Geriatric comanagement reduces perioperative complications and shortens duration of hospital stay after lumbar spine surgery: a prospective single-institution experience

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OBJECTIVE Geriatric patients undergoing lumbar spine surgery have unique needs due to the physiological changes of aging. They are at risk for adverse outcomes such as delirium, infection, and iatrogenic complications, and these complications, in turn, contribute to the risk of functional decline, nursing home admission, and death. Whether preoperative and perioperative comanagement by a geriatrician reduces the incidence of in-hospital complications and length of in-hospital stay after elective lumbar spine surgery remains unknown.

METHODS A unique model of comanagement for elderly patients undergoing lumbar fusion surgery was implemented at a major academic medical center. The Perioperative Optimization of Senior Health (POSH) program was launched with the aim of improving outcomes in elderly patients (> 65 years old) undergoing complex lumbar spine surgery. In this model, a geriatrician evaluates elderly patients preoperatively, in addition to performing routine preoperative anesthesia surgical screening, and comanages them daily throughout the course of their hospital stay to manage medical comorbid conditions and coordinate multidisciplinary rehabilitation along with the neurosurgical team. The first 100 cases were retrospectively reviewed after initiation of the POSH protocol and compared with the immediately preceding 25 cases to assess the incidence of perioperative complications and clinical outcomes.

RESULTS One hundred twenty-five patients undergoing lumbar decompression and fusion were enrolled in this pilot program. Baseline characteristics were similar between both cohorts. The mean length of in-hospital stay was 30% shorter in the POSH cohort (6.13 vs 8.72 days; $p = 0.06$). The mean duration of time between surgery and patient mobilization was significantly shorter in the POSH cohort compared with the non-POSH cohort (1.57 days vs 2.77 days; $p = 0.02$), and the number of steps ambulated on day of discharge was 2-fold higher in the POSH cohort ($p = 0.04$). Compared with the non-POSH cohort, the majority of patients in the POSH cohort were discharged to home (24% vs 54%; $p = 0.01$).

CONCLUSIONS Geriatric comanagement reduces the incidence of postoperative complications, shortens the duration of in-hospital stay, and contributes to improved perioperative functional status in elderly patients undergoing elective spinal surgery for the correction of adult degenerative scoliosis.

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KEY WORDS comanaged care; spine surgery; complications; length of stay; perioperative care; geriatric; lumbar

ABBREVIATIONS AFib = atrial fibrillation; BMI = body mass index; CAD = coronary artery disease; CHF = congestive heart failure; CVD = cardiovascular disease; DM = diabetes mellitus; HTN = hypertension; IQR = interquartile range; LOS = length of stay; MI = myocardial infarction; POSH = Perioperative Optimization of Senior Health; SNF = skilled nursing facility.

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DEGENERATIVE disorders of the lumbar spine are a major cause of low-back pain and morbidity in the rapidly growing geriatric population in the United States.^{13,18,20,22,23} Symptomatic low-back and leg pain can lead to loss of function or the inability to perform basic activities of daily living. Surgical treatment for low-back pain historically has been pursued with limited success in elderly patients; however, the need and demand for surgical treatment in this population have been increasing to reduce pain and disability and to increase quality of life.^{3,7,20}

Geriatric patients undergoing complex spine surgery have unique needs that must be considered. Due to the physiological changes of aging and associated medical comorbidities, elderly patients have a higher risk of perioperative complications and adverse events including delirium, infection, and other iatrogenic complications. These issues ultimately can contribute to functional decline, nursing home admissions, and death. Geriatricians, who are skilled in caring for the clinical and social complexities of the elderly population, may be able to identify and reduce these risks perioperatively. Accordingly, comanagement by both neurosurgeons and geriatricians could offer a way to optimize medical management and improve outcomes for geriatric patients undergoing spinal surgery. However, whether neurosurgical-geriatric comanagement empirically improves the patient's perioperative experience or reduces complications is unknown.

The aim of this study was to determine if neurosurgical-geriatric comanagement significantly improves postoperative care and decreases perioperative complications, in-hospital length of stay (LOS), and 30-day readmission rates.

Methods

Patient Selection

This was a retrospective study of 125 elderly patients undergoing elective spinal surgery at a major academic medical center following implementation of the Perioperative Optimization of Senior Health (POSH) program. The records of the first 100 cases following POSH implementation and the records of the immediately preceding 25 cases were reviewed.

