



Patient-Reported Allergies, a Marker of Preoperative Pain and Disability in Elective Spine Surgery

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Abstract

Study Design: Retrospective review.

Objective: Previous literature demonstrates mixed results regarding the relationship between patient-reported allergies and pain, function, and satisfaction scores. The objective of this study was to investigate the correlation between patient-reported allergies and preoperative Oswestry Disability Index (ODI), Neck Disability Index (NDI), and Patient-Reported Outcomes Measurement System (PROMIS) scores.

Methods: All patients undergoing elective cervical, lumbar procedures between May 2017 and October 2018 were included. Baseline demographic information was recorded, as well as all reported allergies or adverse reactions. Preoperative PROMIS, ODI, and NDI scores were recorded. Hierarchical multiple linear regressions were used to assess the relationship between total number of allergies and the preoperative pain and function scores.

Results: A total of 570 patients were included (476 lumbar, 94 cervical). The mean number of allergies reported was 1.89 ± 2.32 . The mean preoperative ODI and NDI scores were 46.39 ± 17.67 and 43.47 ± 16.51 , respectively. The mean preoperative PROMIS Physical Health and PROMIS Mental Health scores were 37.21 ± 6.54 and 43.89 ± 9.26 , respectively. Hierarchical multiple linear regression showed that total number of reported allergies shared a statistically significant negative relationship with all of the following scores: ODI ($B = 0.83, P = .02$), NDI ($B = 1.45, P = .02$), PROMIS Physical Health ($B = -0.29, P = .013$), and PROMIS Mental Health ($B = -0.38, P = .024$).

Conclusions: Patient-reported allergies share a statistically significant negative relationship with preoperative pain and function scores; as patients have increasing total number of allergies, the ODI/NDI scores become worse (increase) and the PROMIS scores become worse (decrease).

Keywords

patient-reported allergies, preoperative pain, preoperative function, spine surgery

Introduction

Over the past few years, there has been increasing literature demonstrating that patient-reported medication and environmental allergies and sensitivities can be used as a marker of increased pain, disability, and poor outcomes in elective surgery. Various subspecialties, such as hip and knee arthroplasty, have evaluated this and shown that patients with multiple reported allergies have less improvement in patient-reported outcomes postoperatively compared with patients with fewer allergies.¹⁻³ This topic has also been investigated in shoulder

arthroplasty; however, the results have been varied. A recent study by Rosenthal et al revealed that the presence of one or more self-reported allergies did not correlate with worse

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function, satisfaction, pain, or range of motion postoperatively.⁴ On the contrary, another recent study demonstrated that a greater number of patient-reported allergies correlated with severe postoperative pain in patients undergoing elective total shoulder arthroplasty.⁵

To date, there are very few studies in spine surgery that examine patient allergy lists, and their corresponding function and pain scores. Graves et al found that patients with more than 3 allergies had less improvement in their Oswestry Disability Index (ODI) postoperatively compared with patients with less than 3 allergies; they concluded that the number of allergies may serve as a predictive marker for patients at risk for poorer outcomes after elective spine surgery.⁶ Similarly, Kay et al⁷ observed that patients with more than 5 reported allergies had worse pain and disability outcome scores. It has also been shown that the number of reported allergies is associated with both depression and anxiety in patients with lumbar spine disease.⁸

On the contrary, the work of Xiong et al demonstrated that patient-reported allergies actually correlated with subjective improvement in pain and disability postoperatively. However, they found that this relationship did not persist longer than 1 year postoperatively, and they also found that a greater number of allergies corresponded with higher admissions costs and lengths of stay.⁹

As seen from these studies, the evidence is mixed regarding the association or correlation of patient-reported allergy lists and their pain and function scores on presentation for and after elective spine surgery. At this point, the evidence tends to point to the fact that patients with increasing numbers of allergies may have worse pain and function scores, as well as less improvement postoperatively. Another important factor is the role of underlying psychiatric comorbidities. Patient-reported allergies correlate with underlying *Diagnostic and Statistical Manual of Mental Disorders (DSM)* Axis 1 psychological disorders, such as major depression, bipolar disorder, phobias.¹⁰ Various Axis 1 diagnoses (depression, anxiety, somatization, panic disorders, etc) are also associated with poorer outcomes postoperatively and less satisfaction.¹¹ Patients with multiple drug intolerances also tend to have higher levels of anxiety, depression, and somatization.^{12,13} Therefore, allergies may be associated with, or even serve as a surrogate for, Axis 1 disorders.

