RESEARCH ARTICLE

Economic Effects of Anti-Depressant Usage on Elective Lumbar Fusion Surgery

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Abstract

Background: It has been suggested, although not proven, that presence of concomitant psychiatric disorders may increase the inpatient costs for patients undergoing elective surgery. This study was designed to test the hypothesis that elective lumbar fusion surgery is more costly in patients with under treatment for depression.

Methods: This is a retrospective case-control study of 142 patients who underwent elective lumbar fusion. Of those 142 patients, 41 patients were chronically using an antidepressant medication that considered as a "study group", and 101 patients were not taking an antidepressant medication that considered as a "control group". Data was collected for this cohort regarding antidepressant usage patient demographics, length of stay (LOS), age-adjusted Charlson comorbidity index scores and cost. Costs were compared between those with a concomitant antidepressant usage and those without antidepressant usage using multivariate analysis.

Results: Patients using antidepressants and those with no history of antidepressant usage were similar in terms of gender, age and number of operative levels. The LOS demonstrated a non-significant trend towards longer stays in those using anti-depressants. Total charges, payments, variable costs and fixed costs were all higher in the antidepressant group but none of the differences reached statistical significance. Using Total Charges as the dependent variable, gender and having psychiatric comorbidities were retained independent variables. Use of an antidepressant was independently predictive of a 36% increase in Total Charges . Antidepressant usage as an independent variable also conferred a 22% increase in cost and predictive of a 19% increase in Fixed Cost . Male gender was predictive of a 30% increase in Total Charges .

Conclusion: This study suggests use of antidepressant in patients who undergo elective spine fusion compared with control group is associated with increasing total cost and length of hospitalization, although none of the differences reached statistical significance.

Keywords: Antidepressants, Costs, Comorbidities, Elective lumbar fusion surgery, Length of hospitalization

Introduction

The cost of health care in the United States (U.S.), which exceeded $2.5 trillion in 2009, has been the subject of substantial scrutiny in recent years (1). Despite this, there is relatively little data on the specific patient-related factors that may affect the cost of delivering medical care. Others have reported that anti-depressant usage was prevalent in patients undergoing spinal surgery and found that anti-depressant usage was associated with increased inpatient costs for patient undergoing lumbar decompression and fusion surgery (2).

Depression and anxiety are the most common psychiatric disorders found in the U.S. with a lifetime risk of 15.7% and 11.3%, respectively. Antidepressants are the most common prescribed psychiatric medications in the U.S. It is estimated that approximately 10% of the U.S. population uses antidepressant medications, with the prevalence of usage being higher among females compared to males. Patients with depression with or without anxiety have been shown to have higher rates of diabetes mellitus, asthma, cardiovascular diseases, obesity and back pain compared to non-depressed patients (2).

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Depression or anxiety was a predictor of increased complications after Total Joint Arthroplasty (TJA). They found that 12.7% of knee and 6.4% of the hip arthroplasty patients had concomitant depression or anxiety. They also found that charges of the knee arthroplasty were $3420 higher in patients with depression/anxiety ($P < .001$) but not in the hip group. They recommended patient with depression or anxiety undergoing TJA need to be counselled appropriately, and all efforts need to be invested to minimize the complications (3).

The purpose of this study was to define the costs of inpatient care for patients taking anti-depressant medications in comparison to those not taking anti-depressant medications. This information should prove useful to those charged with resource allocation for spinal conditions in the future.

Materials and Methods

Following institutional review board approval, a retrospective study of 142 patients treated with elective lumbar fusion by a single surgeon (TJA) between 2006 and 2010 at a large teaching hospital. In this patient cohort, 41 patients were chronically using an antidepressant medication, 101 patients were not taking an antidepressant medication.

An inclusion criterion for the study group was patients who underwent an elective lumbar spinal fusion for a degenerative condition.

Exclusion criteria for patients in the study and the control groups included age less than 18 years, incomplete medical records that prevented collection of necessary data and treatment for a non-degenerative lumbar condition. Variables collected included patient gender, age, medical co-morbidities, diagnosis requiring elective lumbar fusion and length of hospital stay. Co-morbidities were aggregated using the Charlson Index, which estimates the burden of all co-morbid conditions. Researchers have employed restrictive including criteria in prospective studies by eliminating patients with comorbid conditions from studies, in order to limit the potential that deaths attributable to comorbid disease will confound the evaluation of outcomes. This will increase the efficiency of a trial. However, such restrictions result in considerable losses of patients prior to randomization and limit the generalizability of the results. Using Charlson Index tackles the issue of validating a method of measuring the prognostic impact of comorbid disease (4, 5). Patients underwent one of the four most types of surgery: Anterior lumbar interbody fusion (ALIF), Antero-Posterior lumbar fusion (A/PLF), Posterior lumbar interbody fusion (PIF) and posterio-lateral fusion (PLF).

