

## Original Article

# Decreasing hospital length of stay following lumbar fusion utilizing multidisciplinary committee meetings involving surgeons and other caretakers

Lisa B. E. Shields<sup>1</sup>, Lisa Clark<sup>1</sup>, Steven D. Glassman<sup>2</sup>, Christopher B. Shields<sup>1,3</sup><sup>1</sup>Norton Neuroscience Institute, Norton Healthcare, <sup>2</sup>Department of Orthopedic Surgery, Norton Leatherman Spine Center, <sup>3</sup>Department of Anatomical Science and Neurobiology, University of Louisville School of Medicine, Louisville, Kentucky, USA

E-mail: Lisa B.E. Shields - LBES@earthlink.net; Lisa Clark - Lisa.Clark@nortonhealthcare.org; Steven D. Glassman - SDG12345@aol.com;

\*Christopher B. Shields - cbshields1@gmail.com

\*Corresponding author

Received: 03 August 16 Accepted: 29 October 16 Published: 19 January 17

## Abstract

**Background:** Although hospital length of stay (LOS) following lumbar fusion has decreased for a variety of reasons, different institutions find their LOS over the benchmarks published by the national Agency for Healthcare Research and Quality (AHRQ). Over a 3-year period, this prospective study introduced utilization of multidisciplinary committee meetings between surgeons and other caretakers to decrease LOS following spinal fusion surgery without compromising the quality of care.

**Methods:** A multidisciplinary committee was established to assess factors and institute recommendations that influence hospital LOS following lumbar fusion compared to the national compared to the national AHRQ benchmark at baseline and at 1 and 2 years after adjusting our standard practice. We also analyzed re-admission rates at 7 and 30 days and determined the average variable direct cost.

**Results:** While the national AHRQ benchmark average LOS (ALOS) was statistically better for DRGs 459 and 460 for all three years except for DRG 459 in the baseline year compared to our ALOS, we observed improvement in the ALOS for both DRG 459 and 460 throughout the 3 years of the study. ALOS for DRG 460 was statistically different for 2011–2012 vs 2013–2014 ( $P < 0.001$ ) and 2012–2013 vs 2013–2014 ( $P < 0.001$ ). There was a statistically significant improvement in cost initially for 2012–2013 vs 2011–2012 ( $P < 0.001$ ) and for 2013–2014 vs 2011–2012 ( $P = 0.001$ ).

**Conclusions:** This study established an effective patient discharge plan, patient education, partnerships with rehabilitation facilities, and study review and discussion among physicians and staff. Further monitoring of factors that impact hospital LOS following lumbar fusion is warranted to curtail patient complications and organizational expenditures while providing superior medical care.

**Key Words:** Cost, fusion, hospital stay, lumbar, spine

### Access this article online

**Website:**[www.surgicalneurologyint.com](http://www.surgicalneurologyint.com)**DOI:**

10.4103/2152-7806.198732

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**How to cite this article:** Shields LB, Clark L, Glassman SD, Shields CB. Decreasing hospital length of stay following lumbar fusion utilizing multidisciplinary committee meetings involving surgeons and other caretakers. *Surg Neurol Int* 2017;8:5.

<http://surgicalneurologyint.com/Decreasing-hospital-length-of-stay-following-lumbar-fusion-utilizing-multidisciplinary-committee-meetings-involving-surgeons-and-other-caretakers/>

## INTRODUCTION

Spine-related health-care expenses totaled \$86 billion in 2005, a 65% increase from 1997.<sup>[6,7,19]</sup> In 2011, spinal fusion was the most costly operating room procedure performed in the United States, constituting over \$12 billion in aggregate costs for hospital stays.<sup>[18]</sup> Diminishing length of stay (LOS) following lumbar fusion is a valuable step in curtailing healthcare costs.

Several factors have been identified as increasing postoperative LOS and/or readmission in patients undergoing lumbar fusions, including increased age, increased body mass index, number of levels fused, American Society of Anesthesiologists class 3–4, preoperative hematocrit <36.0, and steroid use.<sup>[1,2,5]</sup> Complications following lumbar fusion including anemia requiring transfusion, wound infection, postoperative fever, or return to the operating room<sup>[3-5,13,15]</sup> may result in a longer hospital stay, which may lead to the additional risks of nosocomial infections and DVT.<sup>[5]</sup>

A multidisciplinary committee was established at our Institution in 2012 to investigate why our hospital LOS data for lumbar fusion was significantly greater than the national Agency for Healthcare Research and Quality (AHRQ) benchmark. We identified and corrected six areas integrally related to complex lumbar spine surgery, which resulted in a significant decrease in LOS.

In the current study, we present our findings of the average LOS (ALOS) compared to the national AHRQ benchmark, the average variable direct cost, and the re-admission rates at 7 and 30 days postoperatively for lumbar fusion with and without major comorbidities over a 3-year time span. We also discuss physician and patient expectations of LOS and analyze factors that play a role in expediting a patient's postoperative hospital stay.

