

## Original Research Article

# Postoperative morbidity and mortality in patients with vertigo undergoing elective laminectomy

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## ABSTRACT

**Background:** Vertigo is frequently encountered in patients undergoing elective spine surgery, yet its association with postoperative morbidity and mortality after laminectomy remains poorly defined. We evaluated short- and long-term postoperative outcomes among patients with preoperative vertigo undergoing elective laminectomy after rigorous adjustment for comorbid disease burden.

**Methods:** We performed a retrospective propensity score-matched cohort study comparing adults undergoing elective laminectomy with preoperative peripheral vertigo to those without. Vertigo was identified using ICD-10 codes (H81.x), excluding central neurologic, cerebrovascular, autonomic, traumatic, and infectious etiologies. Cohorts were matched 1:1 (6,031 per group) on demographics, comorbidities, laboratory values, and medication exposures. Outcomes were assessed at 90 days and 1 year with falls serving as the primary outcome. To account for multiple secondary outcome comparisons, a Bonferroni correction was applied, with statistical significance set at  $p < 0.002$ .

**Results:** Postoperative falls was significantly elevated at 90 days (OR=1.97) and 1 year (OR=1.75). Among secondary outcomes, the vertigo cohort demonstrated significantly higher rates of stroke (OR=2.31 at 90 days; OR=2.33 at 1 year), nausea or vomiting (OR=1.86; OR=1.98), fall-related fractures (OR=1.70 at 90 days), somnolence or stupor (OR=2.44; OR=2.21), myocardial infarction (OR=1.85 at 1 year), urinary tract infection (OR=1.57 at 1 year), amnesia (OR=2.36 at 1 year), and emergency department utilization (OR=1.45 at 1 year). Trends toward elevated venous thromboembolism, myocardial infarction at 90 days, and all-cause mortality at 1 year (OR=1.52;  $p=0.0037$ ) were observed.

**Conclusions:** Preoperative peripheral vertigo is associated with increased postoperative morbidity across neurologic, cardiovascular, functional, and healthcare utilization domains following elective laminectomy, with a trend toward elevated 1-year mortality. These findings suggest vertigo may represent a clinically meaningful risk modifier and support prospective evaluation of enhanced preoperative optimization and fall-prevention protocols in this population.

**Keywords:** Vertigo, Elective laminectomy, Propensity score matching, Falls, Stroke, Spine surgery

## INTRODUCTION

Vertigo and vestibular dizziness are among the most prevalent neurological complaints in clinical practice, with

a lifetime prevalence of vestibular vertigo estimated at approximately 7-8% in the general adult population, rising substantially with age.<sup>1</sup> Beyond its prevalence, vertigo exerts a considerable burden on quality of life, daily

functioning, and healthcare resource utilization, accounting for an estimated \$48 billion in annual medical expenditures in the United States alone.<sup>2</sup> The vestibular system coordinates balance, spatial orientation, and postural control by continuously adjusting muscle tone and reflex responses through its descending vestibulospinal pathways.<sup>3</sup> Disruption of vestibular function produces measurable impairments in postural stability, gait, and fall risk that persist even during clinically quiescent intervals between symptomatic episodes.<sup>4</sup>

Despite this functional vulnerability, the postoperative implications of preoperative vestibular dysfunction in non-otologic surgery remain largely unexplored. Elective laminectomy is one of the most commonly performed surgical procedures in the United States, with approximately 900,000 spine surgeries performed annually, and laminectomy representing a major component of that volume across cervical, thoracic, and lumbar indications for myelopathy and radiculopathy.<sup>5,6</sup> Contemporary perioperative risk stratification in spine surgery has focused predominantly on cardiovascular comorbidity, pulmonary reserve, and frailty as predictors of adverse outcomes.<sup>7,8</sup> Vestibular and balance disorders have not been systematically incorporated into preoperative risk frameworks, despite the physiologic rationale for concern: patients with preoperative vestibular dysfunction enter the postoperative recovery period with a compromised sensorimotor foundation, potentially amplifying the risk of falls, functional decline, and other adverse outcomes across both the short and the longer term.

