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Increased Healthcare Costs and Opioid Use in Patients with Anxiety and Depression Undergoing Rotator Cuff Repair

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Abstract

Purpose: The purpose of this study was to 1) quantify the prevalence of mood disorders in patients undergoing arthroscopic rotator cuff repair using a large claims database and 2) compare opioid use and medical costs in the year before and the year after rotator cuff repair between those with and without comorbid mood disorders.

Methods: The Truven Healthcare Marketscan database was queried to identify those who underwent arthroscopic rotator cuff repair (RCR; CPT code 29827) between October, 2010 and December, 2015. All patients were then screened for insurance claims relating to either anxiety or depression. We then compared net costs and opioid use both one year preoperatively and one year postoperatively between those with and without mood disorders using an analysis of covariance (ANCOVA).

Results: A total of 170,329 patients (97,427 males (57.2%) and 72,902 females (42.8%)) undergoing arthroscopic rotator cuff repair were identified. Of the 170,329 patients, 46,737 (27.4%) had comorbid anxiety or depression, and after adjusting for preoperative cost, sex, age, and both preoperative and postoperative opioid use, the one-year postoperative costs for those with a preoperative mood disorder was 7.05% higher than for those without a mood disorder. In addition, opioid use both in the 180 days prior to surgery (36.7% vs. 26.9%) and more than 90 days after surgery (33.0% vs. 27.2%) were substantially greater in the group with comorbid depression or anxiety.

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Conclusion: In patients with comorbid mood disorders, opioid use and healthcare costs were increased both preoperatively and postoperatively. The increased cost in this patient population is estimated at \$62.3 million annually. In an effort to provide high quality value-based care, treatment strategies should be developed to identify these patients preoperatively and provide the appropriate resources needed to improve the probability of a successful surgical outcome.

Level of Evidence: Level III Retrospective Comparative Therapeutic Study

Introduction

Painful rotator cuff disease is the most common cause of shoulder pain and disability. (1) Favorable outcomes have been shown with arthroscopic rotator cuff repair in the appropriately selected patient. Due to the high prevalence of rotator cuff disease, arthroscopic rotator cuff repair remains one of the most commonly performed orthopaedic surgeries with an estimated 250,000 cases performed annually, in the United States alone. (2–5) With such a high case volume annually arthroscopic rotator cuff repair has a large societal cost. (6)

Both intrinsic and extrinsic patient factors have been extensively studied in respect to their effect on outcome of rotator cuff repair. These extrinsic factors include age, sex, workers' compensation status, smoking, and patients' expectations. (1, 7–9) In regards to shoulder disorders overall, anxiety and depression are associated with a longer duration of shoulder symptoms and higher levels of shoulder disability. (10, 11) Preoperative depression and anxiety has also been linked with lower American Shoulder and Elbow Surgeon (ASES) scores in patients undergoing rotator cuff repair. (10)

There is little available data on the prevalence of co-morbid mood disorders in patients undergoing surgery for rotator cuff repair or the costs associated with it. Therefore, the purpose of this study was to 1) quantify the prevalence of mood disorders in patients undergoing arthroscopic rotator cuff repair using a large claims database and 2) compare opioid use and medical costs in the year before and the year after rotator cuff repair between those with and without comorbid mood disorders. We hypothesize that there will be a higher prevalence of anxiety and depression in patients undergoing rotator cuff repair and that both opioid consumption and medical costs will be elevated in this population.

Methods

The Truven Health Marketscan[®] database was queried to identify those who underwent arthroscopic rotator cuff repair (RCR) between October 2010 and December 2015 using Current Procedural Terminology (CPT) code 29827. Containing over 135 million unique individuals, the Truven database is well studied in the orthopaedic literature. (12, 13) It contains both Marketscan Commercial and Medicare Supplemental claims and encounters including inpatient, outpatient, and pharmacy encounters. The database captures over 20% of all non-Center for Medicare and Medicaid Services (CMS) patients. Patients were excluded if they had either incomplete coverage for one year prior to or following the index surgical procedure or if they had previously undergone arthroscopic RCR in the year prior to

the index surgical procedure. Quantifying the costs for one year prior and one year following the index procedure was consistent with previous studies evaluating cost of procedures. (14)

