



Clinical study

Prolonged length of stay after posterior surgery for cervical spondylotic myelopathy in patients over 65 years of age



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ABSTRACT

Prolonged length of stay (PLOS) has been associated with increased hospital resource utilization and worsened patient outcomes in multiple studies. In this study, we defined and identified factors associated with PLOS after posterior surgery for cervical spondylotic myelopathy in patients over the age of 65. PLOS was defined as length of stay beyond the “prolongation point” (that is, the day after which discharge rates begin to decline). Using the United States Nationwide Inpatient Sample database, 2742 patients met inclusion criteria, out of whom 16.5% experienced PLOS (stay beyond 6 days). After multivariate analysis, increasing age was independently associated with PLOS (odds ratio [OR] 1.04, 95% confidence interval [CI] 1.02–1.06). Multiple comorbid conditions were associated with PLOS, including alcohol abuse (OR 3.85, 95% CI 1.87–7.94), congestive heart failure (OR 1.72, 95% CI 1.11–2.64), obesity (OR 1.70, 95% CI 1.14–2.55), and deficiency anemia (OR 1.44, 95% CI 1.01–2.05); the strongest associated operative parameter was blood transfusion (OR 2.39, 95% CI 1.75–3.28). Major complications independently associated with PLOS were deep vein thrombosis (OR 18.32, 95% CI 6.50–51.61), myocardial infarction (OR 8.98, 95% CI 2.92–27.56), pneumonia (OR 6.67, 95% CI 3.17–14.05), acute respiratory failure (OR 6.27, 95% CI 3.43–11.45), hemorrhage/hematoma (OR 5.04, 95% CI 2.69–9.44), and implant-related complications (OR 2.49, 95% CI 1.24–4.98). Average total hospital charges for patients who experienced PLOS were \$122,965 US dollars, compared to \$76,870 for the control group ($p < 0.001$). Mortality for patients who experienced PLOS was 2.7% versus 0.5% for patients who did not experience PLOS ($p < 0.001$). In conclusion, patients over the age of 65 who underwent posterior surgery for cervical myelopathy and stayed over 6 days in hospital were defined as having PLOS. Hospital charges and mortality rates were significantly higher for patients who experienced PLOS. Potentially modifiable and/or preventable risk factors were also identified.

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1. Introduction

Cervical spondylotic myelopathy (CSM) is the most common cause of spinal cord dysfunction in the elderly population [1]. Although the prevalence of CSM is unknown [2], age-related cervical spondylosis is known to affect almost 95% of patients over the age of 65 [3]. Surgical decompression can be performed anteriorly or posteriorly, and is typically indicated for patients with progressive weakness, gait instability, urinary frequency or incontinence, loss of hand dexterity, and/or impairment in daily activities [4]. Though both approaches have shown relatively equal functional outcomes [5], the posterior approach (typically laminectomy and

stabilization) is sometimes preferred in older patients, given the lower risk of swallowing difficulty and common presence of multi-level disease [6]. Nonetheless, posterior approaches have been associated with a higher rate of surgical site infection [7] and C5 palsy [8], among others, and longer lengths of stay (LOS) when compared to anterior approaches [9].

LOS of any surgical patient is mainly a function of patient characteristics (such as age and comorbid conditions), procedure complexity, development of any postoperative complication or adverse event, and others. In an era of rising healthcare costs, surgeons and providers are constantly seeking ways to improve cost-effectiveness while maintaining or improving patient outcomes [10]. Prolonged length of stay (PLOS), oftentimes the result of a postoperative complication or a severely-ill patient, has been associated with significant increases in hospital resource utilization and

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worsened patient outcomes [11,12]. The definition of PLOS, however, is not universal and varies throughout the literature [12–15].

The purpose of this study is to provide a definition of PLOS based on when discharge rates begin to decline for patients over 65 years of age who underwent posterior surgery for CSM, based on previous work by Silber et al. [13–15]. Secondary objectives include identification of independent risk factors for PLOS, as well as examining the association between PLOS and total hospital charges and in-hospital mortality.

2. Methods

2.1. Study design and inclusion criteria

This case-control study utilized the Nationwide Inpatient Sample (NIS) administrative databases from 2002 to 2011. The NIS is a database containing admission information for over 8 million hospital stays per year, representing a 20% sample of all discharges in the United States for any given year.

Inclusion criteria were patients over the age of 65 undergoing posterior fusion for CSM. Patients were identified via International Classification of Diseases 9th Version (ICD-9) codes 81.03 for posterior cervical fusion and 721.1 for CSM. Non-elective admissions, patients not undergoing surgery, anterior approaches, combined approaches, and revision procedures were excluded (n = 50,755).