Adding to this concern, epidemiologic evidence has linked peripheral vestibular disorders to elevated cardiovascular risk beyond what would be expected from shared comorbidities alone, with population-based cohort studies demonstrating a significantly higher subsequent risk of ischemic stroke in patients with vertigo compared to matched controls.<sup>9,10</sup> Whether these risks translate into measurable excess postoperative morbidity and mortality has not been examined in a large-scale study.

We therefore conducted a propensity score-matched cohort study using TriNetX, a federated health record network encompassing longitudinal data from millions of patients across academic and community health systems in the United States, to evaluate the association between preoperative peripheral vertigo and postoperative outcomes at 90 days and one year following elective laminectomy.

We hypothesized that preoperative peripheral vertigo would be associated with increased rates of postoperative falls, fractures, and functional complications, and we sought to comprehensively characterize the associated morbidity profile across neurologic, cardiovascular, and healthcare utilization domains to inform preoperative risk counseling and monitoring strategies for this underrecognized surgical population.

## METHODS

### Data source and study design

We conducted a retrospective, propensity score-matched cohort study using TriNetX United States Collaborative Network, federated, de-identified electronic health record database comprising academic and community healthcare systems across the United States with longitudinal inpatient and outpatient data, diagnoses, procedures, laboratory values, and medication exposures. All analyses were performed within TriNetX platform in compliance with institutional and federal privacy regulations.

### Study population

Adults ( $\geq 18$  years) undergoing elective laminectomy were identified using CPT codes for cervical, thoracic, and lumbar decompressive procedures, including laminectomy with or without facetectomy, foraminotomy, or discectomy. Patients were required to have adequate longitudinal follow-up. To ensure a homogeneous elective cohort and minimize confounding, patients with central nervous system neoplasms, prior ischemic stroke or cerebral infarction, spinal or torso trauma, vertebral osteomyelitis or discitis, or other major neurologic or infectious spinal pathologies were excluded.

### Cohort selection

Patients were stratified based on the presence of preoperative peripheral vertigo, defined using ICD-10 codes limited to H81.x (disorders of vestibular function), with diagnoses required to occur within 12 months of the index procedure to ensure temporality. Diagnoses associated with central vertigo or autonomic dysfunction, including cerebrovascular disease, multiple sclerosis, syncope, orthostatic hypotension, arrhythmias, and other autonomic disorders, were excluded. The comparator cohort consisted of patients with no documented vertigo or vestibular disorder diagnoses prior to surgery. Flowchart outlining cohort curation is depicted in Figure 1.

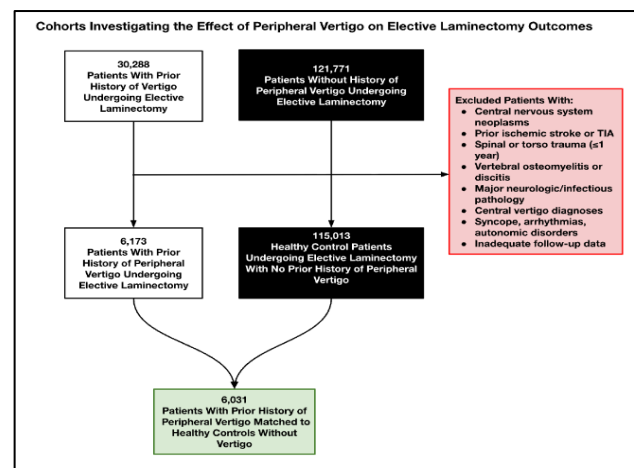


Figure 1: Cohort construction flowchart.

### Propensity score matching

To minimize confounding, 1:1 propensity score matching was performed using a greedy nearest-neighbor algorithm with a predefined caliper.<sup>11</sup> Matching variables included demographics (age, sex, race, ethnicity), BMI categories, cardiovascular and metabolic comorbidities (hypertension, hyperlipidemia, diabetes, obesity, chronic ischemic heart disease), renal and hepatic disease, anemia and malignancy, obstructive sleep apnea, substance use (nicotine and alcohol-related disorders), medication exposures (including corticosteroids and antihistamines), and baseline hemoglobin. This resulted in well-balanced cohorts with standardized mean differences below accepted thresholds.

