUM[TIAB] OR AREDIA[TIAB] OR RISEDRONIC ACID[TW] OR ATELVIA[TIAB] OR ACTONEL[TIAB] OR RISEDRONATE[TIAB] OR TECHNETIUM TC 99M MEDRONATE[TW] OR TC-99 MEDRONATE[TIAB] OR 99MTC-MDP[TIAB] OR TC-99M MDP[TIAB] OR ZOLEDRONIC ACID[TW] OR CGP 42446A[TIAB] OR CGP 42446[TIAB] OR ZOMETA[TIAB] OR ZOLEDRONATE[TIAB]) OR ("BONE DENSITY CONSERVATION AGENTS"[MESH] OR BONE DENSITY CONSERVATION AGENT*[TIAB] OR ANTIRESORPTIVE AGENT*[TIAB] OR BONE RESORPTION INHIBITOR*[TIAB] OR BONE RESORPTION INHIBITORY AGENT*[TIAB] OR ANTIRESORPTIVE DRUG*[TIAB]) OR ("25-HYDROXYVITAMIN D 2"[TW] OR ABALOPARATIDE[TW] OR ALFACALCIDOL[TW] OR BAZEDOXIFENE[TW] OR CALCIFEDIOL[TW] OR CALCITONIN[TW] OR CALCITRIOL[TW] OR CHOLECALCIFEROL[TW] OR CIMADRONATE[TW] OR DENOSUMAB[TW] OR DIHYDROTACHYSTEROL[TW] OR DIHYDROXYCHOLECALCIFEROLS[TW] OR ELDECALCITOL[TW] OR ERGOCALCIFEROLS[TW] OR HYDROXYCHOLECALCIFEROLS[TW] OR METHYLENE DIPHOSPHONATE[TW] OR NANDROLONE DECANOATE[TW] OR OLPADRONIC ACID[TW] OR RALOXIFENE HYDROCHLORIDE[TW] OR SALMON CALCITONIN[TW] OR STRONTIUM RANELATE[TW] OR TAMOXIFEN[TW] OR TERIPARATIDE[TW] OR "HPTH (1-34)"[TIAB] OR "HUMAN PARATHYROID HORMONE (1-34)"[TIAB] OR PARATHAR[TIAB] OR FORTEO[TIAB] OR TILUDRONIC ACID[TW] OR TOREMIFENE[TW] OR VITAMIN D*[TW]) OR (EVENITY[TIAB] OR AMG-785[TIAB] OR CDP 7851[TIAB] OR ROMOSOZUMAB[TIAB]))))) OR ("CALCIUM/ADMINISTRATION AND DOSAGE"[MESH]) OR (CALCIUM SUPPLEMENT*[TIAB] OR ("VITAMIN D/THERAPEUTIC USE"[MESH]) OR ("CALCIUM/THERAPEUTIC USE"[MESH]) OR ("CALCIUM CARBONATE"[MESH]))) AND ("OSTEOPOROSIS"[MESH] OR OSTEOPORO*[TW] OR OSTEOPEN*[TW] OR AGE-RELATED BONE LOSS*[TIAB] OR OSSEOUS DENSIT*[TIAB] OR "BONE DENSITY"[MESH] OR BONE DENSIT*[TIAB] OR BONE MINERAL CONTENT*[TIAB]) AND ((("SPINE/SURGERY"[MESH] OR SPINE SURGER*[TIAB] OR SPINAL SURGER*[TIAB] OR SPINE PROCEDURE*[TIAB] OR "SPINAL FUSION"[MESH] OR SPINAL FUSION*[TIAB] OR SPINE FUSION*[TIAB] OR CERVICAL FUSION*[TIAB] OR THORACIC FUSION*[TIAB] OR SPINE INTERBODY FUSION*[TIAB] OR LUMBAR INTERBODY FUSION*[TIAB] OR VERTEBRAL FUSION*[TIAB] OR THORACOLUMBAR FUSION*[TIAB] OR LUMBAR FUSION*[TIAB] OR TLIF/MITLIF FUSION*[TIAB] OR SPONDYLODES*[TIAB] OR SPONDYLOSYNDES*[TIAB] OR "TOTAL DISC REPLACEMENT"[MESH] OR DISC REPLACEMENT*[TIAB] OR DISK REPLACEMENT*[TIAB] OR DISC ARTHROPLAST*[TIAB] OR DISK ARTHROPLAST*[TIAB] OR "LUMBAR VERTEBRAE/SURGERY"[MESH] OR "THORACIC VERTEBRAE/SURGERY"[MESH] OR "CERVICAL VERTEBRAE/SURGERY"[MESH] OR "FORAMINOTOMY"[MESH] OR FORAMINOTOM*[TIAB] OR "LAMINECTOMY"[MESH] OR LAMINECTOM*[TIAB] OR HEMILAMINECTOM*[TIAB] OR LAMINOTOM*[TIAB] OR "SPINAL CORD COMPRESSION/SURGERY"[MESH] OR SPINAL DECOMPRESSION*[TIAB] OR SPINE DECOMPRESSION*[TIAB] OR SPINAL CORD DECOMPRESSION*[TIAB] OR LUMBAR

DECOMPRESSION*[TIAB] OR THORACIC DECOMPRESSION*[TIAB] OR CERVICAL DECOMPRESSION*[TIAB] OR "LAMINOPLASTY"[MESH] OR LAMINOPLAST*[TIAB] OR LAMINAPLAST*[TIAB] OR "DISKECTOMY"[MESH] OR DISKECTOM*[TIAB] OR DISCECTOM*[TIAB] OR ACDF[TIAB] OR "INTERVERTEBRAL DISC/SURGERY"[MESH]) OR ((SPINE STABILIZATION*[TIAB] OR SPINE STABILISATION*[TIAB] OR SPINAL STABILIZATION*[TIAB] OR SPINAL STABILISATION*[TIAB]) AND (SURGERY*[TW] OR SURGERIES*[TW] OR SURGICAL*[TW])) OR (("DECOMPRESSION, SURGICAL"[MH:noexp] OR SURGICAL DECOMPRESSION OR DECOMPRESSION SURGER*[TIAB] OR "NEUROSURGICAL PROCEDURES"[MESH:noexp] OR "ELECTIVE SURGICAL PROCEDURES"[MESH]) AND (SPINE*[TW] OR SPINAL*[TW] OR VERTEBRAE[TW] OR LUMBAR*[TW] OR CERVICAL*[TW] OR THORACIC*[TW]))) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) AND (ADULT[MESH])))) NOT (EDITORIAL*[PT] OR LETTER*[PT] OR COMMENT*[PT]) AND (hasabstract[text] AND English[lang]))) OR (((PREDICTIVE VALUE OF TESTS[MH] OR HOUNSFIELD UNIT*[TIAB] OR "ABSORPTIOMETRY, PHOTON"[MESH] OR PHOTON ABSORPTIOMETR*[TIAB]) OR (X-RAY DENSITOMETR*[TIAB] OR X-RAY PHOTODENSITOMETR*[TIAB] OR XRAY DENSITOMETR*[TIAB] OR SINGLE-PHOTON ABSORPTIOMETR*[TIAB] OR DUAL-ENERGY X-RAY ABSORPTIOMETRY SCAN*[TIAB] OR DXA[TIAB] OR DEXA[TIAB] OR DUAL-PHOTON ABSORPTIOMETR*[TIAB] OR DUAL-ENERGY RADIOGRAPHIC ABSORPTIOMETR*[TIAB] OR X-RAY ABSORPTIOMETR*[TIAB] OR DUAL-ENERGY X-RAY ABSORPTIOMETR*[TIAB] OR DPX ABSORPTIOMETR*[TIAB] OR DUAL X-RAY ABSORPTIOMETR*[TIAB] OR DUAL EMISSION X RAY ABSORPTIOMETR*[TIAB] OR DUAL ENERGY ROENTGEN ABSORPTIOMETR*[TIAB] OR DUAL ENERGY XRAY ABSORPTIOMETR*[TIAB] OR DUAL XRAY ABSORPTIOMETR*[TIAB] OR DUALENERGY X RAY ABSORPTIOMETR*[TIAB] OR DUEL ENERGY X RAY ABSORPTIOMETR*[TIAB] OR BONE SCAN*[TIAB] OR QUANTITATIVE COMPUTED TOMOGRAPH*[TIAB] OR QCT[TIAB] OR (X-RAY COMPUTED TOMOGRAPH*[TIAB] OR COMPUTED X RAY TOMOGRAPH*[TIAB] OR X-RAY COMPUTER ASSISTED TOMOGRAPH*[TIAB] OR X-RAY COMPUTERIZED TOMOGRAPH*[TIAB] OR CT X RAY*[TIAB] OR TOMODENSITOMETR*[TIAB] OR COMPUTED X-RAY TOMOGRAPH*[TIAB] OR XRAY COMPUTED TOMOGRAPH*[TIAB] OR X-RAY CAT SCAN*[TIAB] OR TRANSMISSION COMPUTED TOMOGRAPH*[TIAB] OR X-RAY CT SCAN*[TIAB] OR X RAY COMPUTERIZED TOMOGRAPH*[TIAB] OR CINE-CT[TIAB] OR ELECTRON BEAM COMPUTED TOMOGRAPH*[TIAB] OR ELECTRON BEAM TOMOGRAPH*[TIAB] OR X-RAY COMPUTERIZED AXIAL TOMOGRAPH*[TIAB]) OR ("TOMOGRAPHY, X-RAY COMPUTED"[MESH:noexp] OR BONE DENSITY TEST*[TIAB] OR "DIAGNOSTIC TESTS, ROUTINE"[MESH] OR DIAGNOSTIC TEST*[TIAB] OR DIAGNOSTIC STUDY[TIAB] OR DIAGNOSTIC STUDIES[TIAB] OR "DIAGNOSTIC IMAGING"[MESH:noexp] OR DIAGNOSTIC IMAGING*[TW] OR "RISK ASSESSMENT"[MESH]))) AND ("OSTEOPOROSIS"[MESH] OR OSTEOPORO*[TW] OR OSTEOPEN*[TW] OR AGE-RELATED BONE LOSS*[TIAB] OR OSSEOUS DENSIT*[TIAB] OR "BONE DENSITY"[MESH] OR BONE DENSIT*[TIAB] OR BONE