We included patients aged 65 years and older with the following characteristics: 1) had back pain and/or radiculopathy; 2) radiographic evidence of thoracolumbar deformity; 3) prior failed nonsurgical treatment; and 4) underwent multilevel lumbar decompression and fusion. Patients were excluded if they had a severe coexisting pathology that could confound the assessment of operative outcome or were nonambulatory at baseline.

Demographic variables that were evaluated included patient age, sex, and body mass index (BMI). Comorbidities included hypertension (HTN), diabetes mellitus (DM), cardiovascular disease (CVD), coronary artery disease (CAD), congestive heart failure (CHF), atrial fibrillation (AFib), and prior myocardial infarction (MI). Smoking status was also determined.

Geriatric Comanagement Model

A unique model of shared care for elderly patients un-

dergoing lumbar fusion surgery was implemented at a major academic medical center. The POSH program was launched with the aim of improving outcomes in elderly patients (> 65 years old) undergoing complex spine surgery procedures. In addition to routine preoperative anesthesia surgical screening, this model utilizes a geriatrician to evaluate patients preoperatively and postoperatively. In addition, the geriatrician manages the patients throughout the course of their hospital stay to manage medical comorbidities and coordinate multidisciplinary rehabilitation with the neurosurgical team.

Postoperative Complications

We assessed the postoperative complications of each patient included in the study. Surgical complications were defined as complications that were the direct result of surgery. These complications included hardware failure requiring a revision procedure, surgical site infections, and new-onset sensory/motor deficits. Nonsurgical complications were defined as complications resulting from medical conditions not directly related to surgery. These complications included deep vein thrombosis, pulmonary embolism, MI, chest pain, fever, and other medical complications.

30-Day Hospital Readmission Rate

We reviewed the hospital charts of each readmission to determine the cause of readmission. Unplanned readmissions were defined as either surgical or nonsurgical complications. Planned readmissions were defined as either a staged or rescheduled procedure. For a staged procedure, the patient was discharged with the expectation that he or she would be readmitted for the subsequent stage of the procedure. A rescheduled procedure occurred when the patient was admitted on the day of surgery but the procedure was cancelled prior to surgery, the patient was discharged, and the procedure was rescheduled to occur within a month. Planned readmissions were not included in the final data analysis and were not used to calculate surgical readmission rates. Only unplanned hospital readmissions were included in the final analysis.

Postoperative Functional Status

Variables included to assess postoperative functional status included the duration to first ambulation, the distance ambulated on the first day of ambulation, and the distance ambulated on the day of discharge. The in-hospital LOS and discharge disposition (home vs skilled nursing facility [SNF] vs acute rehabilitation facility) were also assessed.

Statistical Analysis

Parametric data were expressed as the mean $\pm$ SD and compared using the Student t-test. Nonparametric data were expressed as the median (interquartile range [IQR]) and compared using the Mann-Whitney U-test. Nominal data were compared using the chi-square test. All tests were 2-sided and statistically significant if the *p* value was less than 0.05. We used SAS 9.3 (SAS Institute, Inc.) for all data preparation and analysis.

TABLE 1. Baseline characteristics of elderly patients undergoing lumbar fusion surgery

Characteristic	POSH	Non-POSH	p Value
No. of patients	100	25	
Age, yrs	73.60 ± 6.03	73.04 ± 4.88	0.62
BMI, kg/m ²	28.89 ± 6.24	27.15 ± 5.37	0.17
Male	41.00	36.00	0.65
Smoker	3.00	16.00	0.10
CHF	4.00	12.00	0.25
CAD	21.00	28.00	0.49
CVD	7.00	8.00	0.87
MI	9.00	12.00	0.69
HTN	62.00	64.00	0.85
AFib	2.00	8.00	0.30
DM	23.00	8.00	0.03

Values are shown as the percentage or mean ± SD unless stated otherwise.

