Clinical Practice Guideline

Best practices guidelines in the postoperative management of patients who underwent cervical and lumbar fusions

Rami Elsabeh, John M. Abrahams^

Department of Neurosurgery, New York Brain & Spine Surgery, West Harrison, NY, USA

Contributions: (I) Conception and design: Both authors; (II) Administrative support: Both authors; (III) Provision of study materials or patients: Both authors; (IV) Collection and assembly of data: Both authors; (V) Data analysis and interpretation: Both authors; (VI) Manuscript writing: Both authors; (VII) Final approval of manuscript: Both authors.

Correspondence to: John M. Abrahams, MD. Department of Neurosurgery, New York Brain & Spine Surgery, 4 Westchester Park Drive, Suite 325, West Harrison, NY 10604, USA. Email: jma@nybrainspine.com.

Background: There is a lack of standardization in spine surgery in particular, as relates to postoperative care for the most common spine procedures such as cervical and lumbar fusions. The goal of this study was to develop a standardized postoperative treatment protocol for common spine procedures such as cervical and lumbar fusion to reduce unnecessary visits, imaging studies, and create a standard for all spine surgeons to adhere while maintaining quality.

Methods: We developed a best practices protocol (BPP) for postoperative spine care for anterior cervical diskectomy and fusion (ACDF) and posterior lumbar interbody fusion (PLIF). We compared outcome to retrospective controls (pre-BPP) and a national database [Quality Outcomes Database (QOD)/American Spine Registry (ASR)].

Results: Pre-BPP retrospective controls (n=1,010) were compared to patients enrolled in BPP (n=750). BPP reduced postoperative visits (POV) from 2,201 to 1,061 (52%). Total additional imaging studies computed tomography (CT) and magnetic resonance imaging (MRI) beyond standard X-ray were reduced from 192 studies to 57 (70%); 53% for lumbar fusion and 67% for cervical fusion. Comparing pre-BPP to BPP groups for complications, the number of adverse events was reduced by 52% overall; 45% for lumbar fusion, and 62% for cervical fusion. A subset of BPP patients (n=450) with available data were compared to a national registry QOD and ASR where lumbar and cervical fusion patients showed comparable less lengths of stay, lower 3-month complication rates and lower readmission rates.

Conclusions: This is one of the first studies to standardize postoperative spine care as a first step towards creating uniformly accepted models for value-based care (VBC) in spine surgery.

Keywords: Spine surgery; outcome; practice standards; value-based care (VBC)

Submitted Nov 15, 2023. Accepted for publication Jan 29, 2024. Published online Jul 18, 2024.
doi: 10.21037/jss-23-136
View this article at: https://dx.doi.org/10.21037/jss-23-136

Introduction

Background

Spine surgery is one of the most common and costly procedures in healthcare. Certain reports estimate the total number of instrumented spine fusions at 1.62 million per year in the United States alone (1). In 2008, the aggregate hospital bill for surgical care of all spinal procedures was reported to be $33.9 billion (2). Reviewing the Medicare database, that population undergoes an estimated 128,755

^ ORCID: 0009-0008-3872-916X.

© Journal of Spine Surgery. All rights reserved.

lumbar fusions and 23,032 lumbar discectomy single-level surgeries per year (3). The Medicare Provider Utilization and Payment data in 2015 showed a combined national mean professional and facility cost for a single-level anterior cervical diskectomy and fusion (ACDF) at $13,899 and a single-level posterior lumbar fusion (PLF) at $25,858. Medicare data was published online starting in 2012 showing the physician-specific payments of $77 billion across 880,000 medical providers (4).

Risk factors such as age, body mass index (BMI), and comorbidities have significant and measurable effects on the postoperative hospital costs of elective spinal surgeries (5-7). In this study, we develop practice standards to consider while developing a value-based care (VBC) model for spine surgery at a national level.

Rationale and knowledge gap

We developed and propose a best practices protocol (BPP) for patient care after anterior cervical and PLF surgery. This protocol could serve as a standard for all spine surgeons to follow a similar protocol making reducing cost, maintaining outcome and enabling large scale patient studies. We also developed the model to support VBC in spine surgery.