MINERAL CONTENT*[TIAB]) AND ((("SPINE/SURGERY"[MESH] OR SPINE SURGER*[TIAB] OR SPINAL SURGER*[TIAB] OR SPINE PROCEDURE*[TIAB] OR "SPINAL FUSION"[MESH] OR SPINAL FUSION*[TIAB] OR SPINE FUSION*[TIAB] OR CERVICAL FUSION*[TIAB] OR THORACIC FUSION*[TIAB] OR SPINE INTERBODY FUSION*[TIAB] OR LUMBAR INTERBODY FUSION*[TIAB] OR VERTEBRAL FUSION*[TIAB] OR THORACOLUMBAR FUSION*[TIAB] OR LUMBAR FUSION*[TIAB] OR TLIF/MITLIF FUSION*[TIAB] OR SPONDYLODES*[TIAB] OR SPONDYLOSYNDES*[TIAB] OR "TOTAL DISC REPLACEMENT"[MESH] OR DISC REPLACEMENT*[TIAB] OR DISK REPLACEMENT*[TIAB] OR DISC ARTHROPLAST*[TIAB] OR DISK ARTHROPLAST*[TIAB] OR "LUMBAR VERTEBRAE/SURGERY"[MESH] OR "THORACIC VERTEBRAE/SURGERY"[MESH] OR "CERVICAL VERTEBRAE/SURGERY"[MESH] OR "FORAMINOTOMY"[MESH] OR FORAMINOTOM*[TIAB] OR "LAMINECTOMY"[MESH] OR LAMINECTOM*[TIAB] OR HEMILAMINECTOM*[TIAB] OR LAMINOTOM*[TIAB] OR "SPINAL CORD COMPRESSION/SURGERY"[MESH] OR SPINAL DECOMPRESSION*[TIAB] OR SPINE DECOMPRESSION*[TIAB] OR SPINAL CORD DECOMPRESSION*[TIAB] OR LUMBAR DECOMPRESSION*[TIAB] OR THORACIC DECOMPRESSION*[TIAB] OR CERVICAL DECOMPRESSION*[TIAB] OR "LAMINOPLASTY"[MESH] OR LAMINOPLAST*[TIAB] OR LAMINAPLAST*[TIAB] OR "DISKECTOMY"[MESH] OR DISKECTOM*[TIAB] OR DISCECTOM*[TIAB] OR ACDF[TIAB] OR "INTERVERTEBRAL DISC/SURGERY"[MESH]) OR ((SPINE STABILIZATION*[TIAB] OR SPINE STABILISATION*[TIAB] OR SPINAL STABILIZATION*[TIAB] OR SPINAL STABILISATION*[TIAB]) AND (SURGERY*[TW] OR SURGERIES*[TW] OR SURGICAL*[TW])) OR (("DECOMPRESSION, SURGICAL"[MH:noexp] OR SURGICAL DECOMPRESSION OR DECOMPRESSION SURGER*[TIAB] OR "NEUROSURGICAL PROCEDURES"[MESH:noexp] OR "ELECTIVE SURGICAL PROCEDURES"[MESH]) AND (SPINE*[TW] OR SPINAL*[TW] OR VERTEBRAE[TW] OR LUMBAR*[TW] OR CERVICAL*[TW] OR THORACIC*[TW]))) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) AND (ADULT[MESH]))) NOT (EDITORIAL*[PT] OR LETTER*[PT] OR COMMENT*[PT]) AND (hasabstract[text] AND English[lang]))) OR ((((("SPINE/SURGERY"[MESH] OR SPINE SURGER*[TIAB] OR SPINAL SURGER*[TIAB] OR SPINE PROCEDURE*[TIAB] OR "SPINAL FUSION"[MESH] OR SPINAL FUSION*[TIAB] OR SPINE FUSION*[TIAB] OR CERVICAL FUSION*[TIAB] OR THORACIC FUSION*[TIAB] OR SPINE INTERBODY FUSION*[TIAB] OR LUMBAR INTERBODY FUSION*[TIAB] OR VERTEBRAL FUSION*[TIAB] OR THORACOLUMBAR FUSION*[TIAB] OR LUMBAR FUSION*[TIAB] OR TLIF/MITLIF FUSION*[TIAB] OR SPONDYLODES*[TIAB] OR SPONDYLOSYNDES*[TIAB] OR "TOTAL DISC REPLACEMENT"[MESH] OR DISC REPLACEMENT*[TIAB] OR DISK REPLACEMENT*[TIAB] OR DISC ARTHROPLAST*[TIAB] OR DISK ARTHROPLAST*[TIAB] OR "LUMBAR VERTEBRAE/SURGERY"[MESH] OR "THORACIC VERTEBRAE/SURGERY"[MESH] OR "CERVICAL VERTEBRAE/SURGERY"[MESH] OR "FORAMINOTOMY"[MESH] OR FORAMINOTOM*[TIAB] OR "LAMINECTOMY"[MESH] OR LAMINECTOM*[TIAB] OR HEMILAMINECTOM*[TIAB] OR LAMINOTOM*[TIAB] OR "SPINAL CORD COMPRESSION/SURGERY"[MESH] OR SPINAL DECOMPRESSION*[TIAB] OR SPINE

DECOMPRESSION*[TIAB] OR SPINAL CORD DECOMPRESSION*[TIAB] OR LUMBAR DECOMPRESSION*[TIAB] OR THORACIC DECOMPRESSION*[TIAB] OR CERVICAL DECOMPRESSION*[TIAB] OR "LAMINOPLASTY"[MESH] OR LAMINOPLAST*[TIAB] OR LAMINAPLAST*[TIAB] OR "DISKECTOMY"[MESH] OR DISKECTOM*[TIAB] OR DISCECTOM*[TIAB] OR ACDF[TIAB] OR "INTERVERTEBRAL DISC/SURGERY"[MESH]) OR ((SPINE STABILIZATION*[TIAB] OR SPINE STABILISATION*[TIAB] OR SPINAL STABILIZATION*[TIAB] OR SPINAL STABILISATION*[TIAB]) AND (SURGERY*[TW] OR SURGERIES*[TW] OR SURGICAL*[TW])) OR (("DECOMPRESSION, SURGICAL"[MH:noexp] OR SURGICAL DECOMPRESSION OR DECOMPRESSION SURGER*[TIAB] OR "NEUROSURGICAL PROCEDURES"[MESH:noexp] OR "ELECTIVE SURGICAL PROCEDURES"[MESH]) AND (SPINE*[TW] OR SPINAL*[TW] OR VERTEBRAE[TW] OR LUMBAR*[TW] OR CERVICAL*[TW] OR THORACIC*[TW]))) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) AND (ADULT[MESH]))) NOT (EDITORIAL*[PT] OR LETTER*[PT] OR COMMENT*[PT]) AND (hasabstract[text] AND English[lang])) AND (CHARLSON COMORBIDITY INDEX[TIAB] OR CHARLSON CO-MORBIDITY INDEX[TIAB] OR QUAN ADAPTATION*[TIAB] OR ELIXHAUSER COMORBIDITY INDEX[TIAB] OR ARISCAT[TIAB] OR CHARLESTON COMORBIDITY INDEX*[TIAB] OR AMERICAN SOCIETY OF ANESTHESIOLOGISTS PHYSICAL STATUS CLASSIFICATION*[TIAB] OR MODIFIED CHARLESTON COMORBIDITY INDEX*[TIAB] OR MCCI[TIAB] OR FRAILTY INDEX*[TIAB])) OR ((((("SPINE/SURGERY"[MESH] OR SPINE SURGER*[TIAB] OR SPINAL SURGER*[TIAB] OR SPINE PROCEDURE*[TIAB] OR "SPINAL FUSION"[MESH] OR SPINAL FUSION*[TIAB] OR SPINE FUSION*[TIAB] OR CERVICAL FUSION*[TIAB] OR THORACIC FUSION*[TIAB] OR SPINE INTERBODY FUSION*[TIAB] OR LUMBAR INTERBODY FUSION*[TIAB] OR VERTEBRAL FUSION*[TIAB] OR THORACOLUMBAR FUSION*[TIAB] OR LUMBAR FUSION*[TIAB] OR TLIF/MITLIF FUSION*[TIAB] OR SPONDYLODES*[TIAB] OR SPONDYLOSYNDES*[TIAB] OR "TOTAL DISC REPLACEMENT"[MESH] OR DISC REPLACEMENT*[TIAB] OR DISK REPLACEMENT*[TIAB] OR DISC ARTHROPLAST*[TIAB] OR DISK ARTHROPLAST*[TIAB] OR "LUMBAR VERTEBRAE/SURGERY"[MESH] OR "THORACIC VERTEBRAE/SURGERY"[MESH] OR "CERVICAL VERTEBRAE/SURGERY"[MESH] OR "FORAMINOTOMY"[MESH] OR FORAMINOTOM*[TIAB] OR "LAMINECTOMY"[MESH] OR LAMINECTOM*[TIAB] OR HEMILAMINECTOM*[TIAB] OR LAMINOTOM*[TIAB] OR "SPINAL CORD COMPRESSION/SURGERY"[MESH] OR SPINAL DECOMPRESSION*[TIAB] OR SPINE DECOMPRESSION*[TIAB] OR SPINAL CORD DECOMPRESSION*[TIAB] OR LUMBAR DECOMPRESSION*[TIAB] OR THORACIC DECOMPRESSION*[TIAB] OR CERVICAL DECOMPRESSION*[TIAB] OR "LAMINOPLASTY"[MESH] OR LAMINOPLAST*[TIAB] OR LAMINAPLAST*[TIAB] OR "DISKECTOMY"[MESH] OR DISKECTOM*[TIAB] OR DISCECTOM*[TIAB] OR ACDF[TIAB] OR "INTERVERTEBRAL DISC/SURGERY"[MESH]) OR ((SPINE STABILIZATION*[TIAB] OR SPINE STABILISATION*[TIAB] OR SPINAL STABILIZATION*[TIAB] OR SPINAL STABILISATION*[TIAB]) AND (SURGERY*[TW] OR SURGERIES*[TW] OR SURGICAL*[TW])) OR (("DECOMPRESSION, SURGICAL"[MH:noexp] OR SURGICAL

DECOMPRESSION OR DECOMPRESSION SURGER*[TIAB] OR "NEUROSURGICAL PROCEDURES"[MESH:noexp] OR "ELECTIVE SURGICAL PROCEDURES"[MESH]) AND (SPINE*[TW] OR SPINAL*[TW] OR VERTEBRAE[TW] OR LUMBAR*[TW] OR CERVICAL*[TW] OR THORACIC*[TW]))) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) AND (ADULT[MESH]))) NOT (EDITORIAL*[PT] OR LETTER*[PT] OR COMMENT*[PT]) AND (hasabstract[text] AND English[lang])) AND ((PULMONARY ADVERSE EVENT*[TIAB] OR LUNG ADVERSE EVENT*[TIAB] OR LUNG COMPLICATION*[TIAB] OR RESPIRATORY ADVERSE EVENT*[TIAB]) OR (("Respiratory Distress Syndrome, Adult"[Mesh] OR ADULT RESPIRATORY DISTRESS SYNDROME*[TIAB] OR ARDS[TIAB] OR LUNG SHOCK[TIAB] OR Acute Respiratory Distress Syndrome[TIAB]) OR ("Pneumonia"[Mesh] OR PNEUMONIA*[TIAB] OR PNEUMONIT*[TIAB] OR PULMONARY INFLAMMAT*[TIAB] OR LUNG INFLAMMAT*[TIAB]) OR ("Pulmonary Embolism"[Mesh] OR PULMONARY EMBOLI*[TIAB] OR PULMONARY THROMBOEMBOLI*[TIAB] OR PULMONARY INFARCTION*[TW]) OR ("Pleural Effusion"[Mesh] OR PLEURAL EFFUSION*[TIAB]) OR ("Pneumothorax"[Mesh] OR PNEUMOTHORAX*[TIAB]) OR ("Pulmonary Edema"[Mesh] OR PULMONARY EDEMA*[TIAB] OR WET LUNG*[TIAB]) OR (PULMONARY EFFUSION*[TIAB]) OR (RE-INTUBAT*[TIAB]) OR ("Respiratory Insufficiency"[Mesh] OR RESPIRATORY INSUFFICIENC*[TIAB] OR RESPIRATORY FAILURE*[TIAB] OR Ventilatory Depression*[TIAB]) OR (("Lung Diseases"[Mesh] OR LUNG DISEASE*[TIAB]) AND EXACERBAT*[TIAB]) OR (REINTUBAT*[TIAB]) OR (PROLONGED INTUBATION*[TIAB] OR "INTUBATION/ADVERSE EFFECTS"[MESH] OR "INTUBATION/COMPLICATIONS"[MESH] OR "INTUBATION/MORTALITY"[MESH]) OR (PULMONARY COMPLICATION*[TIAB]) OR (RESPIRATORY COMPLICATION*[TIAB] OR LUNG COLLAPS*[TIAB] OR PULMONARY COLLAPS*[TIAB] OR RESPIRATORY COMPROMISE*[TIAB] AND PULMONARY INFECTION*[TIAB] OR LUNG INFECTION*[TIAB] OR RESPIRATORY INFECTION*[TIAB])))) OR ((((("SPINE/SURGERY"[MESH] OR SPINE SURGER*[TIAB] OR SPINAL SURGER*[TIAB] OR SPINE PROCEDURE*[TIAB] OR "SPINAL FUSION"[MESH] OR SPINAL FUSION*[TIAB] OR SPINE FUSION*[TIAB] OR CERVICAL FUSION*[TIAB] OR THORACIC FUSION*[TIAB] OR SPINE INTERBODY FUSION*[TIAB] OR LUMBAR INTERBODY FUSION*[TIAB] OR VERTEBRAL FUSION*[TIAB] OR THORACOLUMBAR FUSION*[TIAB] OR LUMBAR FUSION*[TIAB] OR TLIF/MITLIF FUSION*[TIAB] OR SPONDYLODES*[TIAB] OR SPONDYLOSYNDES*[TIAB] OR "TOTAL DISC REPLACEMENT"[MESH] OR DISC REPLACEMENT*[TIAB] OR DISK REPLACEMENT*[TIAB] OR DISC ARTHROPLAST*[TIAB] OR DISK ARTHROPLAST*[TIAB] OR "LUMBAR VERTEBRAE/SURGERY"[MESH] OR "THORACIC VERTEBRAE/SURGERY"[MESH] OR "CERVICAL VERTEBRAE/SURGERY"[MESH] OR "FORAMINOTOMY"[MESH] OR FORAMINOTOM*[TIAB] OR "LAMINECTOMY"[MESH] OR LAMINECTOM*[TIAB] OR HEMILAMINECTOM*[TIAB] OR LAMINOTOM*[TIAB] OR "SPINAL CORD COMPRESSION/SURGERY"[MESH] OR SPINAL DECOMPRESSION*[TIAB] OR SPINE DECOMPRESSION*[TIAB] OR SPINAL CORD DECOMPRESSION*[TIAB] OR LUMBAR DECOMPRESSION*[TIAB] OR THORACIC DECOMPRESSION*[TIAB] OR CERVICAL DECOMPRESSION*[TIAB] OR "LAMINOPLASTY"[MESH] OR LAMINOPLAST*[TIAB]