## MATERIALS AND METHODS

Under an institutional review board-approved protocol, the current prospective study (11/1/2011–10/31/2014) was conducted in a 500-bed tertiary spine center with a total spine volume of approximately 2650 cases annually. The cases consisted of lumbar fusion and instrumentation with the DRG codes 459 and 460. DRG 459 denotes spine fusion except cervical with major comorbidities. DRG 460 includes cases of spine fusion except cervical without major comorbidities. A multidisciplinary committee was established at our Institution to assess the various aspects that may play a role in influencing LOS after lumbar fusion [Table 1].

Prior to the study, each spine (neurosurgery and orthopedic) surgeon was asked about their ALOS for a patient undergoing a lumbar fusion. Surgeons frequently left discharge planning to the physical therapists,

discharge planners, and nurses. The LOS data for DRG codes 459 and 460 at our Institution were evaluated over 3 years; (1) baseline – initial multidisciplinary committee meeting (11/1/2011 to 10/31/2012); 2) 1 year later (11/1/2012 to 10/31/2013); and 3) 2 years later (11/1/2013 to 10/31/2014). The average LOS data were compared to the national AHRQ benchmark, the re-admission rates were analyzed at 7 and 30 days following hospital discharge after lumbar fusion, and the average variable direct cost was calculated to determine whether there was an organizational cost saving when patients have a shorter hospital LOS following lumbar fusion. Our Institution does not provide the actual costs of hospital care and, therefore, we presented the cost savings as a percentage change.

The multidisciplinary committee identified six factors that play a significant role in decreasing the hospital LOS following lumbar fusion [Table 2]. We also established ambulation [Table 3] and drain protocols [Table 4] for patients after lumbar fusion.

### Statistical analysis

For the 459 and 460 diagnosis codes, the ALOS for each of the 3 years was compared to the national AHRQ

**Table 1: Multidisciplinary committee to assess hospital length of stay following lumbar fusion**

Neurosurgeon
Orthopedic spine surgeon
Neuroscience program manager
Nurse manager from neuro/spine unit
Director care manager who oversees discharge planning and care managers
Supervisor of physical therapy
Director of clinical effectiveness
Office manager for neurosurgery and orthopedic/spine surgery
Director of operations
Quality manager
Neuro-spine nurse educator
Pre-admission testing/PACU manager in the recovery room

**Table 2: Modifiable features affecting hospital length of stay following lumbar fusion in order of importance**

Physician expectation of length of stay
Patient and family expectations of length of stay
Need for nurses and physical therapists to encourage early mobilization postoperatively
Streamlining the discharge to a subacute rehabilitation center
Improved protocol for hemovac drain use
Discharge early during the day

**Table 3: Ambulation protocol after lumbar fusion**

Timing after Lumbar Fusion	Patient's Instruction
Night of surgery	Sit on edge of bed
Postoperative day 1	Physical therapy on two occasions
Postoperative day 2	Walking in hall and climbing stairs

benchmark using one-sample *t*-tests. Yearly ALOS within codes 459 and 460 were compared with each other using one-way analysis of variance (ANOVA) followed by Tukey HSD *post hoc t*-tests. The differences in cost per year between 2012–2013 and 2013–2014 were compared to the cost value for 2011–2012 using one-sample *t*-tests.

## RESULTS

### Yearly average length of stay compared to AHRQ benchmark and to each year following lumbar fusion

There was a noticeable improvement in the ALOS for both DRG 459 and 460 throughout the 3 years of this study. When the ALOS was compared to the national AHRQ benchmark for the 3-year time period (11/1/2011 to 10/31/2014), the national AHRQ benchmark ALOS was statistically better for both DRGs 459 and 460 for all 3 years of study except for DRG 459 in the baseline year compared to the ALOS at our Institution [Table 5].

The analysis of ALOS comparing each year with each other for DRG 459 was not significant by ANOVA. When the yearly ALOS was compared to each other for both DRGs 459 and 460, the ALOS for DRG 460 for each year vs. benchmark data was statistically significant by ANOVA ( $P < 0.001$ ). The ALOS for DRG 460 was statistically different for 2013–2014 (3.66) vs 2011–2012 (4.17) ( $P < 0.001$ ) and 2013–2014 (3.66) vs 2012–2013 (4.12) ( $P < 0.001$ ) although not for 2011–2012 (4.17) vs 2012–2013 (4.12), as discerned by the Tukey HSD *post hoc t*-test.