All patients undergoing RCR were then screened for one or more insurance claims relating to either anxiety or depression using International Classification of Diseases, Ninth Revision (ICD-9) codes. Codes evaluated included ICD-9 296, 298, 300, 309, and 311. We then collected the total health care costs for each patient in the year preceding and the year after arthroscopic rotator cuff surgery. Diagnosis codes related to anxiety and depression were chosen due to the previous association with postoperative outcomes in rotator cuff surgery. (15, 16) In an effort to get a complete representation of all healthcare costs and utilization we defined total health care costs as the sum of net costs including any co-pays, deductibles, or co-insurance in the year prior to and following arthroscopic rotator cuff repair.

Opioid drug prescriptions were also evaluated in patients undergoing arthroscopic rotator cuff repair. This was done by identifying National Drug Code (NDC) numbers associated with opioid agonists, opioid partial agonists, and opioid combination drug classes. (17)

Statistical Analysis

Cost data was log transformed due to right-skewness. We used numerical summaries to compare total costs in the year prior to and after arthroscopic rotator cuff repair between those with and without comorbid depression or anxiety. Means $\pm$ SDs are reported in the results section. To evaluate opioid usage, the prevalence of patients with claims related to opioid prescriptions < 180 days prior to and > 90 days following arthroscopic rotator cuff repair were calculated for those with and without depression or anxiety. To adjust for preoperative costs, sex, age, and opioid use, an analysis of covariance (ANCOVA) was performed to estimate differences in log-transformed postoperative total costs between both groups. Due to the extremely large sample sizes in this study, traditional hypothesis testing and p -values would be inappropriate and uninformative to our analysis, as any difference between groups will appear to be highly significant. Statistical analysis was performed using R, version 3.4.4 (R Foundation for Statistical Computing, Vienna, Austria).

Results

A total of 170,406 patients undergoing arthroscopic rotator cuff repair were identified. Of these, 77 patients (0.05%) had negative costs in either the year prior to or following surgery and were excluded leaving 170,329 that met the inclusion criteria and were included in the analyses. The cohort consisted of 97,427 males (57.2%) and 72,902 females (42.8%) with a mean age of 53.5 years. Of the 170,329 patients, 46,737 (27.4%) had comorbid anxiety or depression pre-operatively, as defined by having claims related to these diagnoses. Patients with depression and anxiety were more likely to be female (56.3% Female in Depression/Anxiety vs. 37.7% Female in No Depression/Anxiety). Age did not meaningfully differ between the two groups (Depression/Anxiety = 52.3 ± 9.7 vs. No Depression/Anxiety = 53.9 ± 10.4 years). In addition, opioid use both in the 180 days prior to surgery (36.7% vs. 26.9%) and more than 90 days after surgery (33.0% vs. 27.2%) were greater in the group with comorbid depression or anxiety (Table 1).

The median cost for all patients undergoing rotator cuff repair was \$4,958 (Interquartile range = \$2,644 – \$10,806) in the year prior to surgery and \$4,313 (Interquartile range = \$2,040 – \$9,083) in the year immediately after (Table 2). Even after adjusting for preoperative cost, sex, age, and both preoperative and postoperative opioid use, the one-year postoperative costs for those with a preoperative mood disorder was 7.05% higher.

Discussion

The key finding in the present study is the increased health care costs and increased opioid use seen both prior to and after arthroscopic rotator cuff repair in patients with comorbid depression and/or anxiety. With an estimated 250,000 rotator cuff repairs performed annually and a 27% prevalence of anxiety and depression, the annual projected increased societal cost of rotator cuff repair in patients with comorbid depression and anxiety compared to those without is \$62.3 million.