OR LAMINAPLAST*[TIAB] OR "DISKECTOMY"[MESH] OR DISKECTOM*[TIAB] OR DISCECTOM*[TIAB] OR ACDF[TIAB] OR "INTERVERTEBRAL DISC/SURGERY"[MESH]) OR ((SPINE STABILIZATION*[TIAB] OR SPINE STABILISATION*[TIAB] OR SPINAL STABILIZATION*[TIAB] OR SPINAL STABILISATION*[TIAB]) AND (SURGERY*[TW] OR SURGERIES*[TW] OR SURGICAL*[TW])) OR (("DECOMPRESSION, SURGICAL"[MH:noexp] OR SURGICAL DECOMPRESSION OR DECOMPRESSION SURGER*[TIAB] OR "NEUROSURGICAL PROCEDURES"[MESH:noexp] OR "ELECTIVE SURGICAL PROCEDURES"[MESH]) AND (SPINE*[TW] OR SPINAL*[TW] OR VERTEBRAE[TW] OR LUMBAR*[TW] OR CERVICAL*[TW] OR THORACIC*[TW]))) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) AND (ADULT[MESH]))) NOT (EDITORIAL*[PT] OR LETTER*[PT] OR COMMENT*[PT]) AND (hasabstract[text] AND English[lang])) AND ("REOPERATION"[MESH] OR REOPERAT*[TIAB] OR SURGICAL REVISION[TIAB] OR REVISION SURGERY[TIAB] OR REVISION SURGERIES[TIAB] OR REPEAT SURGERY[TIAB] OR RE-OPERAT*[TIAB] OR "SECOND-LOOK SURGERY"[MESH] OR SECOND LOOK SURGER*[TIAB] OR INFECTION*[TW] OR INFECTED[TIAB]) AND ((SMOKING*[TW] OR VAPING[TW] OR "TOBACCO USE"[MESH] OR TOBACCO USE*[TIAB] OR TOBACCO CONSUMPTION*[TIAB]) OR ("BODY MASS INDEX"[MESH] OR BODY MASS INDEX*[TIAB] OR BMI[TIAB] OR QUETELET INDEX*[TIAB] OR "Obesity"[Mesh] OR OBES*[TIAB] OR "Overweight"[Mesh] OR OVERWEIGHT*[TIAB]) OR ("GLYCATED HEMOGLOBIN A"[MESH] OR GLYCATED HEMOGLOBIN A[TIAB] OR "HB A1A+B"[TIAB] OR HBA1[TIAB] OR HB A1[TIAB] OR GLYCOHEMOGLOBIN A[TIAB] OR "HEMOGLOBIN A(1)"[TIAB] OR HB A1A-2[TIAB] OR GLYCATED A1A-2 HEMOGLOBIN[TIAB] OR GLYCOSYLATED A1A-1 HEMOGLOBIN[TIAB] OR HB A1A-1[TIAB] OR GLYCATED A1B HEMOGLOBIN[TIAB] OR HB A1B[TIAB] OR GLYCOSYLATED A1B HEMOGLOBIN[TIAB] OR GLYCATED HEMOGLOBINS[TIAB] OR GLYCOSYLATED HEMOGLOBIN[TIAB] OR A1C*[TW] OR HBA1C*[TIAB] OR "DIABETES MELLITUS"[MESH] OR DIABET*[TW] OR GLUCOSE CONTROL*[TIAB] OR BLOOD SUGAR*[TIAB] OR GLYCEMIC CONTROL*[TIAB]))) OR ((((ACRYLFENTANYL[TW] OR ALFENTANIL[TW] OR ALPHAPRODINE[TW] OR BETA-CASOMORPHINS[TW] OR BUPRENORPHINE*[TW] OR BUTORPHANOL[TW] OR CARFENTANIL[TW] OR CODEINE[TW] OR CROTONYLFENTANYL[TW] OR CYCLOPROPYLFENTANYL[TW] OR DERMORPHIN[TW] OR DESOMORPHINE[TW] OR DEXTROMORAMIDE[TW] OR DEXTROPROPOXYPHENE[TW] OR DEZOCINE[TW] OR DIHYDROCODEINE[TW] OR DIHYDROMORPHINE[TW] OR DIPHENOXYLATE[TW] OR ENDOMORPHIN 1[TW] OR ENDOMORPHIN 2[TW] OR ESEROLINE[TW] OR ETHYLKETOCYCLAZOCINE[TW] OR ETHYLMORPHINE[TW] OR ETORPHINE[TW] OR FENTANYL[TW] OR HEROIN[TW] OR HYDROCODONE[TW] OR HYDROMORPHONE[TW] OR KETOBEMIDONE[TW] OR LEVORPHANOL[TW] OR LOFENTANIL[TW] OR MEPERIDINE[TW] OR MEPTAZINOL[TW] OR METHADONE[TW] OR METHADYL ACETATE[TW] OR MORPHINE[TW] OR NALBUPHINE[TW] OR NOCISTATIN[TW] OR NORMETHADONE[TW] OR O-DEMETHYLTRAMADOL[TW] OR OPIUM[TW] OR OXYCODONE[TW] OR OXYMORPHONE[TW] OR PARACYMETHADOL[TW] OR PENTAZOCINE[TW] OR PHENAZOCINE[TW] OR PHENOPERIDINE[TW] OR PIRINITRAMIDE[TW] OR

PROMEDOL[TW] OR PROTOPINE[TW] OR REMIFENTANIL[TW] OR SUFENTANIL[TW] OR TAPENTADOL[TW] OR TILIDINE[TW] OR TRAMADOL[TW]) OR ("ANALGESICS, OPIOID"[PHARMACOLOGICAL ACTION]) OR ("ANALGESICS, OPIOID"[MESH] OR OPIOID*[TW] OR OPIATE*[TW])) OR (NARCOTIC*[TW])) AND ((("SPINE/SURGERY"[MESH] OR SPINE SURGER*[TIAB] OR SPINAL SURGER*[TIAB] OR SPINE PROCEDURE*[TIAB] OR "SPINAL FUSION"[MESH] OR SPINAL FUSION*[TIAB] OR SPINE FUSION*[TIAB] OR CERVICAL FUSION*[TIAB] OR THORACIC FUSION*[TIAB] OR SPINE INTERBODY FUSION*[TIAB] OR LUMBAR INTERBODY FUSION*[TIAB] OR VERTEBRAL FUSION*[TIAB] OR THORACOLUMBAR FUSION*[TIAB] OR LUMBAR FUSION*[TIAB] OR TLIF/MITLIF FUSION*[TIAB] OR SPONDYLODES*[TIAB] OR SPONDYLOSYNDES*[TIAB] OR "TOTAL DISC REPLACEMENT"[MESH] OR DISC REPLACEMENT*[TIAB] OR DISK REPLACEMENT*[TIAB] OR DISC ARTHROPLAST*[TIAB] OR DISK ARTHROPLAST*[TIAB] OR "LUMBAR VERTEBRAE/SURGERY"[MESH] OR "THORACIC VERTEBRAE/SURGERY"[MESH] OR "CERVICAL VERTEBRAE/SURGERY"[MESH] OR "FORAMINOTOMY"[MESH] OR FORAMINOTOM*[TIAB] OR "LAMINECTOMY"[MESH] OR LAMINECTOM*[TIAB] OR HEMILAMINECTOM*[TIAB] OR LAMINOTOM*[TIAB] OR "SPINAL CORD COMPRESSION/SURGERY"[MESH] OR SPINAL DECOMPRESSION*[TIAB] OR SPINE DECOMPRESSION*[TIAB] OR SPINAL CORD DECOMPRESSION*[TIAB] OR LUMBAR DECOMPRESSION*[TIAB] OR THORACIC DECOMPRESSION*[TIAB] OR CERVICAL DECOMPRESSION*[TIAB] OR "LAMINOPLASTY"[MESH] OR LAMINOPLAST*[TIAB] OR LAMINAPLAST*[TIAB] OR "DISKECTOMY"[MESH] OR DISKECTOM*[TIAB] OR DISCECTOM*[TIAB] OR ACDF[TIAB] OR "INTERVERTEBRAL DISC/SURGERY"[MESH]) OR ((SPINE STABILIZATION*[TIAB] OR SPINE STABILISATION*[TIAB] OR SPINAL STABILIZATION*[TIAB] OR SPINAL STABILISATION*[TIAB]) AND (SURGERY*[TW] OR SURGERIES*[TW] OR SURGICAL*[TW])) OR (("DECOMPRESSION, SURGICAL"[MH:noexp] OR SURGICAL DECOMPRESSION OR DECOMPRESSION SURGER*[TIAB] OR "NEUROSURGICAL PROCEDURES"[MESH:noexp] OR "ELECTIVE SURGICAL PROCEDURES"[MESH]) AND (SPINE*[TW] OR SPINAL*[TW] OR VERTEBRAE[TW] OR LUMBAR*[TW] OR CERVICAL*[TW] OR THORACIC*[TW]))) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) NOT (("CHILD"[MESH] OR "ADOLESCENT"[MESH] OR "INFANT"[MESH]) AND (ADULT[MESH]))) NOT (EDITORIAL*[PT] OR LETTER*[PT] OR COMMENT*[PT]) AND (hasabstract[text] AND English[lang]))) Filters: Abstract

EMBASE

Query('spine surgery'/de OR 'spinal surgery':ti,ab OR 'spinal surgeries':ti,ab OR 'discectomy'/exp OR discectom*:ti,ab OR diskectom*:ti,ab OR 'laminectomy'/exp OR laminectom*:ti,ab OR hemilaminectom*:ti,ab OR laminotom*:ti,ab OR 'laminoplasty'/exp OR laminoplast*:ti,ab OR laminaplast*:ti,ab OR 'spine fusion'/exp OR 'spine fusion':ti,ab OR 'spinal fusion':ti,ab OR spondylodesis:ti,ab OR spondylosyndesis:ti,ab OR 'posterior lumbar interbody fusion':ti,ab,de OR 'spine interbody fusion':ti,ab OR 'cervical fusion':ti,ab OR 'thoracic fusion':ti,ab OR 'lumbar interbody fusion':ti,ab OR 'vertebral fusion':ti,ab OR 'thoracolumbar fusion':ti,ab OR 'lumbar fusion':ti,ab OR 'tlif/mitlif fusion':ti,ab OR 'total disc replacement'/exp OR 'disc