Patient-reported allergy lists can certainly be used as an important piece of data in the elective surgery setting. As reimbursement methods tend to transition to quality-driven models, outcome scores and patient satisfaction become increasingly important. Identifying those at risk and subsequently considering them for and optimizing them prior to elective surgery is key. Therefore, we sought to evaluate patient allergy lists to see how they correlated with preoperative pain and function scores. We hypothesized that patients with multiple reported allergies would have lower preoperative Patient-Reported Outcomes Measurement System (PROMIS) scores, as well as worse preoperative Neck Disability Index (NDI) and ODI scores.

Materials and Methods

Institutional review board approval was obtained for this project; formal consent was waived as this was a retrospective study with minimal risk to subjects. Furthermore, the patient-reported outcome surveys that we used all involved obtaining consent at the time of the initial survey. All patients who had undergone elective lumbar, thoracolumbar, and cervical spine surgery from May 1, 2017, through October 18, 2018, were included in this study, which was conducted at the Spine Center at the Dartmouth-Hitchcock Medical Center, a spine referral center. This time frame was determined based on when the Spine Center started using PROMIS scores. We excluded all fracture, malignancy, and infection cases. We excluded patients who did not complete the preoperative function/pain surveys. A retrospective chart review was then performed of the preoperative association of patient-reported allergies and sensitivities and patient-reported outcomes at baseline.

The PROMIS is a questionnaire for patients that assess their pain and function. PROMIS is a 2-part (Physical Health and Mental Health) questionnaire for patients that assess their pain and function. Numerous studies in the spine literature have demonstrated that both are valid and responsive questionnaires.¹⁴⁻¹⁶ The ODI and the NDI are 2 other commonly used questionnaires that have been in use since the early 1980s and are validated as useful clinical tools representing pain and disability.^{17,18}

The preoperative PROMIS scores were recorded, as well as the preoperative ODI and NDI scores. Baseline demographic information (age, sex, body mass index [BMI], American Society of Anesthesiologists [ASA] score, and smoking status) as well as any documented *DSM* Axis I diagnoses were collected through a retrospective chart review. The total number of listed allergies/adverse drug reactions was recorded. This was broken down into 2 groups, medication allergies and environment/food allergies.

All analyses were conducted in version 3.5.1 of the R environment (R Development Core Team, 2013). Hierarchical multiple linear regression was used to assess the relationship between total number of allergies and the preoperative ODI, NDI, PROMIS Mental Health, and PROMIS Physical Health scores after controlling for relevant demographics. Hierarchical multiple linear regression was used to demonstrate how an independent variable of interest (in this case allergies) explains or relates to variance in a dependent variable (PROMIS scores and ODI/NDI scores).^{19,20} In this statistical method, a model is built that includes numerous independent variables, such as the various patient demographics (age, sex, BMI, etc). Then, a second model is created that introduces another variable (allergies). The models are then compared, and if the difference in R^2 between the 2 models is statistically significant, the variable that was introduced in the second model is assumed to explain the difference.

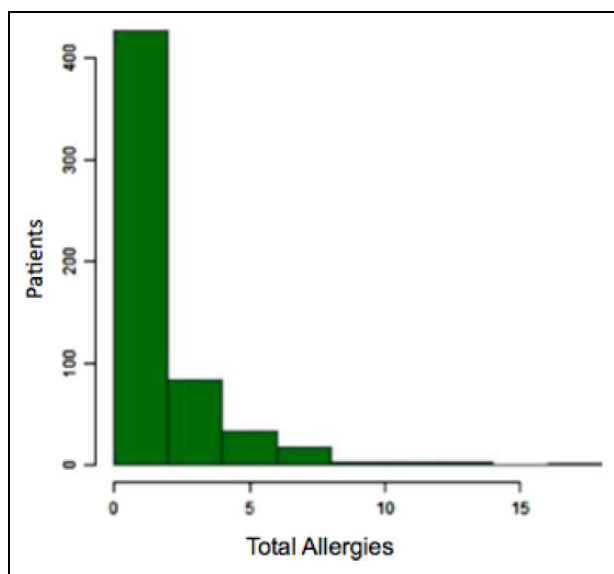
Results

A total of 923 patients underwent elective spine surgery between May 2017 and October 2018. All cases of infection, tumor, and fracture were excluded. Patients who did not

Table 1. Baseline Characteristics of Patients Undergoing Elective Spine Surgery from May 2017-October 2018.