The association between mental health and orthopaedic disorders, including shoulder pain and rotator cuff tears, has been well documented. For instance, pre-operative pain is more closely related to mental health disorders than severity of the labral tear in femoracetabular impingement patients or degree of radiographic disease in patients with osteoarthritis of the knee. (18–20) In regards to shoulder pathology, it has been shown that higher scores on multiple mental health questionnaires are correlated with worse shoulder pain on visual analogy scale (VAS) as well as inferior scores on the Simple Shoulder Test (SST), Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, and American Shoulder and Elbow Surgeons (ASES) scores compared with patients without mental health disorders. (10, 21, 22) Additionally, Tashjian et al prospectively evaluated 169 patients with full thickness rotator cuff tears and found the Short Form-36 Mental Component score (SF-36 MCS) had the strongest correlation with the VAS for shoulder pain, SST, and ASES score. In that cohort, the SF-36 MCS had a stronger relationship with pain and PROs than tear size, tear retraction, and number of involved tendons. (23) Similar associations have also been seen in post-operative outcomes. In a study evaluating return to work after rotator cuff repair, higher preoperative mental health status on the Veterans RAND Mental Component Score (VRMCS) was the strongest predictor of overall return to work. (24) Patients with poorer psychological functioning prior to rotator cuff repair were found to have worse ASES scores at 3 and 12 months after surgery, though ASES scores did improve from pre-op. (25)

The reason for this strong association of worse preoperative patient perceived pain and disability and postoperative outcomes in shoulder patients with comorbid depression and anxiety is unclear. This is likely multifactorial with multiple mechanisms playing at least a partial role. Patients with mental health disorders such as anxiety and depression have been shown to have higher levels of chronic pain, which may lead to physiological changes such as central sensitization. Central sensitization is the downstream effect of chronic pain which can amplify the pain response in the presence of stimuli which would normally result in a lower level of pain. (26, 27) This central sensitization may account for the disproportionate pain response seen in patients with depression and anxiety in association with rotator cuff tears irrespective of tear size, tear retraction, or tear severity. (23) Depression and anxiety also lead to a persistent inflammatory state. Those with depression and/or anxiety have been

shown to have increased levels of interleukin-6 (IL-6), a pro-inflammatory cytokine which has been studied as a biomarker for pain. (28) These chronic, pro-inflammatory changes may enhance the effect of central sensitization. Additionally, patients with depression and anxiety have consistently been shown to have poor coping strategies for pain such as catastrophizing. These patients are more likely to magnify their pain as well as project feelings of hopelessness and helplessness. In rotator cuff patients, pain catastrophizing has been linked to patient reported disease severity. (29)

We also found preoperative opioid use, as well as postoperative opioid use at 60 and 90 days, to be associated with anxiety and depression which is consistent with other studies of mental health disorders and opioid use. A study of over 550 patients using a state Prescription Drug Monitoring Program found psychiatric disorders, along with pre-operative opioid use, insurance type, procedure type, body mass index, and smoking status, to be associated with prolonged post-operative opioid use after shoulder surgery. (30) Another study, using the Humana national claims database, showed pre-operative opioid use and depression to be risk factors for chronic postoperative opioid use after common orthopaedic procedures. Specifically, the authors showed an odds ratio of 1.51 (1.28 to 1.77) for chronic postoperative opioid use in patients with depression undergoing rotator cuff repair. (31) The relationship between mental health disorders and opioid use has also been shown in the total joint arthroplasty literature. (32, 33)

Healthcare costs continue to rise in the United States and remain among the highest in the world. In 2016, healthcare accounted for 17.9% of the Gross Domestic Product (GDP) and is expected to eclipse 20% by 2026. (34) Because of these rising costs, a recent emphasis has been placed on cost savings initiatives and value-based care. Rotator cuff repair has previously been shown to be cost-effective, providing \$3.44 billion per year of national cost savings when including both direct and indirect medical costs as well as lost income. (6) We found 7.05% higher costs in the one year following rotator cuff surgery in patients with comorbid depression and anxiety. While this may seem small, this represents a significant cost. With over 250,000 rotator cuff surgeries being performed annually, this accounts for over \$62.3 million in additional cost.