replacement':ti,ab OR 'disk replacement':ti,ab OR 'disc arhtroplasty':ti,ab OR 'disk arthroplasty':ti,ab OR 'foraminotomy'/exp OR foraminotom*:ti,ab OR 'spinal cord decompression'/exp OR 'spinal cord decompression':ti,ab OR 'spinal decompression':ti,ab OR 'spinal cord compression surgery':ti,ab OR 'spinal compression surgery':ti,ab OR 'lumbar decompression':ti,ab OR 'thoracic decompression':ti,ab OR 'cervical decompression':ti,ab OR 'spine stabilization'/exp OR 'spine stabilisation':ti,ab OR 'spine fixation':ti,ab OR (('spinal stabilisation':ti,ab OR 'spinal stabilization':ti,ab) AND (surger*:ti,ab,de OR surgical*:ti,ab,de)) OR ('decompression surgery'/de AND (spine*:ti,ab,de OR spinal:ti,ab,de)) OR 'spinal cord surgery'/de OR ('spine'/exp AND 'surgery'/lnk)) AND [embase]/lim NOT ([embase]/lim AND [medline]/lim) AND ('article'/it OR 'article in press'/it OR 'review'/it) NOT ('animal'/exp NOT ('animal'/exp AND 'human'/exp)) NOT ('juvenile'/exp NOT ('juvenile'/exp AND 'adult'/exp)) AND [english]/lim NOT ('editorial'/exp OR 'letter'/exp) AND [abstracts]/lim NOT 'case report'/exp AND ('opiate agonist'/exp OR opioid*:ti,ab OR 'opiate receptor agonist':ti,ab OR 'opiate receptor stimulant':ti,ab OR 'opiate receptor stimulating agent':ti,ab OR 'opiate receptor stimulator':ti,ab OR ((acetorphine:ti,ab,de OR acetylcodeine:ti,ab,de OR acetylmethadol:ti,ab,de OR alphacetylmethadol:ti,ab,de OR alphaprodine:ti,ab,de OR anileridine:ti,ab,de OR apadoline:ti,ab,de OR asalhydromorphone:ti,ab,de OR asimadoline:ti,ab,de OR azidomorphine:ti,ab,de OR benzhydrocodone:ti,ab,de OR bezitramide:ti,ab,de OR bombesin:ti,ab,de OR bremazocine:ti,ab,de OR buprenorphine:ti,ab,de OR capporphin:ti,ab,de OR cebranopadol:ti,ab,de OR ciramadol:ti,ab,de OR cocodamol:ti,ab,de OR codeine:ti,ab,de OR codipront:ti,ab,de OR codydramol:ti,ab,de OR conorfone:ti,ab,de OR cyclorphan:ti,ab,de OR deltakephalin:ti,ab,de OR deltorphin:ti,ab,de OR dermorphin:ti,ab,de OR desmetramadol:ti,ab,de OR dexoxadrol:ti,ab,de OR dextromoramide:ti,ab,de OR dextropropoxyphene:ti,ab,de OR dextrorphan:ti,ab,de OR dezocine:ti,ab,de OR diamorphine:ti,ab,de OR diconal:ti,ab,de OR dihydrocodeine:ti,ab,de OR dihydroetorphine:ti,ab,de OR dihydromorphine:ti,ab,de OR dimethylthiambutene:ti,ab,de OR dipipanone:ti,ab,de OR drotebanol:ti,ab,de OR eledoisin:ti,ab,de OR eluxadoline:ti,ab,de OR enadoline:ti,ab,de OR eptazocine:ti,ab,de OR ethylketazocine:ti,ab,de OR ethylmorphine:ti,ab,de OR etonitazene:ti,ab,de OR etorphine:ti,ab,de OR etoxeridine:ti,ab,de OR fentanyl:ti,ab,de OR frakefamide:ti,ab,de OR furethidine:ti,ab,de OR galanin:ti,ab,de OR hydrocodone:ti,ab,de OR hydromorphone:ti,ab,de OR isomethadone:ti,ab,de OR kassinin:ti,ab,de OR kentsin:ti,ab,de OR ketazocine:ti,ab,de OR ketobemidone:ti,ab,de OR ketogan:ti,ab,de OR kyotorphin:ti,ab,de OR lefetamine:ti,ab,de OR leumorphin:ti,ab,de OR levacetylmethadol:ti,ab,de OR levomethadone:ti,ab,de OR levopropoxyphene:ti,ab,de OR levorphanol:ti,ab,de OR levoxadrol:ti,ab,de OR lexanopadol:ti,ab,de OR lobradimil:ti,ab,de OR meptazinol:ti,ab,de OR metazocine:ti,ab,de OR metenkephalin:ti,ab,de OR metenkephalinamide:ti,ab,de OR methadone:ti,ab,de OR metkephamid:ti,ab,de OR morphiceptin:ti,ab,de OR morphine:ti,ab,de OR morphinomimetic) AND agent:ti,ab,de) OR morphinone:ti,ab,de OR nalbuphine:ti,ab,de OR nalfurafine:ti,ab,de OR naloxone:ti,ab,de OR naltalimide:ti,ab,de OR neurotensin:ti,ab,de OR nicocodine:ti,ab,de OR nicomorphine:ti,ab,de OR nifalatide:ti,ab,de OR niravoline:ti,ab,de OR noracymethadol:ti,ab,de OR norbuprenorphine:ti,ab,de OR nordextropropoxyphene:ti,ab,de OR normorphine:ti,ab,de OR norpethidine:ti,ab,de OR norpropoxyphene:ti,ab,de OR obinepitide:ti,ab,de OR opiate:ti,ab,de OR oripavine:ti,ab,de OR oxycodone:ti,ab,de OR oxymorphone:ti,ab,de OR paregoric:ti,ab,de OR pentamorphone:ti,ab,de OR pethidine:ti,ab,de OR phenadoxone:ti,ab,de OR phenaridine:ti,ab,de OR phenazocine:ti,ab,de OR phencyclidine:ti,ab,de OR phenoperidine:ti,ab,de OR physalaemin:ti,ab,de OR picenadol:ti,ab,de OR piminodine:ti,ab,de

OR piritramide:ti,ab,de OR preprodynorphin:ti,ab,de OR preproenkephalin:ti,ab,de OR prodynorphin:ti,ab,de OR proenkephalin:ti,ab,de OR profadol:ti,ab,de OR propiram:ti,ab,de OR racemorphan:ti,ab,de OR sameridine:ti,ab,de OR semorphone:ti,ab,de OR senktide:ti,ab,de OR septide:ti,ab,de OR spiradoline:ti,ab,de OR tachykinin:ti,ab,de OR tapentadol:ti,ab,de OR thebaine:ti,ab,de OR tifluadom:ti,ab,de OR tilidine:ti,ab,de OR tonazocine:ti,ab,de OR trimeperidine:ti,ab,de OR urotensin:ti,ab,de OR narcotic*:ti,ab OR 'plasma protein'/exp OR 'plasma protein':ti,ab OR 'blood protein':ti,ab OR 'serum protein':ti,ab OR 'plasma glycoprotein':ti,ab OR plasmatein:ti,ab OR 'transferrin'/exp OR 'transferrin*':ti,ab OR transferrinemia:ti,ab OR serotransferrin*:ti,ab OR siderophilin*:ti,ab OR 'beta-1 metal-binding globulin':ti,ab OR isotransferrin*:ti,ab OR 'prealbumin blood level'/exp OR prealbumin*:ti,ab OR 'transthyretin'/exp OR transthyretin*:ti,ab OR 'pre albumin':ti,ab OR 'sr 270258':ti,ab OR 'pre-albumin':ti,ab OR 'blood cell count'/exp OR 'blood cell count':ti,ab OR 'complete blood count':ti,ab OR 'blood cell number':ti,ab OR 'erythrocyte count':ti,ab OR 'leukocyte count':ti,ab OR 'platelet count':ti,ab OR 'platelet distribution width':ti,ab OR 'red blood cell distribution width':ti,ab OR 'reticulocyte count':ti,ab OR 'hypoproteinemia'/exp OR hypoproteinem*:ti,ab OR hypoproteinaem*:ti,ab OR 'hypoalbuminemia'/exp OR hypoalbuminem*:ti,ab OR hypalbuminaem*:ti,ab OR hypalbuminem*:ti,ab OR hypoalbuminaem*:ti,ab OR 'malnutrition'/exp OR 'malnutrition':ti,ab OR 'deficient nutrition':ti,ab OR malnourish*:ti,ab OR underfeeding:ti,ab OR undernourish*:ti,ab OR 'undernutrition' OR underfed*:ti,ab OR 'prognostic nutritional index'/exp OR 'prognostic nutritional index':ti,ab OR 'prognostic nutrition index':ti,ab OR 'nutritional assessment'/exp OR 'nutritional assessment':ti,ab OR 'nutrition assessment':ti,ab OR 'dietary assessment':ti,ab OR 'dietary evaluation':ti,ab OR 'nutritional evaluation':ti,ab OR 'nutrition indexes'/exp OR 'nutrition indexes':ti,ab OR 'nutrition index':ti,ab OR 'nutritional status'/exp OR 'nutritional status':ti,ab OR 'nutrition status':ti,ab OR 'nutrition state':ti,ab OR 'nutritional state':ti,ab OR eutrophia:ti,ab OR 'nutritional management':ti,ab OR 'nutrition management':ti,ab OR 'serum albumin'/exp OR 'serum albumin':ti,ab OR albumisol:ti,ab OR 'blood albumin':ti,ab OR 'plasma albumen':ti,ab OR 'plasma albumin':ti,ab OR 'serum albumine':ti,ab OR 'albumin'/exp OR 'albumin':ti,ab OR albumen:ti,ab OR 'proalbumin'/exp OR 'proalbumin':ti,ab OR 'nutritional biomarker':ti,ab OR 'nutrition biomarker':ti,ab OR 'nutritional disorder'/de OR 'nutritional disorder':ti,ab OR 'nutritional deficiency':ti,ab,de OR 'nutrition deficiency':ti,ab OR 'nutrition deficient':ti,ab OR 'nutritional risk score'/exp OR 'nutritional risk score':ti,ab OR 'nutrition risk score':ti,ab OR 'malnutrition screening tool'/exp OR 'malnutrition screening tool':ti,ab OR 'mini nutritional assessment'/exp OR 'mini nutritional assessment':ti,ab OR 'malnutrition universal screening tool'/exp OR 'malnutrition universal screening tool':ti,ab OR 'nutrition risk screening 2002'/exp OR 'nutrition risk screening':ti,ab OR 'subjective global assessment'/exp OR 'subjective global assessment':ti,ab OR ('nutrition'/exp AND 'therapy'/lnk) OR 'nutrition therapy':ti,ab OR 'nutritional therapy':ti,ab OR 'diet therapy'/exp OR 'diet therapy':ti,ab OR 'diet intervention':ti,ab OR 'diet treatment':ti,ab OR 'dietary intervention':ti,ab OR 'dietary therapy':ti,ab OR 'dietary treatment':ti,ab OR 'nutritional support'/exp OR 'nutritional support':ti,ab OR 'nutrition support':ti,ab OR 'nutrition supplement'/exp OR 'nutrition supplement':ti,ab OR 'nutritional supplement':ti,ab OR ('malnutrition'/exp AND ('drug therapy'/lnk OR 'therapy'/lnk)) OR 'dietary modification':ti,ab OR ('lungs'/exp AND 'complication'/lnk) OR (pulmonary:ti,ab,de AND 'complication'/lnk) OR 'pulmonary adverse event':ti,ab OR 'respiratory adverse event':ti,ab OR 'respiratory distress'/exp OR 'respiratory distress':ti,ab OR 'respiration distress':ti,ab OR ards:ti,ab OR 'lung shock':ti,ab OR 'pneumonia'/exp OR 'pneumonia':ti,ab OR 'inflammatory lung