### Outcomes

Postoperative outcomes were assessed at 90 days and 1 year following laminectomy and included falls and fall-related fractures (W00-W19, S72.x, S82.x), gait abnormalities (R26.x), ischemic stroke (I63.x), myocardial infarction (I21.x-I22.x), venous thromboembolism (I26.x, I82.x), acute kidney injury (N17.x), urinary tract infection (N39.0), sepsis (A41.x), and all-cause mortality. The primary outcome was postoperative falls at 90 days, selected a priori based on the established mechanistic link between vestibular dysfunction and fall risk. All remaining outcomes were designated as secondary. Given the exploratory nature of secondary outcome assessment, a Bonferroni correction was applied to adjust for multiple comparisons, with statistical significance for secondary outcomes set at  $p < 0.002$ . Outcomes were identified using ICD-10 diagnostic codes from inpatient and outpatient encounters.

Two prespecified subgroup analyses were attempted to further characterize the association between vertigo subtype and medication exposure on postoperative outcomes. Stratification of the vertigo cohort by ICD-10 subtype, including benign paroxysmal positional vertigo (H81.1), Meniere's disease (H81.0), and vestibular neuritis (H81.2), was pursued but was not feasible due to insufficient subgroup sizes to support stable propensity score matching. A sensitivity analysis stratifying patients by preoperative antihistamine exposure to evaluate the independent contribution of vestibular suppressant pharmacotherapy to postoperative risk was similarly limited by inadequate cohort sizes within the antihistamine-naïve vertigo subgroup following stratification. These analyses remain priorities for future investigation in larger datasets.

### Negative control analysis

To assess for residual bias and differences in healthcare utilization between cohorts, negative control outcomes were evaluated, including Raynaud's syndrome, burns, and Mohs surgery. These outcomes were selected a priori as clinically unrelated to vertigo and laminectomy and

were analyzed at the same postoperative timepoints to ensure no systematic differences between groups.

### Statistical analysis

Following matching, outcomes were compared between cohorts using odds ratios with 95% confidence intervals generated within the TriNetX platform. Two-sided  $p$  values were reported. Statistical significance for primary outcome was set at  $p < 0.05$ . For secondary outcomes, a Bonferroni correction was applied to account for multiple comparisons, yielding an adjusted significance threshold of  $p < 0.002$ . A forest plot was constructed using Python 3.13 to visually summarize odds ratios and 95% confidence intervals for all postoperative outcomes at 90 days and 1 year. Each outcome was displayed as a paired row with diamond-shaped point estimates and horizontal error bars representing the confidence interval. A vertical reference line at  $OR = 1.0$  denoted the null effect threshold.

## RESULTS

Baseline characteristics are summarized in Table 1. Before matching, patients with vertigo ( $n = 6,173$ ) were older ( $67.7 \pm 11.3$  vs  $61.7 \pm 13.6$  years,  $p < 0.0001$ ) and had a substantially higher burden of comorbidities, including hypertension (73.8% vs 41.0%), hyperlipidemia (61.5% vs 23.9%), diabetes (32.4% vs 16.5%), and chronic ischemic heart disease (24.0% vs 9.6%) (all  $p < 0.0001$ ), along with greater use of medications such as opioids (88.6% vs 54.3%) and gabapentinoids (65.4% vs 36.7%). After 1:1 propensity matching, cohorts were well balanced ( $n = 6,031$  each), with no meaningful differences in age (67.6 vs 67.5 years,  $p = 0.36$ ), sex, race, comorbidities, BMI, laboratory values, or medication use (all  $p > 0.05$ ).

Postoperative outcomes are visually summarized in Figure 2. Postoperative falls at 90 days, was significantly higher in the vertigo cohort (3.24% vs 1.67%;  $OR = 1.97$ ;  $p < 0.0001$ ), surviving Bonferroni correction. This association persisted at 1 year (6.88% vs 4.05%;  $OR = 1.75$ ;  $p < 0.0001$ ).

Among secondary outcomes at 90 days, stroke ( $OR = 2.31$ ), nausea/vomiting ( $OR = 1.86$ ), fall-related fractures ( $OR = 1.70$ ), and somnolence ( $OR = 2.44$ ) were all significantly elevated and survived Bonferroni correction (all  $p < 0.002$ ). VTE, MI, UTI, amnesia, and emergency department visits were also higher in the vertigo cohort (all  $p < 0.05$ ) but did not meet the Bonferroni-adjusted threshold. No differences were observed in sepsis, AKI, disorientation, or mortality at 90 days.