In effort to improve postoperative outcomes, lower the risk of chronic opioid dependence, and control healthcare costs strategies should be developed to identify patients with comorbid depression and anxiety being scheduled for rotator cuff repair surgery. Identifying these patients preoperatively will allow the surgeon to be better aware of the risk of postoperative opioid abuse and potentially allow for intervention prior to undergoing this elective surgical procedure. It is currently unclear if preoperative psychological interventions, such as cognitive behavior therapy, would improve postoperative outcomes or decrease chronic opioid dependence. There is limited data in the spine literature showing improved clinical outcomes in patients undergoing psychological 'prehabilitation' prior to surgery for lumbar stenosis. Another study showed improved outcomes with psychological counseling in addition to routine physical therapy in patients with neurogenic claudication. (35, 36) These are areas that should be explored in patients with mental health disorders scheduled for rotator cuff repair surgery.

We found a 27.4% prevalence of mood disorders in our large cohort of patients undergoing rotator cuff repair, which is similar to that previously reported. Warner et al found a 26.8% incidence of depression in a cohort of 107 patients scheduled for rotator cuff repair when administering the Hospital Anxiety and Depression Scale (HADS) pre-operatively. (10) Another study measuring psychological function in 124 patients undergoing rotator cuff repair surgery rated 32% of the cohort as poor, signifying higher rates of anxiety and depression. (25) This is in contrast to the 12-month prevalence of major depressive disorder in the general population, which is estimated at 10.4%. (37) It is not currently known why depression and anxiety are seen in such higher numbers in the rotator cuff surgery population. However, patients with rotator cuff tears and comorbid depression or anxiety may be more likely to become symptomatic and seek care due to pain catastrophizing and the chronic inflammatory changes discussed earlier.

Limitations

Our study was not without limitations. This is an analysis of claims data and has all of the limitations inherent to any large database study. We were unable to independently verify the accuracy of the data inputted into the database. Second, due to inherent limitations of the Truven Health Marketscan database, we were unable to verify our re-operation data in the setting of depression and anxiety. It would be interesting to know if these repeat operations were true re-operations due to a poor clinical outcome, however the database does not control for laterality and it is unknown if the repeat procedure was on the ipsilateral or contralateral side. We also chose to focus on anxiety and depression and not other mental health diagnoses. This could be viewed as a limitation, however this was chosen for clarity purposes and to be consistent with previously published data. We were also unable to account for how patients were being treated for their anxiety and depression and the cost associated with this. While assessing different treatment modalities is possible with the Truven database, there is no way to know if these treatments were successful or not, and therefore were not included in the analysis. Finally, due to the limitations of the database, we were unable to control for other factors that have been shown to directly correlate with chronic opioid use postoperatively such as obesity, smoking, or alcohol use.