disease':ti,ab OR lobitis:ti,ab OR peripneumonia:ti,ab OR pleuropneumonitis:ti,ab OR 'pneumonic lung':ti,ab OR 'pneumonic pleurisy':ti,ab OR 'pneumonic pleuritis':ti,ab OR pneumonitis:ti,ab OR 'pulmonal inflammation':ti,ab OR 'pulmonary inflammation':ti,ab OR 'pulmonic inflammation':ti,ab OR pneumonit*:ti,ab OR 'lung inflammation':ti,ab OR 'lung embolism'/exp OR 'lung embolism':ti,ab OR 'lung emboli':ti,ab OR 'pulmonary embolism':ti,ab OR 'pulmonary emboli':ti,ab OR 'lung embolization':ti,ab OR 'lung embolus':ti,ab OR 'lung emboly':ti,ab OR 'lung microembolism':ti,ab OR 'lung microembolization':ti,ab OR 'lung microembolus':ti,ab OR 'lung thromboembolism':ti,ab OR 'pulmonary embolization':ti,ab OR 'pulmonary embolus':ti,ab OR 'pulmonary microembolism':ti,ab OR 'pulmonary thromboembolic disease':ti,ab OR 'pulmonary thromboembolism':ti,ab OR 'lung infarction'/exp OR 'lung infarction':ti,ab OR 'pulmonary infarction':ti,ab OR 'lung infarct':ti,ab OR 'pulmonary infarct':ti,ab OR 'pleura effusion'/exp OR 'pleura effusion':ti,ab OR 'pleural effusion':ti,ab OR pleurorrhea:ti,ab OR pleurorrhoea:ti,ab OR 'pneumothorax'/exp OR 'pneumothorax':ti,ab OR 'lung edema'/exp OR 'lung edema':ti,ab OR 'pulmonary edema':ti,ab OR 'lung oedema':ti,ab OR 'pulmonary oedema':ti,ab OR 'lung interstitial edema':ti,ab OR 'lung interstitial oedema':ti,ab OR 'wet lung':ti,ab OR 'pulmonary effusion':ti,ab OR 'reintubation'/exp OR reintubat*:ti,ab OR 'respiratory failure'/exp OR 'respiratory failure':ti,ab OR 'respiration deficiency':ti,ab OR 'respiration disturbance':ti,ab OR 'respiration failure':ti,ab OR 'respiration insufficiency':ti,ab OR 'respiratory deficiency':ti,ab OR 'respiratory disturbance':ti,ab OR 'respiratory dysfunction':ti,ab OR 'respiratory insufficiency':ti,ab OR 'respiratory tract insufficiency':ti,ab OR 'lung insufficiency':ti,ab OR 'respiratory arrest':ti,ab OR 'ventilatory depression':ti,ab OR ('lung disease' NEAR/3 exacerbat*) OR 'prolonged intubation':ti,ab OR (('intubation'/exp OR intubat*:ti,ab) AND 'complication'/lnk) OR (respiratory:ti,ab AND 'complication'/lnk) OR 'lung collapse':ti,ab OR 'pulmonary collapse':ti,ab OR 'respiratory compromise':ti,ab OR 'lung compromise':ti,ab OR 'lung infection'/exp OR 'lung infection':ti,ab OR 'pulmonary infection':ti,ab OR 'pulmonic infection':ti,ab OR 'respiratory infection':ti,ab,de OR 'charlson comorbidity index'/exp OR 'charlson comorbidity index':ti,ab OR 'charlson comorbidity score':ti,ab OR 'charlson index':ti,ab OR 'charlson co-morbidity index':ti,ab OR 'quan adaptation':ti,ab OR 'elixhauser comorbidity index'/exp OR 'elixhauser comorbidity index':ti,ab OR 'elixhauser (co morbidity)':ti,ab OR 'elixhauser (comorbidity)':ti,ab OR 'elixhauser (score)':ti,ab OR 'elixhauser index':ti,ab OR ariscat:ti,ab OR 'charleston comorbidity index':ti,ab OR 'american society of anesthesiologists physical status classification'/exp OR 'american society of anesthesiologists physical status classification':ti,ab OR mcci:ti,ab OR 'frailty index'/exp OR 'frailty index':ti,ab) OR (('spine surgery'/de OR 'spinal surgery':ti,ab OR 'spinal surgeries':ti,ab OR 'discectomy'/exp OR discectom*:ti,ab OR diskectom*:ti,ab OR 'laminectomy'/exp OR laminectom*:ti,ab OR hemilaminectom*:ti,ab OR laminotom*:ti,ab OR 'laminoplasty'/exp OR laminoplast*:ti,ab OR laminaplast*:ti,ab OR 'spine fusion'/exp OR 'spine fusion':ti,ab OR 'spinal fusion':ti,ab OR spondylodesis:ti,ab OR spondylosyndesis:ti,ab OR 'posterior lumbar interbody fusion':ti,ab,de OR 'spine interbody fusion':ti,ab OR 'cervical fusion':ti,ab OR 'thoracic fusion':ti,ab OR 'lumbar interbody fusion':ti,ab OR 'vertebral fusion':ti,ab OR 'thoracolumbar fusion':ti,ab OR 'lumbar fusion':ti,ab OR 'tlif/mitlif fusion':ti,ab OR 'total disc replacement'/exp OR 'disc replacement':ti,ab OR 'disk replacement':ti,ab OR 'disc arhtroplasty':ti,ab OR 'disk arthroplasty':ti,ab OR 'foraminotomy'/exp OR foraminotom*:ti,ab OR 'spinal cord decompression'/exp OR 'spinal cord decompression':ti,ab OR 'spinal decompression':ti,ab OR 'spinal cord compression surgery':ti,ab OR 'spinal compression surgery':ti,ab OR 'lumbar decompression':ti,ab OR 'thoracic decompression':ti,ab OR 'cervical decompression':ti,ab OR

'spine stabilization'/exp OR 'spine stabilisation':ti,ab OR 'spine fixation':ti,ab OR (('spinal stabilisation':ti,ab OR 'spinal stabilization':ti,ab) AND (surger*:ti,ab,de OR surgical*:ti,ab,de)) OR ('decompression surgery'/de AND (spine*:ti,ab,de OR spinal:ti,ab,de)) OR 'spinal cord surgery'/de OR ('spine'/exp AND 'surgery'/lnk)) AND [embase]/lim NOT ([embase]/lim AND [medline]/lim) AND ('article'/it OR 'article in press'/it OR 'review'/it) NOT ('animal'/exp NOT ('animal'/exp AND 'human'/exp)) NOT ('juvenile'/exp NOT ('juvenile'/exp AND 'adult'/exp)) AND [english]/lim NOT ('editorial'/exp OR 'letter'/exp) AND [abstracts]/lim NOT 'case report'/exp AND ('reoperation'/exp OR reoperat*:ti,ab OR 'revision surgery'/exp OR 'revision surgery':ti,ab OR 'surgical revision':ti,ab OR 'revision surgeries':ti,ab OR 'repeat surgery':ti,ab OR 'repeat surgeries':ti,ab OR 're-operation':ti,ab OR 'second look surgery'/exp OR 'second look surgery':ti,ab OR 'reentry surgery':ti,ab OR 'second look operation':ti,ab OR 'infection'/exp OR infect*:ti,ab,de OR (revision NEAR/3 (surgery OR surgeries OR surgical))) AND ('diabetes mellitus'/exp OR diabet*:ti,ab,de OR 'glycemic control'/exp OR 'glycemic control':ti,ab OR 'glucose blood level'/exp OR 'blood sugar':ti,ab OR 'serum glucose':ti,ab OR 'hyperglycemia'/exp OR hyperglycemi*:ti,ab OR 'hemoglobin a1c'/exp OR a1c:ti,ab OR 'haemoglobin a 1c':ti,ab OR 'haemoglobin a (1c)':ti,ab OR 'hb a (1c)':ti,ab OR 'hba 1c':ti,ab OR 'hba1c':ti,ab OR 'hemoglobin a 1c':ti,ab OR 'hemoglobin a (1c)':ti,ab OR 'obesity'/exp OR obes*:ti,ab,de OR overweight:ti,ab,de OR 'smoking'/exp OR smoking:ti,ab OR smoker*:ti,ab OR 'vaping'/exp OR 'vaping':ti,ab OR 'tobacco use'/de OR 'tobacco use':ti,ab OR 'tobacco usage':ti,ab OR 'tobacco consumption':ti,ab)) OR (('spine surgery'/de OR 'spinal surgery':ti,ab OR 'spinal surgeries':ti,ab OR 'discectomy'/exp OR discectom*:ti,ab OR diskectom*:ti,ab OR 'laminectomy'/exp OR laminectom*:ti,ab OR hemilaminectom*:ti,ab OR laminotom*:ti,ab OR 'laminoplasty'/exp OR laminoplast*:ti,ab OR laminaplast*:ti,ab OR 'spine fusion'/exp OR 'spine fusion':ti,ab OR 'spinal fusion':ti,ab OR spondylodesis:ti,ab OR spondylosyndesis:ti,ab OR 'posterior lumbar interbody fusion':ti,ab,de OR 'spine interbody fusion':ti,ab OR 'cervical fusion':ti,ab OR 'thoracic fusion':ti,ab OR 'lumbar interbody fusion':ti,ab OR 'vertebral fusion':ti,ab OR 'thoracolumbar fusion':ti,ab OR 'lumbar fusion':ti,ab OR 'tlif/mitlif fusion':ti,ab OR 'total disc replacement'/exp OR 'disc replacement':ti,ab OR 'disk replacement':ti,ab OR 'disc arhtroplasty':ti,ab OR 'disk arthroplasty':ti,ab OR 'foraminotomy'/exp OR foraminotom*:ti,ab OR 'spinal cord decompression'/exp OR 'spinal cord decompression':ti,ab OR 'spinal decompression':ti,ab OR 'spinal cord compression surgery':ti,ab OR 'spinal compression surgery':ti,ab OR 'lumbar decompression':ti,ab OR 'thoracic decompression':ti,ab OR 'cervical decompression':ti,ab OR 'spine stabilization'/exp OR 'spine stabilisation':ti,ab OR 'spine fixation':ti,ab OR (('spinal stabilisation':ti,ab OR 'spinal stabilization':ti,ab) AND (surger*:ti,ab,de OR surgical*:ti,ab,de)) OR ('decompression surgery'/de AND (spine*:ti,ab,de OR spinal:ti,ab,de)) OR 'spinal cord surgery'/de OR ('spine'/exp AND 'surgery'/lnk)) AND [embase]/lim NOT ([embase]/lim AND [medline]/lim) AND ('article'/it OR 'article in press'/it OR 'review'/it) NOT ('animal'/exp NOT ('animal'/exp AND 'human'/exp)) NOT ('juvenile'/exp NOT ('juvenile'/exp AND 'adult'/exp)) AND [english]/lim NOT ('editorial'/exp OR 'letter'/exp) AND [abstracts]/lim NOT 'case report'/exp AND ('osteoporosis'/exp OR 'osteoporo*':ti,ab OR 'age-related bone loss':ti,ab OR 'pathologic decalcification':ti,ab OR 'osteopenia'/exp OR osteopen*:ti,ab OR 'bone density'/exp OR 'bone density':ti,ab OR 'bone mineral density':ti,ab OR 'osseous density':ti,ab OR 'bone mineral content':ti,ab) AND ('hounsfield unit'/exp OR 'hounsfield unit':ti,ab OR 'bone scintiscanning'/de OR 'bone scintiscanning':ti,ab OR 'bone scan':ti,ab OR 'spine scintiscanning'/exp OR 'spine scintiscanning':ti,ab OR 'bone scanning':ti,ab OR 'bone scintigram':ti,ab OR 'bone scintigraphy':ti,ab OR 'bone scintimetry':ti,ab OR

osteoscintigraph*:ti,ab OR 'skeletal scintigraphy':ti,ab OR 'skeleton scanning':ti,ab OR 'skeleton scintigraphy':ti,ab OR 'skeleton scintiscanning':ti,ab OR 'absorptiometry'/exp OR absorptiometr*:ti,ab,de OR 'radiodensitometry'/exp OR radiodensitometr*:ti,ab OR 'radiologic densitometry':ti,ab OR 'roentgen densimetry':ti,ab OR 'roentgen densitometry':ti,ab OR 'roentgendensimetry':ti,ab OR tomodensitometry:ti,ab OR 'x-ray densitometry':ti,ab OR dexa:ti,ab OR dxa:ti,ab OR 'quantitative computed tomography'/exp OR 'quantitative computed tomography':ti,ab OR qct:ti,ab OR 'x-ray computed tomography'/exp OR 'x-ray computed tomography':ti,ab OR 'ct scan':ti,ab OR 'ct scanning':ti,ab OR 'ct x-ray':ti,ab OR tomodensitometr*:ti,ab OR 'xray computed tomography':ti,ab OR 'x-ray cat scan':ti,ab OR 'transmission computed tomography':ti,ab OR 'x-ray ct scan':ti,ab OR 'cine-ct':ti,ab OR 'electron beam tomography'/exp OR 'electron beam tomography':ti,ab OR 'electron beam computed tomography':ti,ab OR 'x-ray computerized axial tomography':ti,ab OR 'bone density test':ti,ab OR 'bone density testing':ti,ab OR 'diagnostic imaging'/exp OR 'diagnostic imaging':ti,ab OR 'medical imaging':ti,ab)) OR (('spine surgery'/de OR 'spinal surgery':ti,ab OR 'spinal surgeries':ti,ab OR 'discectomy'/exp OR discectom*:ti,ab OR diskectom*:ti,ab OR 'laminectomy'/exp OR laminectom*:ti,ab OR hemilaminectom*:ti,ab OR laminotom*:ti,ab OR 'laminoplasty'/exp OR laminoplast*:ti,ab OR laminaplast*:ti,ab OR 'spine fusion'/exp OR 'spine fusion':ti,ab OR 'spinal fusion':ti,ab OR spondylodesis:ti,ab OR spondylosyndesis:ti,ab OR 'posterior lumbar interbody fusion':ti,ab,de OR 'spine interbody fusion':ti,ab OR 'cervical fusion':ti,ab OR 'thoracic fusion':ti,ab OR 'lumbar interbody fusion':ti,ab OR 'vertebral fusion':ti,ab OR 'thoracolumbar fusion':ti,ab OR 'lumbar fusion':ti,ab OR 'tlif/mitlif fusion':ti,ab OR 'total disc replacement'/exp OR 'disc replacement':ti,ab OR 'disk replacement':ti,ab OR 'disc arhtroplasty':ti,ab OR 'disk arthroplasty':ti,ab OR 'foraminotomy'/exp OR foraminotom*:ti,ab OR 'spinal cord decompression'/exp OR 'spinal cord decompression':ti,ab OR 'spinal decompression':ti,ab OR 'spinal cord compression surgery':ti,ab OR 'spinal compression surgery':ti,ab OR 'lumbar decompression':ti,ab OR 'thoracic decompression':ti,ab OR 'cervical decompression':ti,ab OR 'spine stabilization'/exp OR 'spine stabilisation':ti,ab OR 'spine fixation':ti,ab OR (('spinal stabilisation':ti,ab OR 'spinal stabilization':ti,ab) AND (surger*:ti,ab,de OR surgical*:ti,ab,de)) OR ('decompression surgery'/de AND (spine*:ti,ab,de OR spinal:ti,ab,de)) OR 'spinal cord surgery'/de OR ('spine'/exp AND 'surgery'/lnk)) AND [embase]/lim NOT ([embase]/lim AND [medline]/lim) AND ('article'/it OR 'article in press'/it OR 'review'/it) NOT ('animal'/exp NOT ('animal'/exp AND 'human'/exp)) NOT ('juvenile'/exp NOT ('juvenile'/exp AND 'adult'/exp)) AND [english]/lim NOT ('editorial'/exp OR 'letter'/exp) AND [abstracts]/lim NOT 'case report'/exp AND ('osteoporosis'/exp OR 'osteoporo*':ti,ab OR 'age-related bone loss':ti,ab OR 'pathologic decalcification':ti,ab OR 'osteopenia'/exp OR osteopen*:ti,ab OR 'bone density'/exp OR 'bone density':ti,ab OR 'bone mineral density':ti,ab OR 'osseous density':ti,ab OR 'bone mineral content':ti,ab) AND ('osteoporosis'/exp AND ('drug therapy'/lnk OR 'therapy'/lnk) OR 'bone morphogenetic protein'/exp OR 'bone morphogenetic protein':ti,ab OR 'bone morphogenic protein':ti,ab OR ('anabolic agent'/exp AND ('drug therapy'/lnk OR 'therapy'/lnk)) OR 'anabolic therapy':ti,ab OR 'anabolic treatment':ti,ab OR 'antiosteoporotic agent'/exp OR 'antiosteoporotic agent':ti,ab OR 'anti-osteoporotic agent':ti,ab OR 'bone density conservation agent'/exp OR 'bone density conservation agent':ti,ab OR 'antiresorptive agent'/exp OR 'abaloparatide'/exp OR 'abaloparatide':ti,ab OR eladynos:ti,ab OR tymlos:ti,ab OR ('parathyroid hormone derivative'/exp AND ('drug therapy'/lnk OR 'therapy'/lnk)) OR 'parathyroid hormone therapy':ti,ab OR 'bisphosphonic acid derivative'/exp OR 'bisphosphonic acid derivative':ti,ab OR diphosphonate*:ti,ab OR bisphosphonate*:ti,ab OR