| Characteristics | Mean (\pm SD) or Sum (%) |
|-------------------------------------|-----------------------------|
| N | 570 |
| Age | 58.06 (\pm 15.02) |
| BMI | 30.20 (\pm 6.12) |
| ASA | 2.38 (\pm 0.59) |
| Sex | |
| Male (%) | 329 (57.7) |
| Female (%) | 241 (43.3) |
| Current smoker (%) | 92 (16.1) |
| Surgery | |
| Thoracolumbar (%) | 476 (83.5) |
| Cervical (%) | 94 (16.5) |
| Allergies | |
| Total | 1.89 (\pm 2.32) |
| Medications | 1.49 (\pm 2.00) |
| Environmental/food | 0.43 (\pm 0.91) |
| Presence of Axis I disorder(s) (%) | 191 (33.5) |
| Preoperative ODI | 46.39 (\pm 17.67) |
| Preoperative NDI | 43.47 (\pm 16.51) |
| Preoperative PROMIS Physical Health | 37.21 (\pm 6.54) |
| Preoperative PROMIS Mental Health | 43.89 (\pm 9.26) |

Abbreviations: BMI, body mass index; ASA, American Society of Anesthesiologists score; ODI, Oswestry Disability Index; NDI, Neck Disability Index; PROMIS, Patient-Reported Outcomes Measurement System.

**Figure 1.** Distribution of allergies.

complete preoperative PROMIS, ODI, or NDI questionnaires were also excluded. A total of 570 patients met the inclusion criteria, and their baseline characteristics are presented in Table 1. The distribution of the number of allergies per patient is demonstrated in Figure 1. Hierarchical multiple linear regression and then ANOVA were used to assess the relationship between allergies and preoperative ODI (Table 2), NDI (Table 3), PROMIS Mental Health (Table 4), and PROMIS

Table 2. Hierarchical Multiple Regression Models with Dependent Variable (DV) ODI Scores.

| Predictors | DV: Preoperative ODI Scores | | | |
|--|-----------------------------|----------------|-----------|----------------|
| | Estimates | CI | Estimates | CI |
| (Intercept) | 47.88*** | 37.12 to 58.65 | 46.97*** | 36.23 to 57.71 |
| Age | -0.21*** | -0.32 to -0.09 | -0.22*** | -0.33 to -0.11 |
| Sex ^a | -1.58 | -4.75 to 1.59 | -0.49 | -3.78 to 2.80 |
| BMI | 0.15 | -0.11 to 0.41 | 0.16 | -0.10 to 0.42 |
| ASA | 2.4 | -0.56 to 5.37 | 2.15 | -0.81 to 5.11 |
| Current smoker (Yes ^b) | 9.89*** | 5.36 to 14.41 | 9.95*** | 5.45 to 14.45 |
| Axis I disorders (Yes ^b) | 0.77 | -2.58 to 4.12 | 0.32 | -3.03 to 3.67 |
| Total allergies | | | 0.83* | 0.13 to 1.52 |
| Observations | | 472 | | 472 |
| R ² (Δ R ²) | | 0.09 | | 0.1 |
| $\Delta\chi^2 = 5.4067^*$ | | | | |

Abbreviations: DV, dependent variable; ODI, Oswestry Disability Index; CI, confidence interval; BMI, body mass index; ASA, American Society of Anesthesiologists score.

^aFemale is referent.

^bNo is referent

* $P < .05$. ** $P = .001$. *** $P < .001$.

Physical Health (Table 5). All regressions demonstrated that there was a statistically significant relationship between total number of allergies and these pain/function scores. As the number of allergies increased, the preoperative ODI and NDI scores increased (patients had increased pain and disability) and the preoperative PROMIS scores decreased (patients had worse mental and physical health). Since the magnitude of the effect was small, as demonstrated by the ΔR^2 metric, a χ^2 test for nested models was employed to investigate whether model fit significantly improved with the introduction of the allergy predictor. These results showed that allergies did account for the variance and that the variance was statistically significant ($P < .05$).

As mentioned above, 4 nested models were analyzed to understand the impact of allergies on preoperative scores over and above age, sex, BMI, ASA score, smoking status, and the presence of *DSM-IV* Axis I disorders. The first included preoperative ODI as the dependent variable (Table 2). ODI is a function score that assesses low back pain and disability; therefore, it was used for the subset of patients undergoing lumbar and thoracolumbar procedures. As the number of reported allergies increased by 1, the ODI score increased by 0.83, which was statistically significant ($B = 0.83$, $P = .02$). The inclusion of number of allergies significantly increased the variance explained in the ODI dependent variable ($\chi^2 = 5.4067$, $P = .02049$).