Conclusion

In patients with comorbid mood disorders, opioid use and healthcare costs were increased both preoperatively and postoperatively. The increased cost in this patient population is estimated at \$62.3 million annually. In an effort to provide high quality value-based care, treatment strategies should be developed to identify these patients preoperatively and provide the appropriate resources needed to improve the probability of a successful surgical outcome.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Henn RF 3rd, Kang L, Tashjian RZ, Green A. Patients' preoperative expectations predict the outcome of rotator cuff repair. *J Bone Joint Surg Am*. 2007 9;89(9):1913–9. [PubMed: 17768186]
2. Martin CT, Gao Y, Pugely AJ, Wolf BR. 30-day morbidity and mortality after elective shoulder arthroscopy: a review of 9410 cases. *J Shoulder Elbow Surg*. 2013 12;22(12):1667–75 e1. [PubMed: 24060598]
3. Hill JR, McKnight B, Pannell WC, Heckmann N, Sivasundaram L, Mostofi A, et al. Risk Factors for 30-Day Readmission Following Shoulder Arthroscopy. *Arthroscopy*. 2017 1;33(1):55–61. [PubMed: 27641638]
4. Seida JC, LeBlanc C, Schouten JR, Mousavi SS, Hartling L, Vandermeer B, et al. Systematic review: nonoperative and operative treatments for rotator cuff tears. *Ann Intern Med*. 2010 8 17;153(4):246–55. [PubMed: 20621893]
5. Narvy SJ, Ahluwalia A, Vangsness CT Jr. Analysis of Direct Costs of Outpatient Arthroscopic Rotator Cuff Repair. *Am J Orthop (Belle Mead NJ)*. 2016 1;45(1):E7–E11. [PubMed: 26761928]
6. Mather RC 3rd, Koenig L, Acevedo D, Dall TM, Gallo P, Romeo A, et al. The societal and economic value of rotator cuff repair. *J Bone Joint Surg Am*. 2013 11 20;95(22):1993–2000. [PubMed: 24257656]
7. Mallon WJ, Misamore G, Snead DS, Denton P. The impact of preoperative smoking habits on the results of rotator cuff repair. *J Shoulder Elbow Surg*. 2004 Mar-Apr;13(2):129–32. [PubMed: 14997086]
8. Oh JH, Kim SH, Ji HM, Jo KH, Bin SW, Gong HS. Prognostic factors affecting anatomic outcome of rotator cuff repair and correlation with functional outcome. *Arthroscopy*. 2009 1;25(1):30–9. [PubMed: 19111216]
9. Smith KL, Harryman DT 2nd, Antoniou J, Campbell B, Sidles JA, Matsen FA 3rd. A prospective, multipractice study of shoulder function and health status in patients with documented rotator cuff tears. *J Shoulder Elbow Surg*. 2000 Sep-Oct;9(5):395–402. [PubMed: 11075323]
10. Cho CH, Seo HJ, Bae KC, Lee KJ, Hwang I, Warner JJ. The impact of depression and anxiety on self-assessed pain, disability, and quality of life in patients scheduled for rotator cuff repair. *J Shoulder Elbow Surg*. 2013 9;22(9):1160–6. [PubMed: 23594716]
11. Cho CH, Jung SW, Park JY, Song KS, Yu KI. Is shoulder pain for three months or longer correlated with depression, anxiety, and sleep disturbance? *J Shoulder Elbow Surg*. 2013 2;22(2):222–8. [PubMed: 22738644]
12. Crijns TJ, Bernstein DN, Ring D, Gonzalez R, Wilbur D, Hammert WC. Factors Associated With a Discretionary Upper-Extremity Surgery. *The Journal of hand surgery*. 2019 2;44(2):155 e1- e7. [PubMed: 29908926]
13. Gil JA, Gunaseelan V, DeFroda SF, Brummett CM, Bedi A, Waljee JF. Risk of Prolonged Opioid Use Among Opioid-Naive Patients After Common Shoulder Arthroscopy Procedures. *The American journal of sports medicine*. 2019 4;47(5):1043–50. [PubMed: 30735622]
14. Bedard NA, Dowdle SB, Anthony CA, DeMik DE, McHugh MA, Bozic KJ, et al. The AAHKS Clinical Research Award: What Are the Costs of Knee Osteoarthritis in the Year Prior to Total Knee Arthroplasty? *The Journal of arthroplasty*. 2017 9;32(9S):S8–S10 e1. [PubMed: 28209276]
15. Lau BC, Scribani M, Wittstein J. The Effect of Preexisting and Shoulder-Specific Depression and Anxiety on Patient-Reported Outcomes After Arthroscopic Rotator Cuff Repair. *The American journal of sports medicine*. 2019 11;47(13):3073–9. [PubMed: 31585048]
16. Kennedy P, Joshi R, Dhawan A. The Effect of Psychosocial Factors on Outcomes in Patients With Rotator Cuff Tears: A Systematic Review. *Arthroscopy*. 2019 9;35(9):2698–706. [PubMed: 31500758]

