Factors influencing the length of stay in patients with lumbar pedicle screw fixation

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INTRODUCTION

The changing climate in the health care industry is placing more focus on decreasing both the hospital stay and cost. An analysis of national health spending in 2004 found that although the rate of growth for overall spending slightly slowed to 7.9%, hospital spending continued to steadily increase. An analysis by Goz et al. revealed that the numbers of spinal fusion surgeries performed in the United States are increasing over time, with lumbar spinal fusions increasing at the greatest pace.\(^5\) In addition, the cost associated with these procedures is also increasing. The increased focus on cost and utilization by hospitals and payment organizations proposes length of stay (LOS) as a potentially modifiable factor to reduce the overall financial burden.

The goal of this retrospective analysis was to use our large database to definitively examine age, body mass index (BMI), American society of Anesthesiologists (ASA) and analyzed to determine a potential relationship with LOS.

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(BMI), and American society of Anesthesiologists (ASA) score as preoperative factors associated with an increased LOS in lumbar fusion patients. By definition, ASA score classifies patients into groups based on the overall medical condition. Therefore, our primary hypothesis was that a higher ASA score will be associated with increasing LOS. Secondary hypotheses were that increasing age and BMI may be associated with an increased LOS following lumbar spine fusion.

**MATERIALS AND METHODS**

**Data source**

After obtaining the appropriate institutional review board review, the medical records from all patients who underwent posterior instrumented lumbar spinal fusion from January 1, 2008 through July 31, 2014 were examined in a retrospective, blind fashion. All the patients underwent lumbar fusion by a single neurosurgeon at a single facility. Patients who met the criteria were pulled out of the electronic record based on a search by procedure codes. The information was entered by one coinvestigator and coded to maintain its integrity. All patients who met the criteria of undergoing instrumented posterior lumbar fusion were included in the database.

**Patient data**

Patient data including age, gender, BMI, and medical comorbidities were recorded, along with the ASA class. While the presence or absence of litigation and work injury/motor vehicle accident and variables related to the inpatient stay (including estimated blood loss and postoperative complications) were recorded, only age, BMI, and ASA class were tested to focus on our main hypotheses. LOS was noted for each patient and divided into three categories based on clinical significance and average stay.

**Statistical tests**

Descriptive statistics are presented using mean and standard deviation for the continuous variables of LOS, age, and BMI. ASA class is presented as median and interquartile range (because it is ordinal data). The presence of a relationship between LOS and age and BMI, and ASA class were tested using multiple linear regression. A constant term was included in the model because all patients required some LOS. A forward model building strategy was used with the Probability-of-F-to enter <=0.050 set as the criterion for model entry.

**RESULTS**

A total of 1360 cases were identified. Descriptive statistics and bivariate correlations are presented in Table 1. All variables showed significant but small correlations with the exception of the BMI-age pairing. Using multiple regression to predict LOS from ASA, BMI, and age, a statistically significant relationship was found; F (3, 1356) = 54.8, P < 0.001, R² = 0.108. The unstandardized coefficients, standardized coefficients, and t-scores for the complete regression model are presented in Table 2. All three variables were statistically significant to the prediction, P < 0.05. The Durbin-Watson coefficient for the full model was 2.007, indicating that there are no first order linear auto-correlations in our data.

**DISCUSSION**

The influence of patient variables on the length of hospital stay has been evaluated in an attempt to reduce the overall financial burden associated with these procedures. In this study, patients underwent lumbar fusion by one surgeon at one facility, thus eliminating some of the possible variability. As Table 2 shows, all variables had positive correlations with LOS, indicating that those with higher ASA, age, and BMI would be expected to have longer length of stays. The standardized coefficients suggest that age is the strongest predictor of LOS; however, the effect is small for this and all other variables, as reflected in the low overall R².

**Age**

There are conflicting reports in the literature regarding the predictive value of age for LOS following lumbar fusion. One theory is that advanced age may be associated with a higher complication rate postoperatively, thus increasing LOS. However, even this theory has been challenged in the literature. The results of the current analysis are summarized in Figure 1. The

**Table 1: Descriptive statistics and bivariate correlations**

| Variables | Bivariate correlations | Mean (median) | Standard deviation (IQR) | Range |
|-----------|------------------------|---------------|--------------------------|-------|
| LOS       |                        | 3.47          | 1.04                     | 1-7 days |
| ASA       | 0.20*                  | 2             | 2.3                      | 1-4    |
| BMI       | 0.06* 0.20*            | 29.5          | 5.38                     | 14.6-48.8 kg/m² |
| Age       | 0.32* 0.40* -0.04*     | 62            | 13                       | 20-91 years |

*P<0.05; LOS: Length of stay, ASA: American Society of Anesthesiologists, BMI: Body mass index

**Table 2: Multiple linear regression results for length of stay**

|                     | Unstandardized coefficients | Standardized coefficients | t-score | P     |
|---------------------|-----------------------------|---------------------------|---------|-------|
| B                   | 1.416                       | -                         | 7.027   | <0.001|
| Standard error      | 0.202                       |                           |         |       |
| Beta                |                             |                           |         |       |
| Age                 | 0.023                       | 0.002                     | 0.288   | 10.236| <0.001|
| ASA                 | 0.134                       | 0.054                     | 0.072   | 2.510 | 0.012 |
| BMI                 | 0.11                        | 0.005                     | 0.055   | 2.099 | 0.036 |

ASA: American Society of Anesthesiologists, BMI: Body mass index
statistical significance of the small effect of age is seen in this dataset likely because of the large number of patients studied; therefore, the discordant results seen in prior investigations are because of the relatively small sample sizes of those studies.

**Body mass index**

The possible effect of BMI on LOS has also been debated.\(^2\,3\,7\,9\) Prior studies in this regard did not find that obesity was associated with longer hospitalization.\(^3\) The current analysis found a statistically significant but small relationship between obesity and LOS similar to age, which is summarized in Figure 2.

**American society of Anesthesiologists**

The association between ASA class and LOS has been deliberated, as well as which ASA class may have an effect.\(^1\,6\,9\) Our analysis showed a small relationship between ASA and LOS and Figure 3 summarizes the results seen here.

**Additional factors**

Given that age, BMI, and ASA class explained only approximately 10% of the variation in LOS, it is likely that intraoperative and/or postsurgical factors would be the logical next targets for analysis. Chief among these may be patient function and walking distance.\(^6\) There is the possibility that combining the effect of more than one variable could have a greater impact on hospital stay. The current study was done to focus the study on the three most commonly investigated and debated factors regarding LOS, and we believe convincingly shows that they only have a minor association with LOS. Future studies will investigate the effect of intra and postoperative factors on LOS.

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**Conflicts of interest**

There are no conflicts of interest.

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