Results

One hundred twenty-five adult patients (25 patients in the non-POSH cohort and 100 patients in the POSH cohort) were included in this study. There was no significant difference in the mean age between groups (73.04 ± 4.88 years in the non-POSH cohort vs 73.60 ± 6.03 years in the POSH cohort; $p = 0.62$). An approximately equal percentage of men were included in both groups (36.00% of the non-POSH cohort vs 41.00% of the POSH cohort; $p = 0.65$). There was no significant difference in BMI (27.15 ± 5.37 kg/m² in the non-POSH cohort vs 28.89 ± 6.24 kg/m² in the POSH cohort; $p = 0.17$) or smoking status (16.00% of the non-POSH cohort vs 3.00% of the POSH cohort were smokers; $p = 0.10$) between cohorts. There were no significant differences in the prevalence of other comorbidities such as CHF, CAD, CVD, MI, HTN, AFib, or DM. A comparison of these baseline characteristics is shown in Table 1.

The median (IQR) number of fusion levels between groups was similar (6.5 [3–11] levels in the non-POSH cohort vs 6 [3–10] levels in the POSH cohort; $p = 0.90$). The percentage of patients with intraoperative durotomy was similar between both groups (12.00% of the non-POSH cohort vs 9.00% of the POSH cohort; $p = 0.68$). There were no incidences of nerve root injury or spinal cord injury in either group (Table 2).

Postoperative Complications Profile

The postoperative incidence of delirium was not significantly different between groups (16.00% in the non-POSH cohort vs 18.00% in the POSH cohort; $p = 0.81$). The incidence of ileus was also similar between cohorts (16.00% in the non-POSH cohort vs 10.00% in the POSH cohort; $p = 0.46$). The incidences of pneumonia (4.00% in the non-POSH cohort vs 5.00% in the POSH cohort; $p = 0.82$) and urinary tract infection (4.00% in the non-POSH cohort vs 8.00% in the POSH cohort; $p = 0.41$) were not significantly different between groups. There were no incidences of postoperative deep vein thrombosis or pulmonary embolism in the non-POSH cohort, but 1 case of DVT and 2 cases of pulmonary embolism in the POSH cohort ($p = 0.31$ and $p = 0.31$, respectively). There was a similar incidence of MI in both groups (1.00% in the non-POSH cohort vs 1.00% in the POSH cohort; $p = 0.47$). A comparison of these postoperative complications is shown in Table 2.

TABLE 2. Total and cohort-specific postoperative complication rates

Variable	POSH	Non-POSH	p Value
Operative details/complications			
No. of levels	6 (3–10)	6.5 (3–11)	0.90
Intraop durotomy	9.00	12.00	0.68
Nerve root injury	0.00	0.00	1.00
Spinal cord injury	0.00	0.00	1.00
Postoperative complications			
Delirium	18.00	16.00	0.81
Ileus	10.00	16.00	0.46
Pneumonia	5.00	4.00	0.82
Urinary tract infection	8.00	4.00	0.41
Deep vein thrombosis	1.00	0.00	0.31
Pulmonary embolism	2.00	0.00	0.31
MI	1.00	1.00	0.47

Values are presented as the percentage or median (IQR) unless stated otherwise.

lism in the non-POSH cohort, but 1 case of DVT and 2 cases of pulmonary embolism in the POSH cohort ($p = 0.31$ and $p = 0.31$, respectively). There was a similar incidence of MI in both groups (1.00% in the non-POSH cohort vs 1.00% in the POSH cohort; $p = 0.47$). A comparison of these postoperative complications is shown in Table 2.

Postoperative Functional Status

Compared with the POSH cohort, the non-POSH cohort had a 2-fold increase in the number of days from surgery to ambulation (2.77 ± 2.28 days in the non-POSH cohort vs 1.57 ± 0.96 days in the POSH cohort; $p = 0.02$) (Fig. 1). The number of feet walked on ambulatory Day 1 was almost 2.5 times greater for the POSH group compared with the non-POSH group (44.92 ± 75.38 feet in the non-POSH cohort vs 110.31 ± 122.99 feet in the POSH cohort; $p = 0.01$) (Table 3). The number of feet walked on the day of discharge was also greater in the POSH group compared with the non-POSH group (111.60 ± 116.59 feet in the non-POSH cohort vs 211.61 ± 250.23 feet in the POSH cohort; $p = 0.04$) (Fig. 1).

The mean in-hospital LOS was approximately 2 days (30%) shorter for the POSH group than the non-POSH group (8.72 ± 6.10 days in the non-POSH cohort vs 6.13 ± 5.73 days in the POSH cohort; $p = 0.06$) (Fig. 1). The majority of patients in the POSH cohort were discharged directly home (24.00% in the non-POSH cohort vs 54.00% in the POSH cohort; $p = 0.01$), with only a minority of patients requiring an additional stay at an SNF or acute rehabilitation facility (20.00% in the non-POSH cohort vs 3.00% of the POSH cohort; $p = 0.04$) (Fig. 1).