The hospital accounting department provided financial records including: Total Charges, Total Payment Received, Variable Cost, and Fixed Cost. To comply with the disclosure agreement of various third party payers, this data was provided without any further breakdown to identify costs associated with specific aspects of patient care. From these variables we were additionally able to calculate secondary variables including Contribution Margin (=Payment – Variable Cost) and Net Profit/Loss (=Contribution Margin – Fixed Cost). Variable costs are expenses that change in proportion to the activity of a company. Variable cost is a cost of labor, material, or overhead that changes according to the change in production units. Fixed Cost is a cost that does not change with the increase or decrease in the amount of goods or services produced. Fixed costs and variable costs make up the two components of total cost. Contribution margin is the profit on a product calculated by subtracting its payment (variable revenues) from its variable costs. Because variable revenues and costs are largely dependent on the business cycle, a business with a high contribution margin is expected to have an even higher margin during economic growth.

Demographic variables including co-morbidities were compared between groups using the chi square test. Age, number of levels, length of stay and cost parameters were compared between the study and control groups using the Student's t-test. We further evaluated the impact of anti-depressant usage on cost through regression analysis by creating negative binomial models using Total Charges, Payment, Variable Charges, Fixed Charges, Profit-Loss and Contribution Margin as dependent variables. For each model, we used age, gender, number of operated levels, surgery type (ALIF vs. A/PLF vs. PIF vs. PLF), Charlson Index, and presence/absence of psychiatric co-morbidity as independent variables. To optimize each model, the base model including all variables was trimmed to minimize "an information criterion" (AIC) (5). Significance was assumed for $P<0.05$.

Results

Baseline Characteristics:

The antidepressant and control groups were similar in terms of the percentage of male patients (29% vs. 33%, $P=0.61$, respectively), age (61.9 years vs. 62.7 years, $P=0.75$, respectively) and Charlson Index score (2.24 vs. 2.38, $P=0.62$, respectively). In the antidepressant group, 9.7% of patients underwent stand-alone anterior lumbar interbody fusion (ALIF), 7.3% underwent ALIF with instrumented posterior fusion (A/PLF), 12.2% underwent instrumented posterior interbody fusion (PIF) and the remaining 70.7% underwent instrumented posterior fusion (PLF). In the control group, 5.9% underwent stand alone ALIF ($P=0.42$ vs. antidepressant group), 7.9% underwent A/PLF ($P=0.9$), 18.8% underwent PIF ($P=0.34$) and 67.3% had PLF ($P=0.69$). The number of operative levels was similar between antidepressant and control groups (2.1 levels vs. 2.2 levels, respectively, $P=0.43$).

There were higher rates of some co-morbidities in the non-antidepressant group compared to antidepressant group: myocardial infarction (8.9% vs. 2.4%), chronic obstructive pulmonary disease (COPD) (1.9% vs. 0), diabetes mellitus (7.9% vs. 7.3%), diabetes mellitus with chronic complications (0.9% vs.0), history of coronary vascular disease (1.9% vs. 0), peptic ulcer (13.8% vs. 12.1%), malignancy (5.9% vs. 4.8%), dementia (0.9% vs.0), peripheral vascular disease (0.9% vs.). Rheumatologic disease (19.5% vs. 12.8%), mild liver

disease (2.4% vs. 0) were all more frequent in the non-antidepressant group.

In the antidepressant group, about 41.4% of patients in whom spine surgery was performed had a score of 3 on the Charlson Index; 39% were in the 1-2 range; 10% were in the 4-5 range and 9.7% had a score of 0. In the control group, 24% of patients had Charlson score of 3; 20% had 0 score; 19% were in the range of 1-2; 18.8% had score of 4; and 9% were in the 5-7 range.