At 1 year, stroke ( $OR = 2.33$ ), MI ( $OR = 1.85$ ), nausea/vomiting ( $OR = 1.98$ ), UTI ( $OR = 1.57$ ), somnolence ( $OR = 2.21$ ), amnesia ( $OR = 2.36$ ), and emergency department visits ( $OR = 1.45$ ) were all elevated in the vertigo cohort (all  $p < 0.002$ ). VTE, fall-related fractures, disorientation, and all-cause mortality ( $OR = 1.52$ ;  $p = 0.0037$ ) showed consistent directional trends but did not

meet the Bonferroni-adjusted threshold. Sepsis and AKI remained similar between groups at both timepoints.

To evaluate for residual confounding and potential differences in baseline healthcare utilization, negative

control outcomes were assessed and are shown in Table 2. There were no significant differences between cohorts for Raynaud’s syndrome, burns, or Mohs surgery at either 90 days or 1 year (all  $p>0.05$ ), supporting that the observed associations are unlikely to be driven by systematic bias.

### 90 Day and 1 Year Postoperative Outcomes in Patients with Peripheral Vertigo Undergoing Elective Laminectomy Compared to Matched Controls

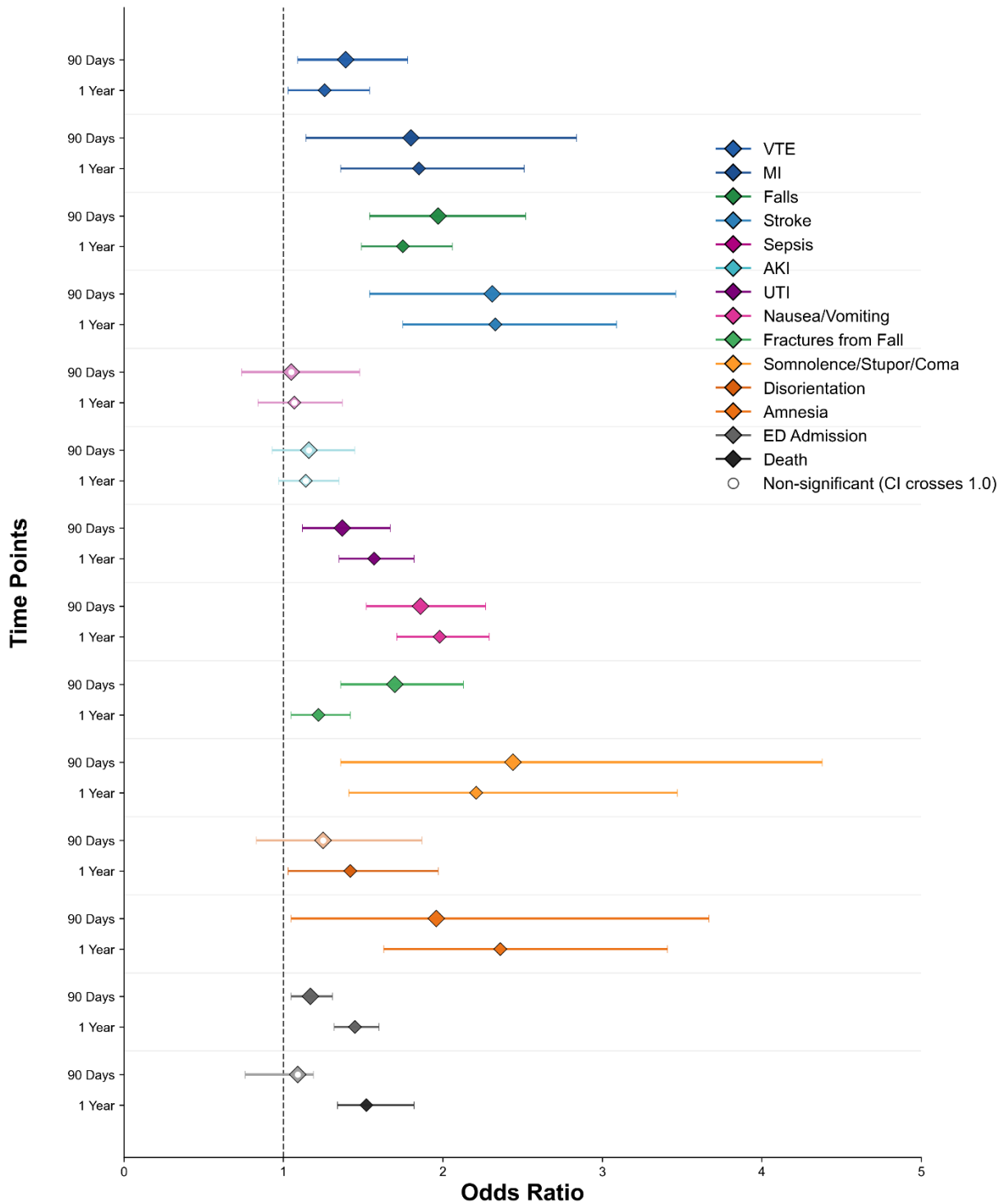


Figure 2: 90 day and 1 year postoperative outcomes in patients with peripheral vertigo undergoing elective laminectomy compared to matched controls.

**Table 1: Baseline demographic, clinical, laboratory, and medication characteristics of patients undergoing elective laminectomy before and after propensity score matching.**

Covariate	Before matching: vertigo cohort, (n=6,173)	Before matching: no vertigo cohort, (n=115,013)	Before p value	After matching: vertigo cohort, (n=6,031)	After matching: no vertigo cohort, (n=6,031)	After p value
<b>Demographics</b>						
Age at index (in years) (Mean±SD)	67.7±11.3	61.7±13.6	<0.0001	67.6±11.3	67.5±10.5	0.36
White	5,230 (84.72%)	93,245 (81.07%)	<0.0001	5,107 (84.68%)	5,107 (84.68%)	1
Black or African American	514 (8.33%)	9,591 (8.34%)	0.97	504 (8.36%)	504 (8.36%)	1
Asian	121 (1.96%)	2,027 (1.76%)	0.25	119 (1.97%)	119 (1.97%)	1
Unknown race	177 (2.87%)	7,077 (6.15%)	<0.0001	172 (2.85%)	172 (2.85%)	1
Male	2,710 (43.90%)	66,517 (57.83%)	<0.0001	2,686 (44.54%)	2,686 (44.54%)	1
Female	3,461 (56.07%)	48,457 (42.13%)	<0.0001	3,345 (55.46%)	3,345 (55.46%)	1