Highlight box

Key recommendations

- We recommend standardizing postoperative management of common spine procedures such as anterior cervical and posterior lumbar fusions. Patients should undergo the minimum number of visits, studies, and follow-up period while maintaining the same quality of care. We recommend follow-up at 2 weeks, 1 month, 3 months and 1 year with only X-ray imaging to assess quality of the fusion. After 1 year, patients should be discharged from care unless there are active problems.

What was recommended and what is new?

- There is no evidence supporting postoperative management of common spine procedures. We think that this study supports developing a national model for value-based care in spine surgery.
- We recommend limiting the number of visits to 2 weeks, 1 month, 3 months and 1 year. Patients should undergo X-ray imaging only and reserve other imaging modalities for patients do not follow the standard with excessive pain or adjacent segment disease.

What is the implication, and what should change now?

- This is the first step in developing a national model for value-based care in spine surgery. In addition, this will allow for easier recruitment of multisite studies for larger patient numbers. Providers should next focus on a standard for pre-operative management.

Objective

The major aim of the protocol is to encourage spine surgeons to reduce medical waste such as excessive visits, unnecessary imaging, and overall lack of standardization in adult patients undergoing anterior cervical and PLF surgery. We present this article in accordance with the RIGHT reporting checklist (available at https://jss.amegroups.com/article/view/10.21037/jss-23-136/rc).

Methods

The senior author developed the concept for a BPP as a method to standardize care and reduce the need for useless visits and studies when patients are improving and approaching normal function. We polled fifteen spine surgeons (4 orthopedic surgeons and 11 neurosurgeons) who were questioned about imaging frequency, number of visits, and use of bone growth stimulators. The results are highlighted in *Table 1*. Based on these results, we developed the BPP.

Index cases included ACDF, one to four levels, and transforaminal lumbar interbody fusion (TLIF), one to three levels. We included degenerative diagnoses excluding trauma and tumor cases. Patients ages 21 to 80 years were included in the study. Patients were directed towards one of two pathways of expected outcome or unexpected outcome, depending on the patient's course after surgery during the initial postoperative 90 days. The program was started in 2018 and therefore those designated as the control or pre-BPP included patients tracked from 2014–2018 and the BPP as those patients who were entered into the program from 2019–2021.

The two care pathways were designated as Tier I and Tier II (*Table 2*). Tier I patients had an uneventful course whereas Tier II patients had an eventful course after surgery. An eventful course included excessive postoperative pain requiring additional visits and extended narcotics administration, surgical complications such as infection, cerebrospinal fluid leak, hematoma, or new deficit; medical complication or extended hospital stay; pseudoarthrosis or hardware failure; readmission; or return to operating room. Tier I patients had postoperative visits (POV) at 2 weeks, 1 month, 3 months, and 1 year; then discharged

© Journal of Spine Surgery. All rights reserved.

Table 1 Survey results of standard postoperative care from fifteen spine surgeons

Clinical measure	Response I	Response II	Response III
Patient follow-up after surgery	Every 3 months for 1 year and discharge (n=4)	Every 3 months and yearly for 3 years (n=6)	Every 3 months and yearly for 5 years (n=5)
Imaging preference	X-ray only (n=7)	CT scan at 1 year (n=6)	CT scan at 1 year, and then yearly for 5 years (n=2)
Bone growth stimulation	Never (n=3)	Failed fusion or smoking (n=5)	Every patient (n=7)

CT, computed tomography.