'diphosphonic acid derivative':ti,ab OR 'alendronic acid':ti,ab,de OR 'aminobutanediphosphonic acid':ti,ab,de OR 'aminohexanediphosphonic acid':ti,ab,de OR 'aminopropanediphosphonic acid':ti,ab,de OR belfosdil:ti,ab,de OR 'butedronate technetium tc 99m':ti,ab,de OR 'butedronic acid':ti,ab,de OR 'calcium carbonate':ti,ab,de OR cangrelor:ti,ab,de OR 'clodronic acid':ti,ab,de OR 'etidronic acid':ti,ab,de OR 'ibandronic acid':ti,ab,de OR 'incadronic acid':ti,ab,de OR 'lidadronic acid':ti,ab,de OR 'medronic acid':ti,ab,de OR 'minodronic acid':ti,ab,de OR 'neridronic acid':ti,ab,de OR 'olpadronic acid':ti,ab,de OR 'pamidronic acid':ti,ab,de OR 'risedronic acid':ti,ab,de OR 'tiludronic acid':ti,ab,de OR 'zoledronic acid':ti,ab,de OR alendronate:ti,ab OR fosamax*:ti,ab OR cl2mdp:ti,ab OR 'mk-271':ti,ab OR clodronate*:ti,ab OR bonefos*:ti,ab OR 'hydroxyethylidene diphosphonic acid':ti,ab OR etidronate*:ti,ab OR ethanehydroxydiphosphonate*:ti,ab OR xidifon:ti,ab OR xydiphone:ti,ab OR xidiphon:ti,ab OR didronel:ti,ab OR ibandronate:ti,ab OR boniva:ti,ab OR bonviva:ti,ab OR 'rpr 102289a':ti,ab,de OR bondronat*:ti,ab,de OR 'bm 21.0955':ti,ab,de OR 'bm 210955':ti,ab,de OR 'bm-21.0955':ti,ab,de OR 'bm21.0955':ti,ab,de OR 'bm-210955':ti,ab,de OR pamidronate:ti,ab,de OR ahprbp:ti,ab,de OR aminopropanehydroxydiphosphonate:ti,ab,de OR amidronate:ti,ab,de OR pamidronate*:ti,ab OR aredia:ti,ab OR atelvia:ti,ab OR actonel:ti,ab OR risedronate:ti,ab OR 'technetium 99m'/exp OR 'technetium 99m':ti,ab OR 'medronate technetium tc 99m'/exp OR 'medronate technetium tc 99m':ti,ab OR '99mtc-mdp':ti,ab OR 'tc-99m mdp':ti,ab OR zolendrate:ti,ab OR 'cgp 42446a':ti,ab OR 'cgp 42446':ti,ab OR zometa:ti,ab OR 'antiresorptive agent':ti,ab OR 'bone resorption inhibitor':ti,ab OR 'bone resorption inhibitory agent':ti,ab OR 'antiresorptive drug':ti,ab OR (('25 hydroxyergocalciferol'/exp OR '25 hydroxyergocalciferol':ti,ab OR ercalcidiol:ti,ab OR hydroxycalciferol:ti,ab OR '25 hydroxycalciferol':ti,ab OR 25) AND 'hydroxyvitamin d 2':ti,ab) OR '25 hydroxyvitamin d2':ti,ab OR '25-hydroxyvitamin d 2':ti,ab OR 'alfacalcidol'/exp OR 'alfacalcidol':ti,ab OR '1 hydroxycholecalciferol':ti,ab OR '1 hydroxycolecalciferol':ti,ab OR '1 hydroxyvitamin d3':ti,ab OR '1alpha hydroxycholecalciferol':ti,ab OR '1alpha hydroxycolecalciferol':ti,ab OR '1alpha hydroxyvitamin d 3':ti,ab OR '1alpha hydroxyvitamin d3':ti,ab OR alfarol:ti,ab OR 'alpha calcidiol':ti,ab OR 'alpha calcidol':ti,ab OR 'alpha d3':ti,ab OR alphacalcidol:ti,ab OR einsalpha:ti,ab OR etalpha:ti,ab OR 'one alpha':ti,ab OR 'one-alpha':ti,ab OR 'onealfa':ti,ab OR oxidevite:ti,ab OR oxydevit:ti,ab OR unalfa:ti,ab OR unalpha:ti,ab OR 'bazedoxifene'/exp OR 'bazedoxifene':ti,ab OR conbriza:ti,ab OR 'calcifediol'/exp OR 'calcifediol':ti,ab OR '25 hydroxy vitamin d 3':ti,ab OR '25 hydroxycholecalciferol':ti,ab OR '25 hydroxycolecalciferol':ti,ab OR '25 hydroxyvitamin d 3':ti,ab OR '25 hydroxyvitamin d3':ti,ab OR '25-hydroxycholecalciferol':ti,ab OR calderol:ti,ab OR dedrogyl:ti,ab OR delakmin:ti,ab OR didrogyl:ti,ab OR dydrogil:ti,ab OR hidroferol:ti,ab OR rayaldee:ti,ab OR 'u 32070':ti,ab OR u32070:ti,ab OR 'calcitonin derivative'/exp OR calcitonin:ti,ab OR 'thyrocalcitonin derivative':ti,ab OR 'calcitriol'/exp OR 'calcitriol':ti,ab OR calcijex:ti,ab OR (((((((1 AND alpha AND 25 AND dihydroxyvitamin AND d AND 3:ti,ab OR 25) AND dihydroxyvitamin AND d3:ti,ab OR 1alpha) AND 25 AND dihydroxycolecalciferol:ti,ab OR bocatriol:ti,ab OR bonky:ti,ab OR cabone:ti,ab OR calcijex:ti,ab OR caraben) AND sc:ti,ab OR cicarol:ti,ab OR citrihexal:ti,ab OR decostriol:ti,ab OR difix:ti,ab OR dn) AND 101:ti,ab OR dn101:ti,ab OR ecatrol:ti,ab OR ecatrol) AND f:ti,ab OR hitrol:ti,ab OR kolkatriol:ti,ab OR kosteo:ti,ab OR lemytriol:ti,ab OR meditrol:ti,ab OR osteotriol:ti,ab OR poscal:ti,ab OR renatriol:ti,ab OR rexamat:ti,ab OR ro) AND 21 AND 5535:ti,ab) OR rocaltrol:ti,ab OR roical:ti,ab OR rolsical:ti,ab OR silkis:ti,ab OR sitriol:ti,ab OR soltriol:ti,ab OR tariol:ti,ab OR tirocal:ti,ab OR triocalcit:ti,ab OR vectical:ti,ab OR 'colecalciferol derivative'/exp OR colecalciferol*:ti,ab OR 'vitamin d3':ti,ab OR 'vitamin d2':ti,ab

OR 'vitamin d':ti,ab OR 'cholecalciferol derivative'/exp OR cholecalciferol:ti,ab OR cimadronate:ti,ab OR 'denosumab'/exp OR 'denosumab':ti,ab OR 'amg 162':ti,ab OR amg162:ti,ab OR amgiva:ti,ab OR prolia:ti,ab OR xgeva:ti,ab OR (('dihydrotachysterol'/exp OR 'dihydrotachysterol':ti,ab OR 'a.t.10':ti,ab OR antitanil:ti,ab OR antitetanin:ti,ab OR antitetanine:ti,ab OR 'at 10':ti,ab OR 'at-10':ti,ab OR at10:ti,ab OR atecen:ti,ab OR calcamin:ti,ab OR calcamine:ti,ab OR calcinosefaktor:ti,ab OR 'dht intensol':ti,ab OR dichistrolum:ti,ab OR dichysterol:ti,ab OR dichystrol:ti,ab OR dihydral:ti,ab OR dihydrotachysterin:ti,ab OR dihydrotachysterine:ti,ab OR 'dihydrotachysterol 2':ti,ab OR 'dihydrotachysterol 3':ti,ab OR dikystrol:ti,ab OR dygratyl:ti,ab OR hytakerol:ti,ab OR manipal:ti,ab OR parterol:ti,ab OR tachidon:ti,ab OR tachysterol,) AND dihydro:ti,ab) OR tachystin:ti,ab OR tachystine:ti,ab OR tachystol:ti,ab OR tetilan:ti,ab OR 'ed 71':ti,ab OR ed71:ti,ab OR 'ergocalciferol derivative'/exp OR ergocalciferol*:ti,ab OR 'hydroxycolecalciferol'/exp OR 'hydroxycolecalciferol':ti,ab OR hydroxycholecalciferol:ti,ab OR hydroxycholecalciferols:ti,ab OR 'nandrolone decanoate'/exp OR 'nandrolone decanoate':ti,ab OR retabolic:ti,ab OR retabolil:ti,ab OR 'deca-durabolin':ti,ab OR kabolin:ti,ab OR 'raloxifene'/exp OR 'raloxifene':ti,ab OR bonmax:ti,ab OR celvista:ti,ab OR evista:ti,ab OR keoxifene:ti,ab OR loxar:ti,ab OR loxifen:ti,ab OR 'ly 139481':ti,ab OR 'ly 156758':ti,ab OR ly139481:ti,ab OR ly156758:ti,ab OR optruma:ti,ab OR raxeto:ti,ab OR 'strontium ranelate'/exp OR 'strontium ranelate':ti,ab OR osseor:ti,ab OR protelos:ti,ab OR protos:ti,ab OR 'ranelate strontium':ti,ab OR 'ranelic acid distrontium salt':ti,ab OR 's 12911':ti,ab OR 's 12911 2':ti,ab OR s12911:ti,ab OR 's12911 2':ti,ab OR 'tamoxifen'/exp OR 'tamoxifen':ti,ab OR ebefen:ti,ab OR kessar:ti,ab OR 'nsc 180973':ti,ab OR tamoplac:ti,ab OR tamoxasta:ti,ab OR tamoxifene:ti,ab OR teriparatide:ti,ab OR 'hpth (1-34)':ti,ab OR 'human parathyroid hormone (1-34)':ti,ab OR parathar:ti,ab OR forteo:ti,ab OR 'toremifene'/exp OR 'toremifene':ti,ab OR estrimex:ti,ab OR fareston:ti,ab OR 'fc 1157 a':ti,ab OR 'fc 1157a':ti,ab OR fc1157a:ti,ab OR 'vitamin d'/exp OR evenity:ti,ab OR 'amg-78':ti,ab OR 'cdp 7851':ti,ab OR 'romosozumab'/exp OR 'romosozumab':ti,ab OR 'calcium supplementation'/exp OR 'calcium supplementation':ti,ab OR 'calcium supplement':ti,ab OR ('calcium'/exp AND 'drug therapy'/lnk)))