<b>Diagnoses (Comorbidities)</b>						
Essential hypertension	4,557 (73.82%)	47,109 (40.96%)	<0.0001	4,430 (73.45%)	4,460 (73.95%)	0.54
Hyperlipidemia	3,795 (61.48%)	27,432 (23.85%)	<0.0001	3,669 (60.84%)	3,725 (61.76%)	0.3
Overweight/obesity	2,537 (41.10%)	19,552 (17.00%)	<0.0001	2,445 (40.54%)	2,459 (40.77%)	0.8
Diabetes mellitus	2,002 (32.43%)	19,012 (16.53%)	<0.0001	1,929 (31.99%)	1,932 (32.03%)	0.95
Chronic ischemic heart disease	1,479 (23.96%)	11,047 (9.61%)	<0.0001	1,405 (23.30%)	1,398 (23.18%)	0.88
Nicotine dependence	1,031 (16.70%)	13,211 (11.49%)	<0.0001	996 (16.52%)	1,014 (16.81%)	0.66
Obstructive sleep apnea	1,582 (25.63%)	10,202 (8.87%)	<0.0001	1,507 (24.99%)	1,526 (25.30%)	0.69
Hypothyroidism	1,400 (22.68%)	9,221 (8.02%)	<0.0001	1,327 (22.00%)	1,334 (22.12%)	0.88
Polyneuropathy	1,322 (21.42%)	7,112 (6.18%)	<0.0001	1,235 (20.48%)	1,221 (20.25%)	0.75
Chronic kidney disease	979 (15.86%)	5,521 (4.80%)	<0.0001	922 (15.29%)	945 (15.67%)	0.56
Diseases of liver	973 (15.76%)	4,722 (4.11%)	<0.0001	912 (15.12%)	859 (14.24%)	0.17
Osteoporosis	1,023 (16.57%)	4,809 (4.18%)	<0.0001	952 (15.79%)	941 (15.60%)	0.78
<b>BMI and labs</b>						
25-30 kg/m <sup>2</sup>	3,151 (51.05%)	43,048 (37.43%)	<0.0001	3,063 (50.79%)	3,050 (50.57%)	0.81
30-35 kg/m <sup>2</sup>	2,911 (47.16%)	36,926 (32.11%)	<0.0001	2,821 (46.78%)	2,788 (46.23%)	0.55
35-40 kg/m <sup>2</sup>	1,852 (30.00%)	20,262 (17.62%)	<0.0001	1,781 (29.53%)	1,729 (28.67%)	0.3
≥40 kg/m <sup>2</sup>	1,023 (16.57%)	11,144 (9.69%)	<0.0001	987 (16.37%)	955 (15.84%)	0.43
Hemoglobin A1c (Mean±SD)	6.05±1.06	6.13±1.21	<0.0001	6.05±1.06	6.07±1.10	0.43
<b>Medications</b>						
Opioids	5,472 (88.64%)	62,389 (54.25%)	<0.0001	5,334 (88.44%)	5,343 (88.59%)	0.8
Gabapentinoids	4,034 (65.35%)	42,168 (36.66%)	<0.0001	3,906 (64.77%)	3,873 (64.22%)	0.53
Skeletal muscle relaxants	3,903 (63.23%)	35,825 (31.15%)	<0.0001	3,774 (62.58%)	3,739 (61.99%)	0.51
Antihistamines	4,030 (65.28%)	29,236 (25.42%)	<0.0001	3,901 (64.68%)	3,982 (66.03%)	0.12
Antidepressants	3,350 (54.27%)	30,455 (26.48%)	<0.0001	3,226 (53.49%)	3,181 (52.74%)	0.41
NSAIDs	2,210 (35.80%)	20,596 (17.91%)	<0.0001	2,122 (35.19%)	2,080 (34.49%)	0.42
Antipsychotics	1,967 (31.87%)	11,730 (10.20%)	<0.0001	1,881 (31.19%)	1,925 (31.92%)	0.39