2.2. Recorded variables

Data gathered from each admission included patient age at surgery, sex, race, primary payer, comorbidities, hospital teaching status, hospital location (urban versus rural), hospital region (Northeast, Midwest, South, or West), number of levels fused (less than 3 or more than 3), use of blood transfusion, and use of bone morphogenetic protein-2 (BMP-2). Recorded complications included implant-related complications, hemorrhage/hematoma, accidental puncture, spinal cord injury, nerve root injury, deep vein thrombosis, pulmonary embolism, cardiac arrest, pneumonia, myocardial infarction, acute respiratory failure, and incidental durotomy.

2.3. Outcome measures

The primary outcome measure examined was PLOS. PLOS was defined as LOS beyond the “prolongation point”, or the day the discharge rate decreased [15]. This definition is based on the work by Silber et al., and stems from the observation that as “patients stay longer in the hospital, their daily rate of discharge at first increases and then declines” [13–15]. In other words, PLOS assumes that “the longer one has stayed in the hospital, the longer one will stay” [15]. The daily discharge rate is calculated as follows: Discharge rate = (patients discharged today*100)/remaining patients from the previous day.

The secondary outcome measures were total hospital charges and in-hospital mortality. Although the NIS does not include exact information on cost, total charges are included, which exclude professional fees. Monetary values are expressed in 2015 United States dollars (US dollars, \$), and were adjusted for inflation based on the information available on <http://data.bls.gov/cgi-bin/cpicalc.pl>.

2.4. Statistical models and analysis

Descriptive statistics were performed to compare cases to controls. Data is presented as means and standard deviations or proportions. Comparisons were made via Student’s t-test or chi-squared test as appropriate. Statistical significance was set at $p < 0.05$, and all parameters which met these criteria were included

in a multiple logistic regression model to identify independent predictors of PLOS. Results of multivariate models are presented as odds ratios (OR) with 95% confidence intervals (95% CI). All analyses were performed in STATA SE 12 (StataCorp LP, College Station, TX, USA), and graphs were created in GraphPad Prism 6 (GraphPad Software Inc., La Jolla, CA, USA).

3. Results

A total of 2742 admissions were examined. After analysis, discharge rates for patients who underwent posterior surgery for CSM were increasing through day 6; each passing day would increase the discharge rate, thus bringing patients closer to release (Fig. 1). After day 6, the discharge rate decreased, meaning that with each passing day patients would be less likely to be discharged; this was defined as PLOS. After 10 days, discharge patterns became unstable due to the low sample size. Average LOS was 4.7 days (median: 4) for all patients.

3.1. Demographics

General patient and hospital characteristics are summarized in Table 1. Out of 2742 patients, 453 experienced PLOS (16.5%). The mean age at surgery for all patients was 74 years (range: 66–92), and 41.7% were female. Patients in the PLOS group were older ($p < 0.001$), and had a higher prevalence of alcohol abuse ($p < 0.001$), deficiency anemia ($p < 0.001$), congestive heart failure ($p < 0.001$), chronic pulmonary disease ($p = 0.010$), obesity ($p = 0.008$), and renal failure ($p < 0.001$) when compared to patients who did not experience PLOS. Notably, there were no significant differences in terms of hospital teaching status, location, or region. Average total hospital charges for patients who experienced PLOS were \$122,965, compared to \$76,870 for patients who did not experience PLOS ($p < 0.001$) (Fig. 2). Mortality for patients who experienced PLOS was 2.7%, compared to 0.5% for the control group ($p < 0.001$).

3.2. Operative parameters

The proportion of patients who underwent stabilization of three or more spinal levels was not significantly different between groups (56.2% for patients who did not experience PLOS and 58.3% for patients who experienced PLOS; $p = 0.411$) (Table 2). However, the rates of transfusion ($p < 0.001$) and use of BMP ($p = 0.001$) were statistically higher for patients who experienced PLOS.

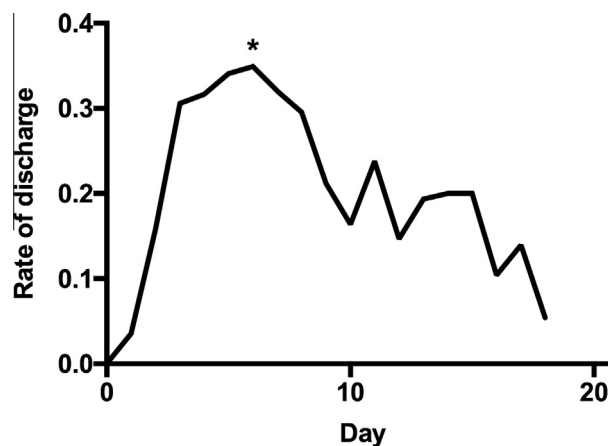


Fig. 1. Rate of hospital discharge for patients undergoing posterior surgery for cervical spondylotic myelopathy. The rate of discharge decreased after day 6 (asterisk), after which was defined as prolonged length of stay.

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