Table 2 Tier I versus Tier II postoperative designation

Tier I
No complications
Expected length of stay
Minimal pain requirements after surgery
Tier II
Excessive postoperative pain
Surgical complications
Infection
Cerebrospinal fluid leak
Hematoma
New neurologic deficit
Medical complication
Extended hospital stay
Readmission
Return to operating room

from care. Imaging for Tier I patients was performed at 1 month, 3 months and 1 year through X-ray only. Computed tomography (CT) scan was obtained for suspicion of pseudoarthrosis or excessive pain and magnetic resonance imaging (MRI) for suspicion of recurrent or adjacent segment disease, or new deficit. Physical therapy was offered as an option for any patient without a motor deficit before or after surgery. bone growth stimulators were prescribed for those patients who had a positive smoking history or had revision surgery. Bone growth stimulators were provided by DJO Global (Dallas, TX, USA) and included the SpinaLogic (Dallas, TX, USA) unit with patients using the apparatus 30 minutes per day starting 7 days after surgery and continuing for 3 months. Patients only underwent bracing for severe discomfort or multilevel anterior cervical fusion construct (four levels). Tier II patients were meant to adhere to the Tier I paradigm as much as possible but invariably required additional visits, imaging using CT or MRI, additional pain medication management, and sometimes re-admission.

Electronic patient reported outcome (ePRO) was tracked through office visits, hospital admission records and an automated software tracking system developed by the authors (DTX Medical Inc., Scarsdale, NY, USA). The software was automated to engage patients through a Health Insurance Portability and Accountability Act (HIPAA)-compliant, short message service (SMS)-based system that automated surveys at predetermined intervals that coincided with their office visits. The software contacted patients with a text then, once they opened the text, a secure browser allowed them to answer outcome questions during their recovery. The artificial intelligence (AI) built in simply alerted the provider for any adverse events such as fever, wound leakage, and worse pain. The providers clinical team could then see the alert and contact the patient for further management. Complications were tracked through an interface built into the practice electronic medical record (Centricity, AthenaHealth, Boston, MA, USA) that prompted the provider at each visit on whether there were any deviations from care to report. AI algorithms were developed and integrated into proprietary software to alert of poor outcomes or issues with care. Functional activity was patient-reported through electronic communications. Functional activity outcome measures focused on whether the patient was ambulating unassisted or assisted, had returned to normal activity, reported any clinical improvement, back to work if they were working prior to surgery, and still on pain medication if they were taking medication before surgery.

Data was compiled each month and stratified based on procedure and insurance provider. Patients were followed for number of visits, number of imaging studies

© Journal of Spine Surgery. All rights reserved.

Table 3 Definition of Tier I and Tier II in the best practices protocol

Measure	Tier I—favorable outcome	Tier II—less favorable outcome
Follow-up visits	2 weeks	2 weeks
	1 month	1 month
	3 months	3 months
	12 months	12 months
		More as needed
Imaging	X-ray at:	Modality as needed by complication
	1 month	
	3 months	
	12 months	
Physical therapy	Optional and recommended for motor deficit only	Modality as needed
Bone growth stimulator	Smoking history or revision	Yes
Bracing	No	As needed by complication

Table 4 Patient demographics

Measure	Pre-BPP	BPP
Number of patients	1,010	750
Male/female	516/494	445/305
Age >65 years, n [%]	210 [21]	170 [23]
Average age, years	54.1	55.3
BMI >30 kg/m^2, n [%]	488 [48]	424 [57]
Diabetes mellitus, n [%]	165 [16]	142 [19]
Current/former smoker, n [%]	518 [51]	423 [56]

BPP, best practices protocol; BMI, body mass index.

and modality, work status, medication status, ambulation status as assisted or unassisted, clinical improvement, and return to normal activity. Any patient with a postoperative complication at any point in the care pathway was converted from Tier I to Tier II. Complications or adverse events documented are listed in *Table 3*. Pre-BPP patients were followed through the entirety of their treatment protocol as long as there were clinical notes to follow in the chart. BPP patients were discharged from care at the 1-year juncture as long as they were clinically stable with no active issues.

Once BPP was developed and implemented, we tracked the first 750 patients that were eligible based on procedure and sufficient data (January 2019–December 2021). As a control, we used the previous 1,010 patients prior to BPP (pre-BPP) implementation to compare paradigms (January 2014–December 2018). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was deemed exempt by the ethics board of WCG Clinical (1019 39th Ave SE, Puyallup, WA 98374, USA) and individual consent for this retrospective analysis was waived.