Supplemental Digital Content 2. Inclusion Criteria

Articles that did not meet the following criteria, for the purposes of this evidence-based clinical practice guideline, were excluded. To be included as evidence in the guideline, an article had to be a report of a study that:

- Investigated patients with cervical spine surgery, thoracic spine surgery, and lumbar spine surgery;
- Excluded patients with tumor, trauma, or infections;
- Included patients ≥18 years of age;
- Were studies that enrolled ≥80% of cervical spine surgery, thoracic spine surgery, and lumbar spine surgery (we include studies with mixed patient populations if they report results separately for each group/patient population);
- Was a full article report of a clinical study;
- Was not a medical records review, meeting abstract, historical article, editorial, letter, or commentary;
- Appeared in a peer-reviewed publication or a registry report;
- Enrolled a minimum of 20 patients;
- Was of humans;
- Was published in or after 1946;
- Quantitatively presented results;
- Was not an in vitro study;
- Was not a biomechanical study;
- Was not performed on cadavers;
- Was published in English;
- Was not a systematic review, meta-analysis, or guideline developed by others.[1]

Systematic reviews or meta-analyses conducted by others, or guidelines developed by others were not included as evidence to support this review due to the differences in article inclusion/exclusion criteria specified compared with the criteria specified by the Guidelines Task Force. Although these articles were not included as evidence to support the review, these articles were recalled for full-text review for the Guidelines Task Force to conduct manual searches of the bibliographies.

[1]The guideline task force did not include systematic reviews, guidelines or meta-analyses conducted by others. These documents are developed using different inclusion criteria than those specified in this guideline; therefore, they may include studies that do not meet the inclusion criteria specific in this guideline. In cases where these types of documents' abstract suggested relevance to the guideline's recommendations, the task force searched their bibliographies for additional studies.

Supplemental Digital Content 3.
Criteria grading the evidence

The task force used the criteria provided below to identify the strengths and weaknesses of the studies included in this guideline. Studies containing deficiencies were downgraded 1 level (no further downgrading allowed, unless so severe that study had to be excluded). Studies with no deficiencies based on study design and contained clinical information that dramatically altered current medical perceptions of topic were upgraded.

1. Baseline study design (i.e., therapeutic, diagnostic, prognostic) determined to assign initial level of evidence.

2. Therapeutic studies reviewed for following deficiencies:
    - Failure to provide a power calculation for a randomized controlled trial (RCT);
    - High degree of variance or heterogeneity in patient populations with respect to presenting diagnosis/demographics or treatments applied;
    - Less than 80% of patient follow-up;
    - Failure to utilize validated outcomes instrument;
    - No statistical analysis of results;
    - Crossover rate between treatment groups of greater than 20%;
    - Inadequate reporting of baseline demographic data;
    - Small patient cohorts (relative to observed effects);
    - Failure to describe method of randomization;
    - Failure to provide flowchart following patients through course of study (RCT);
    - Failure to account for patients lost to follow-up;
    - Lack of independent post-treatment assessment (e.g., clinical, fusion status, etc.);
    - Utilization of inferior control group:
        - Historical controls
        - Simultaneous application of intervention and control within same patient
    - Failure to standardize surgical/intervention technique;
    - Inadequate radiographic technique to determine fusion status (e.g., static radiographs for instrumented fusion).

3. Methodology of diagnostic studies reviewed for following deficiencies:
    - Failure to determine specificity and sensitivity;
    - Failure to determine inter- and intraobserver reliability;
    - Failure to provide correlation coefficient in the form of kappa values.

4. Methodology of prognostic studies reviewed for following deficiencies:
    - High degree of variance or heterogeneity in patient populations with respect to presenting diagnosis/demographics or treatments applied;
    - Failure to appropriately define and assess independent and dependent variables (e.g., failure to use validated outcome measures when available).

Rating evidence quality. Levels of evidence for primary research question[a]

Types of Studies				
	Therapeutic studies: Investigating the results of treatment	**Prognostic studies: Investigating the effect of a patient characteristic on the outcome of disease**	**Diagnostic studies: Investigating a diagnostic test**	**Economic and decision analyses: Developing an economic or decision model**
Level I	• High-quality randomized trial with statistically significant difference or no statistically significant difference but narrow confidence intervals • Systematic review[b] of Level I RCTs (and study results were homogeneous[c])	• High-quality prospective study[d] (all patients were enrolled at the same point in their disease with ≥80% follow-up of enrolled patients) • Systematic review[b] of Level I studies	• Testing of previously developed diagnostic criteria on consecutive patients (with universally applied reference gold standard) • Systematic review[b] of Level I studies	• Sensible costs and alternatives; values obtained from many studies with multiway sensitivity analyses • Systematic review[b] of Level I studies

Level II	• Lesser quality RCT (e.g., <80% follow-up, no blinding, or improper randomization) • Prospective[d] comparative study[e] • Systematic review[b] of Level II studies or Level I studies with inconsistent results	• Retrospective[f] study • Untreated control subjects from an RCT • Lesser quality prospective study (e.g., patients enrolled at different points in their disease or <80% follow-up) • Systematic review[b] of Level II studies	• Development of diagnostic criteria on consecutive patients (with universally applied reference criterion standard) • Systematic review[b] of Level II studies	• Sensible costs and alternatives; values obtained from limited studies with multiway sensitivity analyses • Systematic review[b] of Level II studies
Level III	• Case control study[g] • Retrospective[f] comparative study[e] • Systematic review[b] of Level III studies	• Case control study[g]	• Study of nonconsecutive patients without consistently applied reference criterion standard • Systematic review[b] of Level III studies	• Analyses based on limited alternatives and costs and poor estimates • Systematic review[b] of Level III studies
Level IV	Case series[h]	Case series	• Case-control study • Poor reference standard	• Analyses with no sensitivity analyses

RCT, randomized controlled trial.
[a]A complete assessment of quality of individual studies requires critical appraisal of all aspects of the study design.
[b]A combination of results from ≥2 previous studies.
[c]Studies provided consistent results.
[d]Study was started before the first patient enrolled.
[e]Patients treated one way (e.g., instrumented arthrodesis) compared with a group of patients treated in another way (e.g., uninstrumented arthrodesis) at the same institution.
[f]Study was started after the first patient enrolled.

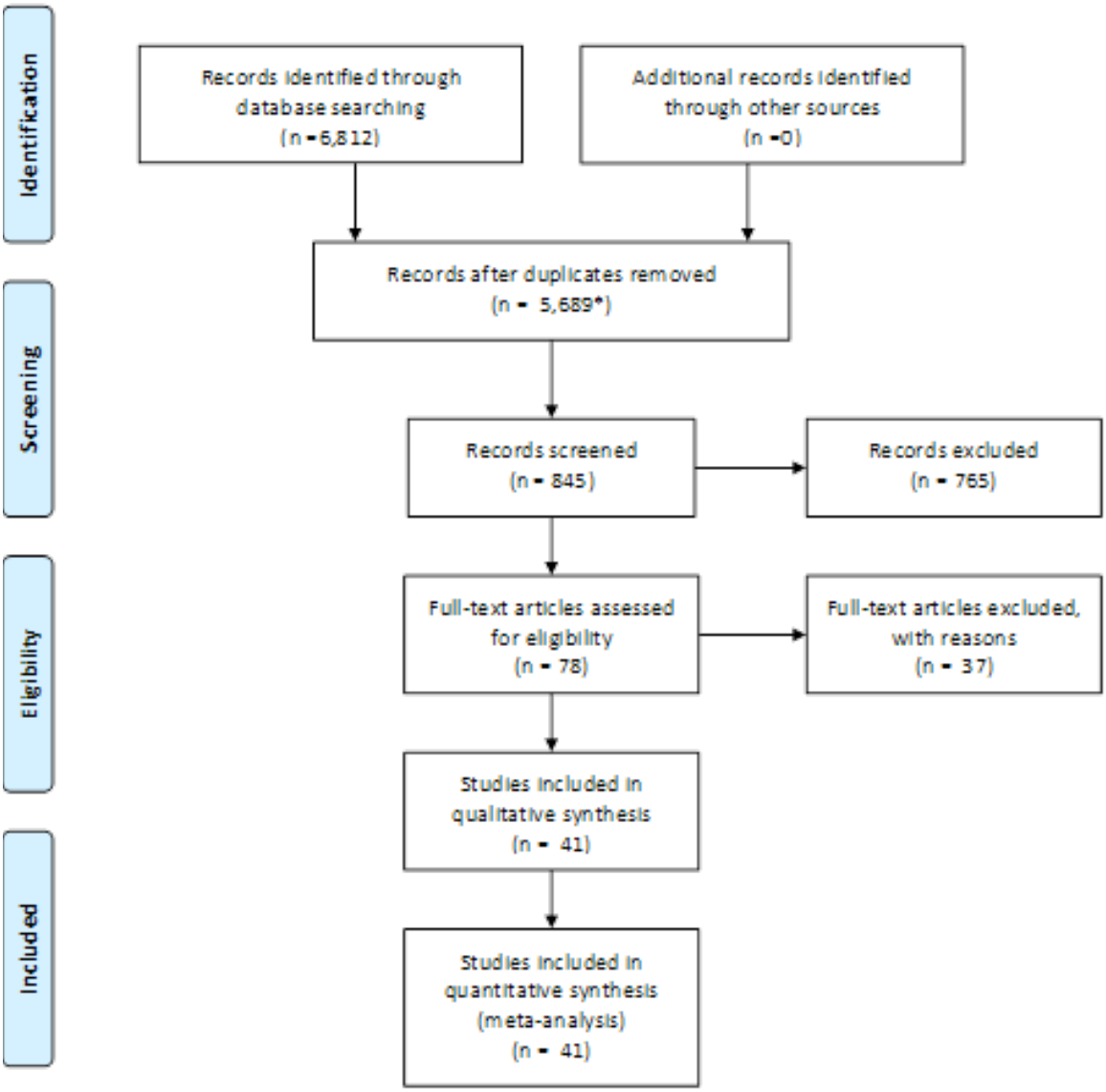
[g]Patients identified for the study based on their outcome, called “cases” (e.g., pseudoarthrosis) are compared with those who did not have outcome, called “controls” (e.g., successful fusion).
[h]Patients treated one way with no comparison group of patients treated in another way.

Supplemental Digital Content 4. Linking levels of evidence to grades of recommendation

Grade of Recommendation	Standard Language	Levels of Evidence	
A	Recommended	≥2 consistent Level I studies	
B	Suggested	One Level I study with additional supporting Level II or III studies	≥2 consistent Level II or III studies
C	Is an option	One Level I, II, or III study with supporting Level IV studies	≥2 consistent Level IV studies
I (insufficient or conflicting evidence)	Insufficient evidence to make recommendation for or against	A single Level I, II, III, or IV study without other supporting evidence	≥1 study with inconsistent findings*

*Note that in the presence of multiple consistent studies, and a single outlying, inconsistent study, the grade of recommendation will be based on the level of the consistent studies.

Supplemental Digital Content 5. PRISMA Flowchart



*In addition to duplicate removal, we also removed strictly animal or children/adolescent studies not identified by search strategy and case reports dealing with 1 to 2 persons as encountered.