17. Hankosky ER, Bush HM, Dwoskin LP, Harris DR, Henderson DW, Zhang GQ, et al. Retrospective analysis of health claims to evaluate pharmacotherapies with potential for repurposing: Association of bupropion and stimulant use disorder remission. *AMIA Annu Symp Proc.* 2018;2018:1292–9. [PubMed: 30815171]
18. Jacobs CA, Burnham JM, Jochimsen KN, Molina Dt, Hamilton DA, Duncan ST. Preoperative Symptoms in Femoroacetabular Impingement Patients Are More Related to Mental Health Scores Than the Severity of Labral Tear or Magnitude of Bony Deformity. *The Journal of arthroplasty.* 2017 12;32(12):3603–6. [PubMed: 28739309]
19. Kim KW, Han JW, Cho HJ, Chang CB, Park JH, Lee JJ, et al. Association between comorbid depression and osteoarthritis symptom severity in patients with knee osteoarthritis. *J Bone Joint Surg Am.* 2011 3 16;93(6):556–63. [PubMed: 21411706]
20. Jacobs CA, Hawk GS, Jochimsen KN, Conley CE, Vranceanu AM, Thompson KL, et al. Depression and Anxiety Are Associated With Increased Health Care Costs and Opioid Use for Patients With Femoroacetabular Impingement Undergoing Hip Arthroscopy: Analysis of a Claims Database. *Arthroscopy.* 2020 3;36(3):745–50. [PubMed: 31924382]
21. Potter MQ, Wylie JD, Greis PE, Burks RT, Tashjian RZ. Psychological distress negatively affects self-assessment of shoulder function in patients with rotator cuff tears. *Clin Orthop Relat Res.* 2014 12;472(12):3926–32. [PubMed: 25080266]
22. Roh YH, Noh JH, Oh JH, Baek GH, Gong HS. To what degree do shoulder outcome instruments reflect patients' psychologic distress? *Clin Orthop Relat Res.* 2012 12;470(12):3470–7. [PubMed: 22907473]
23. Wylie JD, Suter T, Potter MQ, Granger EK, Tashjian RZ. Mental Health Has a Stronger Association with Patient-Reported Shoulder Pain and Function Than Tear Size in Patients with Full-Thickness Rotator Cuff Tears. *J Bone Joint Surg Am.* 2016 2 17;98(4):251–6. [PubMed: 26888672]
24. Gowd AK, Cvetanovich GL, Liu JN, Nwachukwu BU, Cabarcas BC, Cole BJ, et al. Preoperative Mental Health Scores and Achieving Patient Acceptable Symptom State Are Predictive of Return to Work After Arthroscopic Rotator Cuff Repair. *Orthop J Sports Med.* 2019 10;7(10):2325967119878415. [PubMed: 31696133]
25. Thorpe AM, O'Sullivan PB, Mitchell T, Hurworth M, Spencer J, Booth G, et al. Are Psychologic Factors Associated With Shoulder Scores After Rotator Cuff Surgery? *Clin Orthop Relat Res.* 2018 10;476(10):2062–73. [PubMed: 30179945]
26. Lee YC, Nassikas NJ, Clauw DJ. The role of the central nervous system in the generation and maintenance of chronic pain in rheumatoid arthritis, osteoarthritis and fibromyalgia. *Arthritis Res Ther.* 2011 4 28;13(2):211. [PubMed: 21542893]
27. Zambreau L, Wise RG, Brooks JC, Iannetti GD, Tracey I. A role for the brainstem in central sensitisation in humans. Evidence from functional magnetic resonance imaging. *Pain.* 2005 4;114(3):397–407. [PubMed: 15777865]
28. Shimura Y, Kurosawa H, Tsuchiya M, Sawa M, Kaneko H, Liu L, et al. Serum interleukin 6 levels are associated with depressive state of the patients with knee osteoarthritis irrespective of disease severity. *Clin Rheumatol.* 2017 12;36(12):2781–7. [PubMed: 28900748]
29. Gibson E, LeBlanc J, Sabo MT. Intersection of catastrophizing, gender, and disease severity in preoperative rotator cuff surgical patients: a cross-sectional study. *J Shoulder Elbow Surg.* 2019 12;28(12):2284–9. [PubMed: 31371159]
30. Nicholson AD, Kassam HF, Steele JL, Passarelli NR, Blaine TA, Kovacevic D. Development of a clinical risk calculator for prolonged opioid use after shoulder surgery. *J Shoulder Elbow Surg.* 2019 11;28(11):2225–31. [PubMed: 31279718]
31. Brock JL, Jain N, Phillips FM, Malik AT, Khan SN. Postoperative opioid cessation rates based on preoperative opioid use: analysis of common orthopaedic procedures. *Bone Joint J.* 2019 12;101-B(12):1570–7. [PubMed: 31787005]
32. Inacio MC, Hansen C, Pratt NL, Graves SE, Roughead EE. Risk factors for persistent and new chronic opioid use in patients undergoing total hip arthroplasty: a retrospective cohort study. *BMJ Open.* 2016 4 29;6(4):e010664.