### Average variable direct cost

There was a statistically significant difference comparing the cost change from both 2012–2013 and 2013–2014 compared to the baseline (2011–2012) [Table 6]. To calculate the average variable direct cost, we determined the percentage change at each month from 11/1/2012 to 10/1/2014 compared to the initial baseline time period (11/1/2011 to 10/31/2012). For the baseline year, the mean was  $-0.032$  (SD = 0.049,  $N = 12$ ).

### Readmission rates at 7 and 30 days following hospital discharge after lumbar fusion

The readmission rates at both 7 and 30 days following hospital discharge after lumbar fusion for DRGs 459 and 460 were similar for the three periods [Table 7]. The number of patients readmitted at 30 days following discharge was highest for DRG 459 between 11/1/2013 and 10/31/2014. Four (7.7%) patients with the assigned code DRG 459 were readmitted at 30 days, two of whom experienced a postoperative infection. One patient with a history of uncontrolled diabetes mellitus, a body mass index (BMI) over 40, and undergoing hemodialysis underwent a second surgical procedure

### Table 4: Drain protocol after lumbar fusion at our Institution

Deep drains not routinely used on 1 or 2-level spine surgery  
If a deep drain is used, it will be placed to gravity drainage for the first 24 hours and then placed to suction after 24 hours  
All drains will be removed by the second or third day (preferably the second day)

### Table 5: Comparison of average length of stay at our Institution and national AHRQ benchmark following lumbar fusion

Time Period	DRG Code	
	459	460
Baseline		
11/1/2011-10/31/2012		
# inpatients	41	593
ALOS	9.44	4.17
AHRQ	8.9	3.443
<i>P</i>	N.S.	<0.001
11/1/2012-10/31/2013		
# inpatients	47	601
ALOS	7.06	4.12
AHRQ	8.7	3.391
<i>P</i>	0.001	<0.001
11/1/2013-10/31/2014		
# inpatients	52	644
ALOS	6.54	3.66
AHRQ	8.7	3.391
<i>P</i>	<0.001	<0.001

### Table 6: Average variable direct cost of lumbar fusions at our Institution

Years of Study	Mean	SD	<i>P</i>
2011-2012 (Baseline)	-0.032	0.049	
2012-2013	-0.078	0.054	<0.001
2013-2014	-0.074	0.054	0.001

to treat a wound abscess 2 weeks later. Another patient underwent evacuation of a surgical site hematoma 12 days postoperatively. Additional postoperative complications necessitating hospital readmission at 30 days for DRG 460 included a screw replacement in 1 patient and an acute kidney injury secondary to rhabdomyolysis in 1 patient.

## DISCUSSION

Decreasing the length of hospital stay following lumbar fusion is an integral factor in promoting cost-effective medical care. In their study of 103 patients undergoing open 1- to 3-level posterior lumbar fusion, Gruskay *et al.* reported an average LOS of  $3.6 \pm 1.8$  days (mean  $\pm$  SD) (range of 0 to 12 days).<sup>[5]</sup> The average LOS for those with postoperative complication was

**Table 7: Readmission rates at 7 and 30 days following hospital discharge after lumbar fusion**

DRG Code	Baseline			11/1/2012 to 10/31/2013			11/1/2013 to 10/31/2014		
	11/1/2011 to 10/31/2012			N	# and % readmitted at 7 days	# and % readmitted at 30 days	N	# and % readmitted at 7 days	# and % readmitted at 30 days
	N	# and % readmitted at 7 days	# and % readmitted at 30 days						
459	41	0 (0.0%)	0 (0.0%)	47	0 (0.0%)	1 (2.2%)	52	1 (1.9%)	4 (7.7%)
460	593	5 (0.8%)	11 (1.9%)	601	4 (0.7%)	21 (3.5%)	644	5 (0.8%)	17 (2.6%)

increased to  $5.1 \pm 2.3$  days versus  $2.9 \pm 0.9$  days without complications.

### Reduced length of stay with minimally invasive vs. open lumbar fusions

Minimally invasive lumbar fusions resulted in shorter LOS compared with open procedures. In a study by Siemionow *et al.* involving 104 patients undergoing a 1-level minimally invasive transforaminal lumbar interbody fusion (TLIF), 78 patients were discharged more than 24 hours postoperatively, and their mean LOS was  $4 \pm 2$  days.<sup>[12]</sup> Wang *et al.* compared the LOS between 1- and 2-level MIS vs. and open posterior interbody fusions.<sup>[17]</sup> Of the 59 1-level procedures (75% MIS and 25% open), the mean LOS for MIS vs. open surgery was 3.9 and 4.8 days, respectively. Of the 15 2-level procedures (53% MIS and 47% open), the mean LOS for MIS vs. open surgery was 5.1 days and 7.1 days, respectively. Large variations in LOS (maximum 10 days) were attributed to a higher incidence of pulmonary, cardiac, infectious, and dural tear complications. There was no statistically significant difference between the complication rate in the 2-level MIS vs. open surgery groups.