\*Data presented as n (%) unless otherwise indicated. SD, standard deviation; BMI, body mass index; NSAIDs, non-steroidal anti-inflammatory drugs.

**Table 2: Negative control outcomes following elective laminectomy in patients with and without peripheral vertigo.**

Outcome	Timepoint	Vertigo cohort (n=6,031)	No vertigo cohort (n=6,031)	Odds ratio (95% CI)	P value
<b>Raynaud's syndrome</b>	90 days	16 (0.27%)	13 (0.22%)	1.23 (0.59, 2.56)	0.57
	1 year	28 (0.46%)	24 (0.40%)	1.17 (0.67, 2.05)	0.58
<b>Burns</b>	90 days	4 (0.07%)	3 (0.05%)	1.33 (0.30, 5.93)	0.71
	1 year	7 (0.12%)	5 (0.08%)	1.40 (0.44, 4.46)	0.56
<b>Mohs surgery</b>	90 days	8 (0.13%)	5 (0.08%)	1.60 (0.52, 4.94)	0.41
	1 year	13 (0.22%)	10 (0.17%)	1.30 (0.56, 2.99)	0.54

\*Negative control outcomes were selected a priori as clinically unrelated to vertigo or laminectomy.

**DISCUSSION**

The present study represents, to our knowledge, the first large-scale analysis examining the association between preoperative peripheral vertigo and the post-operative outcomes following elective laminectomy. Despite rigorous matching on demographics, comorbidities, baseline laboratory values, and medication exposures, preoperative vertigo was associated with significantly increased morbidity across neurologic, cardiovascular, functional, and healthcare utilization domains at both 90 days and 1 year. A trend toward elevated mortality emerged at 1 year, suggesting a pattern of cumulative postoperative morbidity rather than acute postoperative lethality. These findings suggest preoperative vertigo as a potentially clinically meaningful and previously underrecognized risk modifier in elective spine surgery populations.