The second model included preoperative NDI as the dependent variable (Table 3). This was based on the subset of patients who had undergone cervical procedures. The NDI is a version of the ODI, but it is focused on neck pain and disability, rather than low back pain. Therefore, it was used for

Table 3. Hierarchical Multiple Regression Models with Dependent Variable (DV) NDI Scores.

| DV: Preoperative NDI Scores | | | | |
|------------------------------------|-----------|----------------|-----------|----------------|
| Predictors | Estimates | CI | Estimates | CI |
| (Intercept) | 51.6*** | 31.95 to 71.24 | 53.23*** | 33.96 to 72.50 |
| Age | -0.46*** | -0.70 to -0.22 | -0.48*** | -0.72 to -0.24 |
| Sex ^a | 3.14 | -2.99 to 9.28 | 4.22 | -1.85 to 10.29 |
| BMI | 0.13 | -0.33 to 0.59 | 0.11 | -0.34 to 0.56 |
| ASA | 4.38 | -1.11 to 9.87 | 3.26 | -2.19 to 8.72 |
| Current smoker (Yes ^b) | 10.59* | 3.96 to 17.23 | 10.57* | 4.08 to 17.06 |
| Axis disorders (Yes ^b) | 0.38 | -5.76 to 6.52 | -1.64 | -7.91 to 4.62 |
| Total allergies | | | 1.45* | 0.17 to 2.73 |
| Observations | | 94 | | 94 |
| R ² (ΔR ²) | | 0.242 | | 0.283 |
| Δχ ² = 4.9436* | | | | |

Abbreviations: DV, dependent variable; NDI, Neck Disability Index; CI, confidence interval; BMI, body mass index; ASA, American Society of Anesthesiologists score.

^aFemale is referent.

^bNo is referent.

*P < .05. **P = .001. ***P < .001.

Table 4. Hierarchical Multiple Regression Models with Dependent Variable (DV) PROMIS Physical Health Scores.

| DV: PROMIS Physical Health | | | | |
|--------------------------------------|-----------|----------------|-----------|----------------|
| Predictors | Estimates | CI | Estimates | CI |
| (Intercept) | 46.44*** | 37.15 to 55.73 | 46.85*** | 37.59 to 56.10 |
| Age | 0.06** | 0.02 to 0.10 | 0.07** | 0.03 to 0.11 |
| Sex ^a | 0.19 | -0.86 to 1.25 | -0.17 | -1.27 to 0.92 |
| BMI | -0.12** | -0.21 to -0.03 | -0.12** | -0.21 to -0.04 |
| ASA | -1.80*** | -2.79 to -0.82 | -1.7** | -2.68 to -0.72 |
| Current smoker (Yes ^b) | -3.92*** | -5.35 to -2.48 | -3.93*** | -5.36 to -2.51 |
| Thoracolumbar | -4.23 | -12.83 to 4.37 | -4.41 | -12.97 to 4.15 |
| Cervical | -3.68 | -12.35 to 5.00 | -3.83 | -12.47 to 4.81 |
| Axis I disorders (Yes ^b) | -1.01 | -2.13 to 0.10 | -0.82 | -1.94 to 0.30 |
| Total allergies | | | -0.29* | -0.53 to -0.06 |
| Observations | | 568 | | 568 |
| R ² (ΔR ²) | | 0.123 | | 0.133 (0.01) |
| Δχ ² = 6.1524* | | | | |

Abbreviations: DV, dependent variable; PROMIS, Patient-Reported Outcomes Measurement System; CI, confidence interval; BMI, body mass index; ASA, American Society of Anesthesiologists score.

^aFemale is referent.

^bNo is referent.

*P < .05. **P = .001. ***P < .001.

the subset of patients who underwent cervical procedures. As the number of allergies increased by 1, the NDI increased by 1.45, which was statistically significant ($B = 1.45, P = .02$). The inclusion of number of allergies significantly increased the variance explained in the NDI dependent variable ($\chi^2 = 4.9436, P = .02881$).