### Improvement utilizing multidisciplinary meetings to decrease length of stay following lumbar fusions

We observed an improvement in our Institution's ALOS for both DRG 459 and 460 throughout the 3 years of study [Table 5]. Nevertheless, the national AHRQ benchmark ALOS was statistically better for both DRGs 459 and 460 over all the 3 years (e.g., one exception was DRG 459 in the baseline year vs. ALOS at our Institution).

### Decreased average length of stay directly correlated with cost savings

Both the ALOS and the average variable direct cost were significantly lowered over the course of our study. There was a statistically significant difference comparing the cost change from both 2012–2013 and 2013–2014 compared to the baseline (2011–2012) [Table 6]. In addition, patients were billed for each hour that they remained in the hospital postoperatively and, therefore, discharging a patient earlier in the day was important from both a statistical and cost-effectiveness standpoint.

### Surgeon's perspective of average length of stay following lumbar fusions

A striking aspect of the present study was the surgeon's perspective on the appropriate LOS following lumbar fusion. The LOS in the studies by Wang *et al.* and Gruskay *et al.* studies was prolonged due to complications,<sup>[5,17]</sup> whereas the increased LOS in this study was attributed primarily to the surgeon's preference (e.g. range of ALOS was 2–6 days). Once surgeons realized that patients could be discharged earlier without increased morbidity, the LOS precipitously dropped.

### Surgeon related factors impact average length of stay

Surgeon-related factors in relation to LOS after lumbar fusion are seldom addressed in the literature. Gruskay *et al.* reported that older and sicker patients were more likely to remain in the hospital longer and that surgeon- and hospital-related factors had little effect.<sup>[5]</sup> McGregor *et al.* found demonstrable inconsistencies between spinal surgeons in their survey regarding postoperative management; 79% had a routine postoperative management schemes, however, only 35% had written instructions.<sup>[9]</sup> In the current study, each surgeon's opinion clearly determined LOS following fusion surgery and was the primary target of the multidisciplinary meetings.

### Identification of multiple factors may reduce average length of stay following lumbar surgery

The authors found that the identification of multiple factors contributed to reducing ALOS following lumbar fusion surgery. Identifying patients prior to admission for lumbar fusion who may require care at a subacute/acute rehabilitation center postoperatively decreases the LOS. However, this is limited by mandatory hospital duration of at least 3 overnight stays following lumbar fusion in Medicare/Medicaid patients. The present study protocol for ambulation helped reduce ALOS [Table 3].

### Use of and timing of drain removal impact average length of stay

The use and timing of drains in posterior lumbar fusions impact the ALOS. Walid *et al.* showed that posthemorrhagic anemia and allogeneic blood transfusion were statistically more common in patients with drains.<sup>[14]</sup> There were no significant differences in wound infection

rates between patients with and without drains. The drain protocol in the present study assisted in decreasing the ALOS [Table 4].

### Concern for early (e.g., within 7–30 days) postoperative readmission rate with reduced average length of stay

Several studies in the literature have addressed the reasons for hospital readmission within 30 days following a lumbar fusion [Table 8].<sup>[2,11,16]</sup> The findings in the present study are comparable to the literature regarding readmission at 30 days following complex lumbar fusion [Table 7].

### The value of preoperative patient education in reducing average length of stay following lumbar fusion

Patient education is a valuable tool in decreasing LOS following lumbar fusion. McGregor *et al.* reported the importance of patient education following spinal surgery in an attempt to involve the patient in his/her own medical treatment.<sup>[8,10]</sup> We recommend that patient education should commence concurrently with the surgeon's discussion regarding the surgical procedure with concomitant risk factors. This preoperative education aims to alleviate the stress and anxiety that often accompany lumbar fusions.

### Revision of pain management protocols to reduce average length of stay

There were also modifications in the pain management protocol that included the use of a postoperative patient-controlled analgesia (PCA) pump for 24 hours. When the patients were able to take oral medications, they were given oral narcotics and muscle relaxants. Additional intravenous medications were administered for breakthrough pain as needed.

## CONCLUSION

Future studies will analyze the lasting benefit of the six factors implemented at our Institution to decrease

hospital LOS following lumbar fusion. Further scrutiny may elucidate additional factors which may play a role in shortening hospital stay following lumbar fusion.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

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**Table 8: Hospital readmission following lumbar fusion in the literature**

Study	Hospital Readmission Rate	Reasons for Hospital Readmission
Pugely <i>et al.</i> 2014	5.4% (posterior lumbar fusion) 6.0% (anterior lumbar fusion)	Wound-related Pain-related Thromboembolic Systemic infections
Basques <i>et al.</i> 2014	3.7% (lumbar laminectomy)	Surgical site-related infections Pain-related UTI/urinary retention
Wang <i>et al.</i> 2012	7.3% (lumbar surgery)	Postoperative infections