Best practices results & pitfalls

We compared patients in the pre-BPP (January 2014 to December 2018), to those patients enrolled in the BPP (January 2019 to December 2021) who underwent either anterior cervical or PLF. Patient demographics for each group are shown in *Table 4*. During the pre-BPP period, there were 1,010 patients enrolled with 462 undergoing cervical fusion and 548 undergoing lumbar fusion. During the BPP period, there were 750 patients enrolled with 371 undergoing cervical fusion and 379 undergoing lumbar fusion (*Table 5*).

The total number of POV comparing pre-BPP to BPP for the entire group was reduced from 2,201 to 1,061 or a 52% reduction in visits. Patients underwent X-ray imaging at the 1-month, 3-month and 1-year visits only. The overall number of additional studies in the form of CT and MRI required was reduced by 60%. For lumbar fusion, imaging studies were reduced 53% and for cervical fusion, imaging studies were reduced by 67%. The actual number of studies was reduced from 192 studies to 57 studies. Comparing the pre-BPP to BPP groups for complications, the number of adverse events was reduced by 52% overall (45% for lumbar fusion, 62% for cervical fusion). Adverse events were considered return to operating room; admission with excessive postoperative pain; surgical complications such as infection, cerebrospinal fluid leak, and hematoma; new neurologic deficit; medical complication; and extended hospital stay (>3 days).

Functional activity was tracked at 2 weeks, 6 weeks, and 6 months. Functional activity outcome measures focused on whether the patient was ambulating unassisted or assisted, had returned to normal activity, reported any clinical improvement, was back to work if they were working prior to surgery, and was still on pain medication if they were taking medication before surgery. At the 1-year

© Journal of Spine Surgery. All rights reserved.

Table 5 Pre-BPP and BPP outcome data

Procedure	Patients		POVs			Add'l imaging			AE		
	Pre	BPP	Pre	BPP	Decrease in POV (%)	Pre	BPP	Decrease in imaging (%)	Pre	BPP	Decrease in AE (%)
Cervical fusion	462	371	949	525	45	94	35	63	63	28	56
Lumbar fusion	548	379	1,252	536	57	98	22	78	64	17	73
Total	1,010	750	2,201	1,061	52	192	57	70	127	45	65

BPP, best practices protocol; POV, post-operative visit; Add'l, additional; AE, adverse event.

Table 6 Best practices versus QOD/ASR

Outcome metric	Study group	QOD/ASR	Difference
Mean length of stay (days)			
Lumbar	2.41 [308]	4.36 [48,980]	–45%
Cervical	1.57 [130]	4.84 [28,660]	–70%
Mean 3-month complication rate			
Lumbar	1.9% [6]	4.1% [273]	–54%
Cervical	0%	1.5% [47]	–100%
Mean 3-month readmission rate			
Lumbar	2.2% [8]	2.7% [1,313]	–18.5%
Cervical	0%	2.4% [678]	–100%

Mean length of stay is presented as days for the study group and QOD/ASR with the difference as a percentage. Mean 3-month complication rate & readmission rate are presented as percentages across all groups. Numbers in square brackets represent the total number of patients in each group. QOD, Quality Outcomes Database; ASR, American Spine Registry.

timepoint for all patients, ePRO showed 70% reported unassisted ambulation (n=181), only 16% returned to normal activity (n=16), 68% reported clinical improvement (n=280), 77% were working (n=55), and 64% who were on pain medication before surgery and were now off pain medications (n=70).

Comparison to national database

Our results were then compared to the National Spine Registry [Quality Outcomes Database (QOD)/American Spine Registry (ASR)] composed of over 85 spine surgery practices including hospitals and academic health centers. This included both the QOD from years 2016 to 2019; and the ASR from years 2020 to 2022. Those database sets tracked data including pain after surgery, disability, and quality of life pre-operatively, 3 months after surgery, and 12 months after surgery. We compared these results to 450 patients enrolled in our BPP group with comparable data (*Table 6*). Results for lumbar fusion patients showed a 45% shorter length of stay (LOS), 54% lower 3-month complication rate and 19% lower 3-month readmission rate. For cervical fusion patients, results showed a 70% shorter LOS, a 100% lower 3-month complication rate, and a 100% lower 3-month readmission rate.