The third model included preoperative PROMIS Physical Health as the dependent variable (Table 4). This included all

Table 5. Hierarchical Multiple Regression Models with Dependent Variable (DV) PROMIS Mental Health Scores.

| DV: PROMIS Mental Health Scores | | | | |
|--------------------------------------|-----------|-----------------|-----------|-----------------|
| Predictors | Estimates | CI | Estimates | CI |
| (Intercept) | 43.97*** | 30.72 to 57.23 | 44.5*** | 31.29 to 57.72 |
| Age | 0.09** | 0.04 to 0.15 | 0.1** | 0.04 to 0.15 |
| Sex ^a | 0.28 | -1.23 to 1.79 | -0.2 | -1.76 to 1.36 |
| BMI | 0.02 | -0.10 to 0.15 | 0.02 | -0.10 to 0.14 |
| ASA | -2.56*** | -3.97 to -1.16 | -2.42** | -3.83 to -1.02 |
| Current smoker (Yes ^b) | -4.19*** | -6.24 to -2.15 | -4.21*** | -6.25 to -2.17 |
| Thoracolumbar | 1.72 | -10.55 to 13.98 | 1.48 | -10.74 to 13.70 |
| Cervical | 1.22 | -11.16 to 13.60 | 1.02 | -11.32 to 13.35 |
| Axis I disorders (Yes ^b) | -3.11*** | -4.69 to -1.52 | -2.85*** | -4.45 to -1.26 |
| Total allergies | | | -0.38* | -0.71 to -0.05 |
| Observations | | 568 | | 568 |
| R ² (ΔR ²) | | 0.109 | | 0.118 |
| Δχ ² = 5.0934* | | | | |

Abbreviations: DV, dependent variable; PROMIS, Patient-Reported Outcomes Measurement System; CI, confidence interval; BMI, body mass index; ASA, American Society of Anesthesiologists score.

^aFemale is referent.

^bNo is referent.

*P < .05. **P = .001. ***P < .001.

570 patients in the study (cervical and lumbar surgeries). As the number of allergies increased by 1, the PROMIS Physical Health score decreased by 0.29, which was statistically significant ($B = -0.29, P = .013$). The inclusion of number of allergies significantly increased the variance explained in the PROMIS Physical Health dependent variable ($\chi^2 = 6.1524, P = .01342$).

The fourth model included preoperative PROMIS Mental Health as the dependent variable (Table 5). This included all 570 patients in the study (cervical and lumbar surgeries). As the number of allergies increased by 1, the PROMIS Mental Health score decreased by 0.38, which was statistically significant ($B = -0.38, P = .024$). The inclusion of number of allergies significantly increased the variance explained in the PROMIS Mental Health dependent variable ($\chi^2 = 5.0934, P = .0244$).

Discussion

This study shows that within our patient population, patient-reported allergies shared a statistically significant negative relationship with preoperative pain and disability scores. In other words, with increasing numbers of allergies, patients have worse (higher) ODI and NDI scores and worse (lower) PROMIS mental and physical health scores.

As seen in previous studies, there is an association with increasing amounts of patient reported allergies and poorer pain and disability after elective lumbar spine surgeries.^{6,7} A similar association has also been seen in multiple investigations in hip and knee arthroplasty.^{1,6,21}

Multiple self-reported allergies are also associated with depression and anxiety.¹⁰ Studies have shown that patients with

psychological distress undergoing lower extremity arthroplasty have worse self-perceived preoperative and postoperative function and disability scores.²² This raises the question as to why multiple drug allergies, sensitivities, or multiple drug intolerance syndrome (3 or more unrelated drug class allergies) is associated with poorer preoperative function. One reason may be that patients with multiple allergies tend to be older, overweight, and have higher rates of health care and medication usage.^{23,24}

As the economic landscape continues to change, reimbursement models are increasingly focusing on quality and patient-reported outcomes. Preoperative screening and identification of risk factors has also become a critical factor in elective surgery; poor pain control and function have strong correlations with numerous psychological and behavioral characteristics that may be evaluated in the preoperative setting.⁵ Just as smoking, uncontrolled diabetes, obesity, and liability issues are conditions that can adversely impact surgical outcomes in spine patients, multiple allergies or sensitivities to both medications and environmental factors may play a similar role. An improved understanding of these factors may help establish methods or pathways to counsel and manage these patients prior to considering surgical options.

This study does have some limitations. The distribution of total allergies in our patient population was skewed to the left. Although this is a nonsymmetric distribution, our sample size was large and this distribution is representative of our population. Second, all allergies were included as reported by and confirmed by the patient to the intake nurse, and therefore not all were necessarily confirmed allergies. The patients' perception of the burden of sensitivities and allergies may in fact be the true correlate with outcomes, not whether or not the allergy is real or not. Also, additional analyses evaluating whether or not these relationships also affect postoperative scores will be important in evaluating the role of patient allergies and our assessments of their pain and function.


Declaration of Conflicting Interests


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Ethical Approval

This study was approved by our institution's institutional review board committee, CPHS# STUDY00031299.

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