There was no significant difference in the 30-day readmission rate (8.00% of the non-POSH cohort vs 10.00% of the POSH cohort; $p = 0.77$) or 30-day mortality rate (0.00% of the non-POSH cohort vs 0.00% of the POSH cohort; $p = 0.99$) between groups. A comparison of these functional status outcomes is shown in Table 3.

FIG. 1. Functional status of patients in the POSH cohort appears to be superior to that of non-POSH patients. The number of days from surgery to mobilization is significantly shorter. The majority of patients in the POSH cohort were discharged directly to home.

Discussion

In this retrospective cohort study of elderly patients (> 65 years old) undergoing elective spinal surgery, we observed that patients who received neurosurgical-geriatric comanagement (POSH cohort) had a shorter in-hospital LOS and improved functional status at discharge. Patients participating in the POSH program were mobilized sooner and to a greater degree than non-POSH patients, and they were more likely to be discharged directly home.

Surgical management for the treatment of symptomatic low-back and leg pain is currently associated with more favorable outcomes than nonsurgical management. Recent studies have shown that surgical management of degenerative lumbar disorders can lead to improved quality of life in the geriatric population. In a retrospective study of 4370 patients undergoing lumbar spine surgery, McGirt et al. found that elderly patients experienced a similar improvement in pain, disability, and quality of life without an increase in complications or 90-day hospital readmission when compared with younger patients.¹⁷ Similarly, Devin et al. also found an equivalent improvement in pain, disability, and quality of life among elderly patients undergoing elective lumbar spinal surgery for degenerative disease. Furthermore, Devin et al. observed that the cost-effectiveness, as measured by cost per quality-adjusted life year gained, of lumbar decompression with and without fusion was similar between 2 age groups.⁹ In another retrospective study of 69 elderly patients undergoing revision lumbar decompression and instrumented fusion, Adogwa et al. determined that revision lumbar surgery also leads

to improvement in low-back pain, disability, and quality of life, while demonstrating improved cost-effectiveness over other nonoperative treatment modalities.^{1,2}

Spinal surgery in elderly patients has been associated with an unfavorable complications profile. In a retrospective study of 453 elderly patients (> 65 years old) undergoing surgery for adult degenerative scoliosis, Drazin et al. determined that older age was associated with a higher overall reoperation rate, higher readmission rates, and more complications during index hospitalization and within 30 days of discharge.¹¹ In another retrospective study of elderly patients in the Nationwide Inpatient Sample database who underwent surgery for adult degenerative scoliosis, Worley et al. found that elderly patients had an increased risk of inpatient morbidity and mortality compared with patients between the ages of 25 and 64 years.²⁴ Daubs et al. found that increasing age and age over 69 years predicted complications in patients undergoing surgery for adult spinal deformities.⁸ Deyo et al. found that major medical complications and 30-day mortality rates are independently associated with older age. Additionally, Deyo et al. found that the likelihood of 30-day rehospitalization also increased with age.¹⁰ In a retrospective study of 98 elderly patients undergoing lumbar decompression and arthrodesis, Carreon et al. observed that complication rates increased with increasing age, increased blood loss, longer operative time, and number of levels fused.⁵ Similarly, Li et al. found that complication and mortality rates were directly related to increasing patient age.¹⁶ Accordingly, the high complication rates associated with spine surgery in this subpopula-

TABLE 3. Total and cohort-specific differences in functional outcomes

Outcome	POSH	Non-POSH	p Value
Days from surgery to ambulation	1.57 ± 0.96	2.77 ± 2.28	0.02
No. of feet walked on 1st ambulatory day	110.31 ± 122.99	44.92 ± 75.38	0.01
No. of feet walked on day of discharge	211.61 ± 250.23	111.60 ± 116.59	0.04
LOS, days	6.13 ± 5.73	8.72 ± 6.10	0.06
Discharge to home	54.00	24.00	0.01
Discharge to SNF	43.00	52.00	0.33
Discharge to acute rehabilitation facility	3.00	20.00	0.04
30-day readmission rate	10.00	8.00	0.77
30-day mortality rate	0.00	0.00	1.00

Values are shown as the percentage or mean ± SD unless stated otherwise.

tion of patients underscores the need for a multidisciplinary approach to manage these patients postoperatively.