Strengths & limitations

Our study is one step towards developing a VBC model for the entire continuum of spine care (8-11). VBC is defined by the quality and efficiency divided by the total cost of care. The treatment pathway for spine care starts with the onset of symptoms and conservative care, followed by those who require surgical intervention, and then postoperative care. Most of the cost attributed to spine care is the surgical component including hospital stay, instrument costs, and surgeon fees. It has been estimated that roughly 7% of the aggregate costs for hospitalization after surgical procedures can be attributed to spinal fusion procedures, with an average hospital stay cost of $27,600 per patient (12).

To develop VBC models, all stake holders need comparison metrics to make sure we are all following the same standards. Unfortunately, the goals the physicians, large medical groups, and hospitals are not always aligned. Metrics necessary for a VBC model include performance indicators and performance metrics (8). A performance indicator based on the National Quality Forum definition must meet the following three criteria: (I) comparisons with established standards; (II) the use of risk adjustment and/or exclusion criteria; and (III) the use of benchmarking (11). A performance score or metric is simply an outcome measurement that does not necessarily have any established

© Journal of Spine Surgery. All rights reserved.

standard (13). Performance indicators do not inherently contain information regarding cost. An example of a performance score is patient reported outcome (PRO).

It is difficult to assess the entire episode of care if patients are treated outside of hospital networks or large medical groups. A VBC model would need to be based on cost-effectiveness, performance indicators, performance metrics, and centered on patient care. Outcomes need to include patient-reported outcomes, complication rates, readmission rates, and the appropriateness of surgical interventions including all costs. However, hospital systems and large medical groups encourage a greater number of imaging studies, visits and testing to support infrastructure finances, but may not be what is best for the patient. Our BPP is one step in the process to standardize postoperative care and use metrics for comparison at a regional or national level. A national standard would be necessary to insure adequate comparisons of care.

While VBC in elective spine surgery offers numerous benefits, it also comes with challenges such as data integration, provider alignment, reimbursement models, and patient education. Effective implementation of VBC relies on robust data collection and analysis. Integrating data from various sources, including electronic health records, patient-reported outcomes, and cost data, can be complex. Healthcare organizations need to invest in technology and analytics capabilities to harness the full potential of VBC. Achieving consensus among healthcare providers on the best practices and treatment guidelines in elective spine surgery can be challenging. Interdisciplinary collaboration and standardized protocols are essential to ensure that all stakeholders work toward the same goals. Transitioning from fee-for-service to value-based reimbursement models can be difficult for healthcare organizations. It requires careful planning and may involve financial risks during the transition period. Engaging patients in shared decision-making and promoting non-surgical alternatives require effective patient education. Healthcare providers must invest in resources and tools to empower patients with information to make informed choices.

As surgeons, we are not rewarded for high quality care within a health system since they are only rewarded for greater services to increase revenue. Our study has several limitations. Firstly, we lacked enough data to do any meaningful comparison to QOD/ASR; our goal was simply to show that our outcomes were the same. Secondly, we need larger numbers of patients with additional parameters to include in outcome reporting such as specific number of levels, insurance providers, etc. Lastly, we need to include the total cost of care for each group of patients.

Conclusions

There will soon be a time where neurosurgeons & spine surgeons will be responsible for the overall cost of care to their patients including operative expenditures. In time, insurance companies will reimburse based on better outcomes with lower costs at a baseline quality. Starting on July 1, 2022, the Transparency in Coverage (TiC) Final Rules require group health plans and insurance issuers to disclose, on a public website, information regarding in-network and out-of-network rates for covered items and services [Centers for Medicare and Medicaid Services (CMS) website]. This is the first step in complete cost transparency for patients, providers and hospitals. The next step is adding resource utilization, 30-day complication rates, and outcome data.

Acknowledgments

Funding: None.