Supplemental Digital Content 6. Evidence tables

PICO Question	Author, Year	Type of Evidence	Study Type	Level of Evidence	Reviewer's Conclusions
1	Anderson et al, 2015[8]	Prognostic	Retrospective comparative	II	Study shows that preoperative does impact postoperative outcome. Higher preoperative opioid load ($P < .001$) and duration of use ($P < .001$) were positively associated with higher postoperative rates of COT
1	Connolly et al, 2017[9]	Prognostic	Retrospective comparative	II	This study affirms and shows that quartiles of opioid use duration before surgery associated with outcome
1	Faour et al, 2017[11]	Prognostic	Retrospective comparative	II	Affirms, not PRO but RTW. Prolonged preoperative opioid use was a negative predictor of successful RTW status (OR 0.73 [95% CI 0.55-0.98]; $P = .04$). Answers PICO questions 1 and 2
1	Harris et al, 2020[6]	Prognostic	Retrospective comparative	II	This study concluded that predicted preoperative impacted postoperative factors associated with the highest risk for chronic opioid use were preoperative opioid use (OR 5.7)
1	Jain et al, 2019[17]	Prognostic	Retrospective comparative	II	The study affirms. This study includes duration and 3-month opioid-free period/wean. Patients with a preoperative opioid prescription for ≤3 months before a major arthroplasty or a 1- or 2-level lumbar fusion had a similar risk of adverse outcomes as opioid-naïve patients. While >6 months of opioid use was associated with a higher risk of adverse outcomes, a 3-month prescription-free period before the surgery appeared to mitigate this risk for chronic users. Answers PICO questions 1 and 3

1	Jain et al, 2018[12]	Prognostic	Retrospective comparative	II	Preoperative impact outcome: preoperative opioid use among patients who underwent cervical fusion increases complication rates, postoperative opioid usage, health care resource use, and costs
1	Kalakoti et al, 2018[16]	Prognostic	Retrospective comparative	II	This study affirms and defines duration defined as Rx within 3 months of surgery. Approximately one-third patients chronically use opioids before lumbar arthrodesis and nearly half of the preoperative OUs will continue to use at 1 year
1	Karhade et al, 2019[5]	Prognostic	Retrospective comparative	II	This study confirms the association between preoperative opioid prescription duration with postoperative opioid use, as well as an association between antidepressant use, tobacco use, and Medicaid insurance and postoperative opioid use. The authors also found that longer duration of opioid prescriptions before surgery was associated with postoperative opioid prescriptions. Among opioid-naïve patients, the rate of postoperative opioid prescription was 87 (4.3%). Among patients with <180 days of preoperative opioid prescription, the rate of postoperative opioid prescription was 57 (16.7%) and among patients with >180 days of continuous preoperative opioid prescription, the rate of postoperative opioid prescription was 126 (34.2%)
1	Karhade et al, 2019[7]	Prognostic	Retrospective other	II	The study shows that preoperative use impacts duration—the 3 most important predictors were instrumentation, duration of preoperative opioid prescription, and comorbidity of depression

1	Oleisky et al, 2019[19]	Prognostic	Retrospective comparative	III	Downgraded because of heterogeneity. Although the PICOs were not the primary aim of the study, it showed the Edlund definition, accounting for duration and dosage, had the highest predictive ability for postoperative opioid use (77.5%), followed by Schoenfeld (75.7%), CDC (72.6%), and Svendsen (59.9%-72.5%) definitions. Answers PICO questions 1 and 2
1	Rosenthal et al, 2019[18]	Prognostic	Retrospective comparative	III	Downgraded because of heterogeneity, affirms duration
1	Tank et al, 2018[15]	Prognostic	Retrospective comparative	II	PICO not directly answered; opioid dependence is associated with prolonged length of stay in lumbar fusion, as well as higher costs and higher frequencies of surgical complications
2	Adogwa et al, 2019[30]	Prognostic	Retrospective comparative	II	Study affirms, although PICO not directly answered; page E694; preop associated with postop
2	Adogwa et al, 2019[31]	Prognostic	Retrospective comparative	II	Study affirms and showed preoperative opioid use associated with prolonged postoperative use
2	Ahn et al, 2016[23]	Prognostic	Retrospective comparative	III	Downgraded because of heterogeneity. Study is negative, PICOs are not directly answered; there was no difference in narcotics dependence according to preoperative narcotic utilization (adjusted $P = .798$; Fig 4C)
2	Albert et al, 2000[42]	Prognostic	Retrospective comparative case series	III	This study was downgraded because of the small population and PICOs were not directly addressed. The study was affirmative. The presence of ≥1 abnormal neurologic findings and significant narcotic use before surgery significantly increased the chance of a patient's outcome being functional failure

2	Anderson et al, 2009[21]	Prognostic	Retrospective comparative	II	Study affirms. This study shows "weak" narcotic use a predictor in subanalysis
2	Armaghani et al, 2016[36]	Prognostic	Retrospective comparative	III	Downgraded because of heterogeneity. The study showed diabetes and preoperative opioid use were independent predictors of decreased SF-12 scores, decreased EQ-5D scores, increased ODI or NDI scores, and increased NRS scores ($P < .05$)
2	Armaghani et al, 2016[26]	Prognostic	Retrospective case control	II	The study shows preoperative assessment affects outcomes. Linear regression analysis demonstrated that preoperative opioid use was an independent risk factor for increased donor site pain at 1 and 2 weeks ($P < .05$)
2	Armaghani et al, 2014[28]	Prognostic	Retrospective comparative	II	Downgraded because of heterogeneity. Greater preoperative opioid use before undergoing spine surgery predicts increased immediate postoperative opioid demand and decreased incidence of postoperative opioid independence
2	Deyo et al, 2018[20]	Prognostic	Retrospective comparative	II	The study affirms. In multivariable models, the strongest predictor of long-term postoperative use was cumulative preoperative opioid dose (OR 15.47 [95% CI 8.53-28.06] in the highest quartile)
2	Dunn et al, 2018[37]	Prognostic	Retrospective comparative	III	Downgraded because of heterogeneity. The study shows an impact, although not directly answering the PICO question
2	Elsamadicy et al, 2019[44]	Prognostic	Retrospective comparative	III	Study shows preoperative use of narcotics may impact patient perception of pain and improvement after complex spinal fusions (≥5 levels). This study was downgraded because of heterogeneity, and because smoking and depression were not treated differently statistically

2	Faour et al, 2017[11]	Prognostic	Retrospective comparative	II	Affirms, not PRO but RTW. Prolonged preoperative opioid use was a negative predictor of successful RTW status (OR 0.73 [95% CI 0.55-0.98]; *P* = .04). Answers PICO questions 1 and 2
2	Hassan Hashisha et al, 2019[34]	Prognostic	Prospective comparative	II	This study shows an impact on outcomes. Tramadol abuse before lumbar discectomy was found to be associated with continued tramadol abuse after surgery and worse functional outcomes after surgery
2	Hills et al, 2019[38]	Prognostic	Retrospective comparative	III	Study affirms, downgraded because of heterogeneity. High preoperative opioid dosage was only associated with postoperative chronic opioid use (adjusted OR 4.9 [95% CI 3-7.9])
2	Hockley et al, 2019[14]	Prognostic	Retrospective comparative	II	This study affirms using a subanalysis finding that patients who underwent an open TLIF with a history of preoperative opioid use are significantly more likely to remain on opioids at 6-week follow-up (87% vs 65%, *P* = .027), 3-month follow-up (63% vs 31%, *P* = .008), and 6-month follow-up (50% vs 21%, *P* = .018) compared with MIS TLIF
2	Kalakoti et al, 2019[27]	Prognostic	Retrospective comparative	II	Study affirms and shows chronic opioid therapy 3 months preoperatively; preoperative chronic opioid therapy is a modifiable risk factor that is strongly associated with prolonged postoperative opioid use
2	Kanaan et al, 2015[40]	Prognostic	Retrospective case series	III	The study was downgraded because of heterogeneity. The study did show an impact, although the PICO was not directly addressed. Diagnosis and preoperative use of opioids were the only significant predictors for postoperative leg pain (*P* = .007 and .042, respectively) in the

					model with preoperative leg pain intensity controlled (Table 4). Patients with a diagnosis of spondylolisthesis are likely to have 0.62 points (95% CI −0.360 to 1.59) higher leg pain on VAS scale. Patients with preoperative use of opioids are likely to have more leg pain by 0.78 points (95% CI −0.51 to 2.07). The model explained 25.6% of the variation in postoperative leg pain
2	Kelly et al, 2015[22]	Prognostic	Retrospective comparative	II	Study is negative and looks at strong vs weak opioids; preoperative opioid strength did not adversely affect outcomes in this analysis
2	Lall et al, 2018[29]	Prognostic	Prospective other	II	The study affirms. This study was downgraded because follow-up was not reported. The PICO was not directly answered; among preoperative patient characteristics, only preoperative opioid use significantly predicted weeks to opioid cessation (β = 0.466; *P* = .005)
2	Lawrence et al, 2008[25]	Prognostic	Retrospective comparative	II	The study affirms: daily basis for >6 months preoperatively; chronic narcotic use before cervical arthrodesis was found to be associated with continued narcotic use after surgery and worse functional outcomes after surgery
2	Mesfin et al, 2014[45]	Prognostic	Retrospective comparative	III	Downgrade because of heterogeneity. The preoperative duration was not noted. These findings differ from other studies. The narcotic group had significantly greater improvements in SRS pain scores vs the no narcotic group
2	O'Connell et al, 2018[43]	Prognostic	Retrospective comparative	III	Downgrade because of heterogeneity. This study affirms although, PICO is not directly answered; preoperative opioids

2	O'Donnell et al, 2018[33]	Prognostic	Retrospective comparative	II	The study affirms duration
2	Oleisky et al, 2019[19]	Prognostic	Retrospective comparative	III	Downgraded because of heterogeneity. Although the PICOs were not the primary aim of the study, it showed the Edlund definition, accounting for duration and dosage, had the highest predictive ability for postoperative opioid use (77.5%), followed by Schoenfeld (75.7%), CDC (72.6%), and Svendsen (59.9% to 72.5%) definitions. Answers PICO questions 1 and 2
2	Pugely et al,[10] 2018	Prognostic	Retrospective comparative	II	Preoperative is defined as filled rx within 3 months of surgery. Postoperative opioid use fell dramatically during the first 3 months in NOU, but nearly half of the preoperative OUs will remain on narcotics at 1 year postoperatively
2	Qureshi et al, 2018[13]	Prognostic	Retrospective comparative	II	The study showed an impact: preoperative narcotic use had the largest effect on odds of postoperative prescription (OR 3.4)
2	Reid et al, 2019[24]	Prognostic	Retrospective other	II	This study affirms and shows that increased 30-day opioid utilization was associated with surgery in the prelaw period, preoperative opioid exposure, preoperative benzodiazepine exposure, and number of levels fused (all $P <$ .05). Chronic (>90 day) opioid requirements were associated with preoperative opioid exposure (OR 4.42, $P <$ .001) but not with pre-/postlaw status ($P >$ .05)
2	Tuna et al, 2018[35]	Prognostic	Prospective comparative	III	Downgraded because of heterogeneity. Study shows that preoperative impacts postoperative chronic opiate-consuming patients received more morphine within the first 3 postoperative days when compared with non–opioid-

					consuming patients
2	Villavicencio et al, 2017[32]	Prognostic	Retrospective comparative	II	This study was downgraded because follow up was not reported. This study affirms, but PICOs not directly answered. The use of opioid medications to control pain before patients underwent lumbar fusion for degenerative lumbar conditions was associated with less favorable clinical outcomes postoperatively
2	Wick et al, 2018[39]	Prognostic	Retrospective comparative	III	The study was downgraded because of heterogeneity. The study does show and impact (affirm). MEQ: the final logistic regression model demonstrated that MCID achievement decreased significantly when mean preoperative MEA dose exceeded 47.8 mg/d, with a 95% credible interval of 29.0-60.0 mg/d
2	Wright et al, 2019[41]	Prognostic	Retrospective comparative	III	No preop MEQ or duration or wean. PICO was not the primary aim of the study. The study showed discharge prescription dose exceeding 120 mg/day is independently associated with opioid dependence following spine surgery. The study was downgraded because of heterogeneity
3	Jain et al, 2019[17]	Prognostic	Retrospective comparative	II	The study affirms. This study includes duration and 3-month opioid-free period/wean. Patients with a preoperative opioid prescription for ≤3 months before a major arthroplasty or a 1- or 2-level lumbar fusion had a similar risk of adverse outcomes as opioid-naïve patients. While >6 months of opioid use was associated with a higher risk of adverse outcomes, a 3-month prescription-free period before the surgery appeared to mitigate this risk for chronic users.

					Answers PICO questions 1 and 3

CDC, Centers for Disease Control and Prevention; CI, confidence interval; EQ-5D, EuroQol 5D health-related quality of life survey; MCID, minimal clinically important difference; MEA, morphine equianalgesic dose; MEQ, minimum equivalent dose; MIS, minimally invasive; NDI, Neck Disability Index; NOU, non–opioid user; NRS, numeric rating scale; ODI Oswestry Disability Index; OR, odds ratio; OU, opiod user; PICO, patient/population, intervention, comparison, and outcomes; PRO, patient reported outcomes; RTW, return to work; SF-12, Medical Outcomes Study Survey Short Form 12; SRS, Scoliosis Research Society; TLIF, transforaminal lumbar interbody fusion, VAS, visual analog scale.