Examination of the pre-match baseline characteristics offers important insight into the broader clinical phenotype of laminectomy patients with comorbid vertigo. Before propensity matching, the vertigo cohort carried substantially greater burdens of cardiovascular, metabolic, and neuropsychiatric comorbidity, as well as markedly higher rates of CNS-active medication use. This medication burden is consistent with prior reports demonstrating that polypharmacy is exceedingly common among patients with vestibular disorders; a study of 382 patients presenting to a tertiary neurotology clinic found that over two-thirds met criteria for polypharmacy, with polypharmacy independently associated with greater dizziness-related disability and cognitive complaints.<sup>12</sup> Taken together, these pre-match data suggest that vertigo clusters with broader systemic comorbidity in a manner consistent with a marker of generalized physiologic vulnerability. That the outcome associations observed in this study persisted after rigorous propensity matching for these factors indicates that vertigo confers risk independent of, and additive to, its associated comorbidity burden.

Among the most clinically relevant findings for the spine surgeon is the significantly elevated risk of postoperative falls and fall-related fractures observed in the vertigo cohort. The vestibular system is integral to postural control and spatial orientation, and patients with preexisting

vestibular dysfunction enter the postoperative period with an already-compromised balance system that must contend with the additional insults of postoperative pain, opioid analgesia, and anesthetic aftereffects during early mobilization.<sup>1,13</sup> Falls are a recognized complication of spine surgery, with a large retrospective analysis reporting an in-hospital fall incidence of 2.31%, with older age and higher comorbidity burden among the identified risk factors.<sup>14</sup> In patients with preexisting vestibular dysfunction, this baseline risk is likely substantially amplified. The fall signal persisted robustly at 1 year, suggesting that fall risk extends well beyond the immediate postoperative window and into the outpatient rehabilitation phase, a period during which patients are regaining independence and may have reduced clinical supervision. Additionally, there was a trend towards increased fall-related fractures at 1 year, though this association was attenuated compared to the 90-day signal. For patients undergoing laminectomy who may already have gait instability from myelopathy or radiculopathy, superimposed vestibular dysfunction likely compounds the challenge of postoperative functional recovery.

Beyond falls and fractures, the vertigo cohort demonstrated a broad pattern of increased postoperative morbidity spanning cardiovascular, neurologic, and gastrointestinal outcomes. The significantly elevated risk of stroke at both timepoints is consistent with prior epidemiologic evidence linking vestibular symptoms to subsequent cerebrovascular events. A population-based study of over 25,000 emergency department patients, reported that individuals discharged with a diagnosis of dizziness or vertigo had a 2-fold increased risk of subsequent vascular events, including stroke and MI, over a 3-year follow-up period after adjustment for comorbidities.<sup>15</sup> The inner ear shares terminal vascular supply with the posterior circulation, and it has been proposed that vestibular symptoms may in some cases represent an early clinical manifestation of subclinical cerebrovascular insufficiency.<sup>16,17</sup> Under this hypothesis, the elevated stroke and MI risk observed in our vertigo cohort may partly reflect undetected baseline cerebrovascular vulnerability rather than a de novo surgical complication. MI risk was significantly elevated at 1 year, with a trend in the same direction at 90 days, while VTE showed a consistent directional trend at both timepoints without reaching statistical significance after correction. The VTE trend may reflect reduced

postoperative mobility in patients with vestibular dysfunction, compounding the already-elevated thrombotic risk inherent to spine surgery. The significant associations with altered consciousness and amnesia at 1 year, and the directional trends observed at 90 days, suggest a heightened susceptibility to neurologic and emetogenic complications that may impede early mobilization, prolong recovery, and contribute to the downstream morbidity observed in this cohort. While the precise mechanisms underlying each of these associations cannot be elucidated from an observational study, the consistency of the multi-system signal supports a meaningful association between preoperative vestibular dysfunction and postoperative morbidity.