Length of Stay and Cost Variables

Length of stay demonstrated a trend toward longer stays in the antidepressant group but did not reach statistical significance (3.3 days vs. 2.7 days, respectively, *P*=0.07). Analysis of the primary financial variables demonstrated that total charges, payment, variable cost and fixed cost were higher in the antidepressant group but none of the differences reached statistical significance [Table 1]. Contribution Margin and Profit/Loss were also similar between groups [Table 1], [Figure 1].

Cost Modeling

Separate regression models were constructed for each cost parameter. Using Total Charges as the dependent variable, gender and antidepressant usage were retained independent variables. Male gender was predictive of a 30% increase in Total Charges (95% confidence interval (CI) 11%-67%, *P*=0.008) and use of an antidepressant was independently predictive of a 36% increase in Total Charges (95% CI 7%-57%, *P*=0.003). Using Payment as the dependent variable, antidepressant usage and variables representing the different surgical procedures were retained in the model but no variables were significant predictors of Payment (*P*>0.08).

Holding Variable Cost as the dependent variable, the only retained independent variable was antidepressant usage which conferred a 22% increase in cost (95% CI 0.5%-47%, *P*=0.04). Finally, using Fixed Cost as the dependent variable, the only retained independent variable was antidepressant usage which was predictive of a 19% increase in Fixed Cost (95% CI 2%-41%, *P*=0.037).

Discussion

Our analyses show that use of antidepressants leads to a higher total charges, revenue, variable cost and fixed cost following elective spine fusion compared to patients without history of antidepressant usage, but cost was not differed significantly. We found total charges increased 30% in male and also use of an antidepressant independently increased the Total Charges about 36%. The only retained independent variable was antidepressant usage which conferred a 22% increase in cost, 19% increase in fixed cost by considering variable cost as the dependent variable and fixed cost as the dependent variable respectively.

Approximately 27% of patients with musculoskeletal pain have major depression in primary care settings (6). There are several reports about prevalence of major depression in patients with low back pain in physical therapy settings showing between 26% to 47% exhibited depressive signs or symptoms (6). Sinikallio et al, in a study of 100 patients with lumbar spinal stenosis found that one fifth of those patients (20%) had depression (7). Sinikallio et al, observed that 18% of Lumbar Spinal Stenosis patients were depressed on 1-year follow-up (8). In trauma surgery service, 20% to 55% of hospitalized patients had current or lifetime substance dependence or abuse. 10% to 40% of patients in trauma service develop post traumatic stress disorder (PTSD), major depressive disorder (MDD), anxiety, and acute stress disorder following days to weeks (9).

Other authors have described cost associated with treating spinal conditions in patients with psychiatric illness., particularly given the frequency with which spinal and psychiatric illness coexist (10). The majority (87.1%) of patients with chronic back pain have been shown to have at least one other comorbid condition, including chronic pain (68.6%), chronic physical problems (55.3%), and psychological disorders (35.0%) suggesting this patient population has a higher rate of comorbid psychiatric problems than the general population (11). In addition, patients with chronic lower back pain and concurrent mental disorders have higher direct costs in the US health care, likely related to higher rates of seeking general medical services (12). The reason for these observations is not clear but it has been hypothesized that psychiatric comorbidity complicates the diagnosis and workup when patients with mental disorders are treated for standard medical illnesses (13).

Table 1. Comparison of Total Charges, Payment, Variable Cost and Fixed Cost between antidepressant and control groups

Variable	Antidepressant	Control	Difference	*p*-value
Total Charges	$103,285	$89,173	$14,112	0.10
Payment	$30,190	$25,321	$4,869	0.17
Variable Cost	$17,691	$15,059	$2,632	0.11
Fixed Cost	$10,019	$8,542	$1,477	0.06
Contribution Margin	$12,498	$10,262	$2,236	0.47
Profit (+) / Loss (-)	+$2,478	+$1,720	$759	0.81

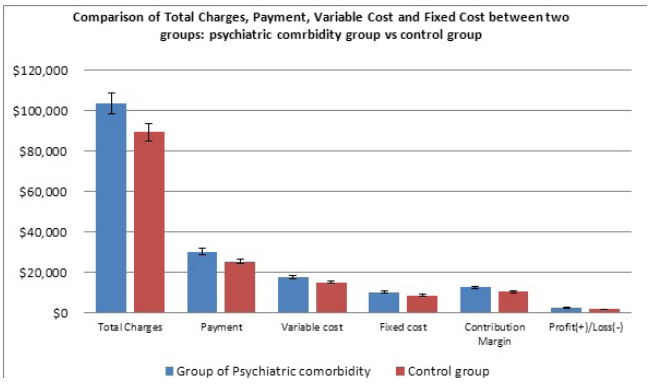

Figure 1. Comparison of Total Charges, Payment, Variable Cost and Fixed Cost between tow groups: psychiatric comorbidity group vs. control group.