33. Singh JA, Lewallen D. Predictors of pain and use of pain medications following primary Total Hip Arthroplasty (THA): 5,707 THAs at 2-years and 3,289 THAs at 5-years. *BMC Musculoskelet Disord.* 2010 5 13;11:90. [PubMed: 20462458]
34. Centers for Medicaid and Medicare Services. National Health Expenditure Data. 2017 [December 8, 2019]; Available from: <https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/index>.
35. Williamson E, Ward L, Vadher K, Dutton SJ, Parker B, Petrou S, et al. Better Outcomes for Older people with Spinal Trouble (BOOST) Trial: a randomised controlled trial of a combined physical and psychological intervention for older adults with neurogenic claudication, a protocol. *BMJ Open.* 2018 10 18;8(10):e022205.
36. Lotzke H, Brisby H, Gutke A, Hagg O, Jakobsson M, Smeets R, et al. A Person-Centered Prehabilitation Program Based on Cognitive-Behavioral Physical Therapy for Patients Scheduled for Lumbar Fusion Surgery: A Randomized Controlled Trial. *Phys Ther.* 2019 8 1;99(8):1069–88. [PubMed: 30951604]
37. Hasin DS, Sarvet AL, Meyers JL, Saha TD, Ruan WJ, Stohl M, et al. Epidemiology of Adult DSM-5 Major Depressive Disorder and Its Specifiers in the United States. *JAMA Psychiatry.* 2018 4 1;75(4):336–46. [PubMed: 29450462]

Table 1.

Demographic data

Demographic Variable		No Pre-op Dep/Anx	Pre-op Dep/Anx
Age		mean = 53.9 (sd = 10.4), n = 123592	mean = 52.3 (sd = 9.7), n = 46737
Sex	Female	46,598 (37.7%)	26,304 (56.3%)
	Male	76,994 (62.3%)	20,433 (43.7%)
Re-operation?	No	110,197 (89.2%)	41,114 (88.0%)
	Yes	13,395 (10.8%)	5,623 (12.0%)
Pre-op Opioid?	No	90,336 (73.1%)	29,578 (63.3%)
	Yes	33,256 (26.9%)	17,159 (36.7%)
Post-60 Opioid?	No	87,265 (70.6%)	29,875 (63.9%)
	Yes	36,327 (29.4%)	16,862 (36.1%)
Post-90 Opioid?	No	89,991 (72.8%)	31,333 (67.0%)
	Yes	33,601 (27.2%)	15,404 (33.0%)

Table 2.

One year preoperative and postoperative healthcare costs

Variable	Pre-Op Depr/Anx?	Min	1 st Quartile	Median	Mean	3 rd Quartile	Max
One Year Pre-op Costs	Overall	\$0	\$2,644	\$4,958	\$10,806	\$10,572	\$2,243,810
(365 days)	Yes	\$0	\$3,655	\$6,970	\$14,723	\$15,188	\$2,243,810
	No	\$0	\$2,396	\$4,380	\$9,325	\$8,954	\$870,419
One Year Post-op Costs	Overall	\$0	\$2,040	\$4,313	\$9,832	\$9,083	\$4,101,985
(365 days)	Yes	\$0	\$2,246	\$5,014	\$11,720	\$11,035	\$1,664,064
	No	\$0	\$1,978	\$4,091	\$9,118	\$8,431	\$4,101,985