Footnote

Reporting Checklist: The authors have completed the RIGHT reporting checklist. Available at https://jss.amegroups.com/article/view/10.21037/jss-23-136/rc

Peer Review File: Available at https://jss.amegroups.com/article/view/10.21037/jss-23-136/prf

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at https://jss.amegroups.com/article/view/10.21037/jss-23-136/coif). R.E. and J.M.A are founders and majority shareholders in outcome reporting software company used in this study, DTX Medical, Inc. The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki

© Journal of Spine Surgery. All rights reserved.

(as revised in 2013). The study was deemed exempt by the ethics board of WCG Clinical (1019 39th Ave SE, Puyallup, WA 98374, USA) and individual consent for this retrospective analysis was waived.

Open Access Statement: This is an Open Access article distributed in accordance with the Creative Commons Attribution-NonCommercial-NoDerivs 4.0 International License (CC BY-NC-ND 4.0), which permits the non-commercial replication and distribution of the article with the strict proviso that no changes or edits are made and the original work is properly cited (including links to both the formal publication through the relevant DOI and the license). See: https://creativecommons.org/licenses/by-nc-nd/4.0/.

References

1. iData Research. How Many Spinal Fusions are Performed Each Year in the United States? [Internet]. iData Research. 2018 [cited 2023 Jun 28]. Available online: https://idataresearch.com/how-many-instrumented-spinal-fusions-are-performed-each-year-in-the-united-states/
2. Oren J, Hutzler LH, Hunter T, et al. Decreasing spine implant costs and inter-physician cost variation: the impact of programme of cost containment on implant expenditure in spinal surgery. Bone Joint J 2015;97-B:1102-5.
3. Lopez CD, Boddapati V, Lombardi JM, et al. Recent trends in medicare utilization and reimbursement for lumbar spine fusion and discectomy procedures. Spine J 2020;20:1586-94.
4. Whoriskey P, Keating D, Sun LH. Data uncover nation's top Medicare billers. The Washington Post [Internet]. 2014 Apr 8 [cited 2023 Jun 28]; Available online: https://www.washingtonpost.com/business/economy/data-uncover-nations-top-medicare-billers/2014/04/08/9101a77e-bf39-11e3-b574-f8748871856a_story.html
5. Puffer RC, Planchard R, Mallory GW, et al. Patient-specific factors affecting hospital costs in lumbar spine surgery. J Neurosurg Spine 2016;24:1-6.
6. Karamian BA, Minetos PD, Levy HA, et al. The Effect of Anterior Cervical Discectomy and Fusion Procedure Duration on Patient-Reported Outcome Measures. World Neurosurg 2022;164:e548-56.
7. de Kunder SL, van Kuijk SMJ, Rijkers K, et al. Transforaminal lumbar interbody fusion (TLIF) versus posterior lumbar interbody fusion (PLIF) in lumbar spondylolisthesis: a systematic review and meta-analysis. Spine J 2017;17:1712-21.
8. Gerlach EB, Richards AR, Plantz MA, et al. Measuring Value in Elective Spine Surgery. Spine Surg Relat Res 2022;6:416-21.
9. Karhade AV, Bono CM, Makhni MC, et al. Value-based health care in spine: where do we go from here? Spine J 2021;21:1409-13.
10. Kahn EN, Ellimoottil C, Dupree JM, et al. Variation in payments for spine surgery episodes of care: implications for episode-based bundled payment. J Neurosurg Spine 2018;29:214-9.
11. St-Pierre GH, Yang MH, Bourget-Murray J, et al. Performance Indicators in Spine Surgery. Spine (Phila Pa 1976) 2018;43:275-80.
12. Weiss AJ, Elixhauser A, Andrews RM. Characteristics of Operating Room Procedures in U.S. Hospitals, 2011. In: Healthcare Cost and Utilization Project (HCUP) Statistical Briefs. Rockville (MD): Agency for Healthcare Research and Quality (US); 2014.
13. Hyder JA, Hirschberg RE, Nguyen LL. Home discharge as a performance metric for surgery. JAMA Surg 2015;150:96-7.

Cite this article as: Elsabeh R, Abrahams JM. Best practices guidelines in the postoperative management of patients who underwent cervical and lumbar fusions. J Spine Surg 2024. doi: 10.21037/jss-23-136

© Journal of Spine Surgery. All rights reserved.