The healthcare utilization and mortality findings in this study warrant particular emphasis. Emergency department utilization was significantly elevated at 1 year, with a trend in the same direction at 90 days, representing a meaningful difference in resource use. This pattern is consistent with evidence from non-surgical populations demonstrating that vertigo is associated with increased healthcare utilization, including repeated outpatient visits, hospitalizations, and emergency presentations, with substantial economic consequences.<sup>18,19</sup> A trend toward elevated all-cause mortality emerged at 1 year that was absent at 90 days. The temporal divergence between short-term and long-term mortality suggests that vertigo patients do not experience excess acute surgical lethality but rather accumulate complications such as falls, fractures, cardiovascular events, and infections that compound over time. While this mortality trend did not reach statistical significance after correction for multiple comparisons, the pattern is reminiscent of frailty-associated postoperative trajectories, in which cumulative morbidity, rather than any single event, drives long-term mortality, and warrants prospective investigation.<sup>7</sup> Polypharmacy, which is both highly prevalent among vestibular disorder patients and commonly driven by the pharmacologic management of vestibular symptoms, has itself been independently associated with increased hospitalization and all-cause mortality in elderly populations, and likely contributes to the healthcare utilization patterns observed here.<sup>20</sup> From a systems-level perspective, these findings suggest that vertigo patients undergoing laminectomy represent a high-utilization phenotype whose postoperative needs extend well beyond the postoperative recovery period.

While the observational design of this study precludes definitive clinical recommendations, these findings generate several hypotheses with potential practical implications for spine surgeons and the multidisciplinary perioperative team. First, preoperative screening for vestibular complaints could be considered within the surgical planning process for elective laminectomy. While vertigo is not a contraindication to surgery, its presence may identify patients who benefit from enhanced postoperative monitoring and recovery protocols. Specifically, fall-prevention strategies, including supervised ambulation, environmental modifications, and

early physical therapy consultation, could be considered for patients with known vestibular dysfunction. Consideration of augmented antiemetic prophylaxis may be warranted given the nearly 2-fold elevation in postoperative nausea and vomiting, which itself can delay mobilization and prolong hospital stay.<sup>21</sup> The cardiovascular risk profile associated with vertigo supports a heightened index of suspicion for thromboembolic and cerebrovascular events during postoperative monitoring. Preoperative counseling could include discussion of the increased risk of falls, emergency department utilization, and delayed complications so that patients and their families can make more informed surgical decisions and plan for appropriate postoperative support. Finally, closer outpatient follow-up in the first postoperative year, including coordination with primary care and vestibular rehabilitation services, may help mitigate the cumulative morbidity burden observed in this population.

This study has several limitations that merit consideration. First, the retrospective design and reliance on the TriNetX database, while enabling a large, multi-institutional analysis, introduces the inherent limitations of administrative claims data. Diagnoses of vertigo and postoperative outcomes were identified through ICD-10 codes, which are subject to coding variability and cannot capture clinical severity or duration.<sup>22</sup> Additionally, distinguishing peripheral from central vestibular pathology through diagnostic coding alone is inherently imprecise, and bidirectional misclassification cannot be excluded, as definitive diagnosis requires formal vestibular function testing unavailable in large administrative databases. Surgical details including the number of levels decompressed, cervical versus lumbar location, open versus minimally invasive technique, and concomitant fusion were not available in the dataset, limiting our ability to stratify risk by procedural complexity or location. Although propensity score matching addressed a comprehensive array of measured confounders, residual confounding from unmeasured variables such as frailty indices, physical therapy utilization, surgical blood loss, and vestibular medication timing cannot be excluded. The application of correction for multiple comparisons, while appropriate for an analysis with numerous secondary outcomes, is conservative for correlated outcomes and may increase the risk of type II error; associations that did not survive correction should be interpreted as exploratory trends rather than definitively null findings. TriNetX aggregates data primarily from insured patients at academic and community health systems, which may limit generalizability to uninsured or underserved populations.<sup>23</sup>

## CONCLUSION

In conclusion, this propensity-matched cohort analysis suggests that preoperative peripheral vertigo is associated with increased postoperative morbidity across neurologic, cardiovascular, functional, and healthcare utilization domains following elective laminectomy. The primary

finding of significantly elevated fall risk was robust at both timepoints, with consistent directional trends observed across stroke, cardiovascular, neurologic, and healthcare utilization outcomes. A trend toward elevated 1-year mortality is consistent with a pattern of cumulative rather than acute postoperative risk. These associations are consistent with vertigo representing a potentially clinically meaningful risk modifier in spine surgery populations, a hypothesis warranting prospective investigation. Future studies should evaluate whether targeted preoperative interventions, including vestibular screening, enhanced fall-prevention protocols, and coordinated outpatient follow-up, can mitigate these risks and improve outcomes for this vulnerable patient subgroup.

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