Walid and Robinson in a retrospective study of 816 patients studied 97 outpatients and 578 inpatients who underwent spinal surgery and estimated the cost impact of different comorbidities, including depression. This study demonstrated that the costs for lumbar discectomy and fusion were 32% less overall in the group without any medical or psychiatric comorbidities ($52,249). The cost of surgery in female patients with depression increased to $55,900, and was $68,782 with combined depression and diabetes [$P<0.05$] (2). We similarly found costs of PLF or PIF when an average of two levels of fusion were $105,443 and $89,228 in an antidepressant group and the control group respectively (P-value=0.08).

Konnopka et al, in a cross-sectional study of 305 patients who underwent lumbar and cervical disc surgery reported the direct and indirect cost differences between patients with and without psychiatric comorbidity. They concluded that a direct cost of lumbar disc procedure in patients with psychiatric co-morbidity was significantly higher than those without psychiatric co-morbidity by about 27% (€7,042 vs. €5,534). After regression analysis of independent variable, they found that psychiatric comorbidity was significantly associated with higher direct costs (P-value<0.043). They also reported that 32% of patient with cervical disc herniation and 23% of patients with lumbar disc herniation suffered from psychiatric co-morbidity (14).

Psychiatric illness has been shown to affect cost and length of stay in fields outside of spinal surgery. Borckardt et al, in a retrospective pilot study of 10716 non-psychiatric inpatients compared with the 149 inpatient medical/surgical patients who were seen in outpatient psychiatric clinics examined differences in hospitalization frequency, duration, and costs during the 6-month-study period. They showed higher number of medical/surgical hospitalizations in patients who had outpatient psychiatric involvement compared to non-psychiatric patients. (P=.003) They also found that the difference of average LOS and total cost between two groups were not statistically significant (13). We had similar finding in terms of LOS and cost. In our study, length of stay was 3.3 days in antidepressant group vs. 2.7 days in the control group which was not statistically significant (P=0.07) but demonstrated a trend toward longer LOS in the antidepressant group. We also found no statistical differences between two groups in terms of total charges, payment, variable cost and fixed cost, although antidepressant group showed a trend toward higher total charges, payment, variable cost and fixed cost. Borckardt et al. found that those patients who had a psychiatric consultation during their inpatient course had a significantly longer LOS and higher total costs than those without a psychiatric consultation (P<.0001, P<.0001 respectively) (13).

Zatzic et al, conducted a retrospective study of all patients who were admitted in the trauma service for 4 years in UC Davis Medical Center trauma surgery service. Their goal was to study the association between psychiatric disorders and cost and LOS in a large cohort of inpatients. LOS and cost was 46% to103% higher in patients with stress disorders, delirium, and ($P < 0.01$) (9).

Patients admitted to internal medicine services with psychiatric disorders have been shown to have higher costs for inpatient treatment. In patients with chronic heart failure (CHF) and co-existing depression, the re-admission rate was three times higher within a year. The prevalence of depressive disorder in general population versus patients with CHF is 6.6% and 35-70% respectively. Finally, this study suggested patients with psychiatric illness had worse outcomes, demonstrating a mortality rate for depressive patients with CHF that was eight times higher after 30 months than the rate in patients without depression (15).

Limitation

There are some limitations in our study that must be considered. First, the statistical power of our study was limited by sample size, which might have reduced our ability to detect differences in cost. Cost data showed a skewed distribution with high standard deviations, necessitating a relatively large sample size or large cost difference to show significant results. Finally, often was clear based on medical record review whether antidepressants were being used as mood-altering drugs or rather to treat chronic psychosomatic pain.

Our analysis used the hospital charges which consider only the cost of surgery and the subsequent hospitalization period, a time frame which does not reflect costs associated with postoperative complications.

Clinicians should be aware of the high prevalence rates of psychiatric co-morbidity in patient who undergo spine surgery and associated cost and length of stay considerations. Psychiatric distress should be assessed by the support of mental health professionals, if pertinent. These multimodal diagnostic and therapy approaches might improve the outcomes of spine surgery and cut the extra costs connected to psychiatric comorbidity.

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