A patient's discharge location after surgery is a surrogate measure of functional status. In a retrospective study of a merged database between the American College of Surgeons National Surgical Quality Improvement Program and Medicare claims between 2005 and 2008, Sacks et al. found that patients with at least 1 complication were discharged to a post-acute care facility and poor functional status was associated with increased odds of discharge to a post-acute care facility.¹⁹

Discharge to a post-acute care facility is associated with increased health care utilization. In an observational study of Medicare data on patients with a stroke or hip fracture event, Buntin et al. found that discharge to an SNF was an average of \$8944 more expensive than discharge to home.⁴ In a retrospective study 1127 patients enrolled in the Cardiac Arrest Registry to Enhance Survival (CARES), Chan et al. found that following cardiac arrest elderly patients who were discharged to an SNF or rehabilitation facility had a greater than 2-fold higher readmission cost compared with patients who were discharged home.⁶ Similarly, in a retrospective study of Medicare claims data for patients undergoing hip or knee replacements, Snow et al. found that patients reduced their health care payments by an average of \$871 by avoiding discharge to post-acute care facilities, including SNFs, home health agencies, and inpatient rehabilitation centers.²¹ Our study demonstrated that the POSH comanagement program led to increased discharges directly to home with a corresponding reduction in discharges to post-acute care facilities. Therefore, implementation of a postoperative comanagement program may lead to decreased health care resource utilization and costs.

To date, there has been a paucity of studies delineating the relationship between comanaged care and perioperative outcomes. In 2008, Friedman et al. described an orthopedic-geriatric comanaged program that resulted in

lower-than-predicted LOS, readmission rates, complication rates, and mortality rates for patients with surgical management of hip fractures.¹² In support of these results, in a retrospective review of 758 patients undergoing surgical management with hip fractures, Kates et al. also found that LOS, 30-day readmission rates, reoperation rates, and mortality rates decreased after implementation of an orthopedic-geriatric comanaged care program.¹⁵ Similarly, Kammerlander et al. described a similar orthopedic-geriatric program that resulted in decreased LOS and mortality rates, as well as an increase in return to prefracture residency, compared with before program implementation.¹⁴ Similar to these other multidisciplinary care programs, we observed that the neurosurgical-geriatric co-care POSH program was associated with a shortened in-hospital LOS and increases in the number of feet walked on ambulatory Day 1 and discharge.

This study has limitations, thereby resulting in possible implications in its interpretation. First, these data were obtained by chart review and are limited by the information recorded during care. This study is also subject to the weaknesses of retrospective analyses. The study was performed following the institution-wide implementation of the POSH program and therefore could not control for systemic changes that resulted from program implementation and may have impacted patient care. Additionally, the patient population chosen for this analysis were participants in the early implementation of the POSH program, which could have resulted in the Hawthorne effect and better outcomes. Lastly, to our knowledge this is the first program that employed a neurosurgical-geriatric postoperative comanagement program. Thus, the optimal preoperative patient selection factors that are predictive of success in such a program are unknown. Despite these limitations, the study has shown that implementing a multidisciplinary program for elderly patients undergoing lumbar spine surgery reduces perioperative complications, shortens in-hospital LOS, and improves postoperative functional status. Therefore, a comanagement program should be considered a part of the surgical management for elderly patients undergoing multilevel decompressive surgery for deformity with refractory symptoms.

Conclusions

In our experience, geriatric comanagement significantly reduces the incidence of postoperative complications, shortens in-hospital LOS, and contributes to improved perioperative functional status in elderly patients undergoing elective spinal surgery for correction of adult degenerative scoliosis.

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Disclosures

Dr. Karikari is a consultant for NuVasive.

Author Contributions

Conception and design: Adogwa, Elsamadicy. Acquisition of data: Elsamadicy. Analysis and interpretation of data: Adogwa, Elsamadicy. Drafting the article: Vuong. Critically revising the article: Adogwa, Elsamadicy, Vuong. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Adogwa. Statistical analysis: Adogwa, Elsamadicy. Study supervision: Adogwa, Cheng, Karikari, Bagley.

Supplemental Information

Previous Presentations

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