# Venous Thromboembolism and Mortality Rates Have Not Improved in Cervical Spine Surgery from 2012-2021

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INTRODUCTION: Venous thromboembolism (VTEs), deep vein thrombosis (DVTs), and pulmonary embolism (PEs) are among the most catastrophic yet preventable post-operative complications following spine surgery. Current North American Spine Society (NASS) and American College of Chest Physicians (ACCP) provide conflicting recommendations regarding postoperative chemoprophylaxis, and literature on predictors and rates of VTE following cervical spine surgery is limited. This study aimed to identify within the past decade (2012-2021) 1) the temporal trends in the rates of VTE, DVTs, PEs, and mortality and 2) independent predictors of VTE following cervical spine surgery.

METHODS: The American College of Surgeons - National Surgical Quality Improvement Program (ACS-NSQIP) database was queried to determine annual incidences of VTEs, DVTs, PEs, and mortality in each operation years between 2012-2021. Differences in baseline characteristics were quantified using Chi-Squared test for categorical variables and one-way ANOVA for continuous variables. Variables that were analyzed included demographic variables: age, sex, race, Hispanic ethnicity BMI, operation time, outpatient surgery, length of stay, non-home discharge, posterior fusion, comorbidities: current smoker, chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), dialysis, bleeding disorder, functional dependence, chronic steroid use, and preoperative lab values: blood urea nitrogen (BUN), creatinine, albumin, total bilirubin, platelet count, partial thromboplastin time (PTT), and international normalized ratio (INR). Incidences of VTEs, DVTs, PEs, and mortality were first stratified by operation year and differences quantified using the Chi-Squared test. Binary multivariate logistic regression models were constructed to compare the primary outcomes with operation years while accounting for significant baseline characteristics. A second multivariate regression analysis was then performed to identify significant independent predictors of VTEs following cervical spine surgery. Finally, results were reported as odds ratios (OR) with 95% confidence intervals (CI), with $p<0.05$ defined as significant.

RESULTS: A total of 91,025 patients were included in our study. For the entire cohort, the average age was 56.2 years, 49.4% female sex, 11.8% black race, 4.4% Hispanic ethnicity, with a BMI of 30.6 kg/m$^2$. Significant variables across operation year included age, black race, Hispanic ethnicity, BMI, operation time, outpatient surgery, length of stay, non-home discharge, posterior fusion, current smoker, COPD, CHF, dialysis, functional dependence, chronic steroid use, bleeding disorder, BUN, creatinine, albumin, bilirubin, platelet count, PTT, and INR. Annual rates of VTEs, DVTs, PEs, and mortality did not change (P>0.10) across any of the operation years between 2012-2021 (Figure 1). When accounting for significant baseline characteristics, multivariate regression analysis further demonstrated no significant difference of VTEs, DVTs, PEs, and mortality across operation years (P>0.10). Significant independent predictors of VTEs included older age, black race, high BMI, longer operation time, length of hospital stay, non-home discharge, history of COPD, functional health, and high INR, while protective factors for VTE included female sex, outpatient surgery, and smoking status in this cohort (Table 1).

DISCUSSION: Despite the latest 2009 NASS guidelines, rates of thromboembolic complications following cervical spine surgery have not improved over the last decade (2012-2021). Factors such as older age, black race, high BMI, longer operation time, length of hospital stay, non-home discharge, history of COPD, functional dependence, and high preoperative INR values were independent predictors of VTEs while female sex, outpatient surgery, and smoking status were the protective factors.

SIGNIFICANCE/CLINICAL RELEVANCE: We found that 30-day postoperative rates of VTE and mortality have not improved over the last decade and identified several independent predictive and protective factors that may increase the likelihood of VTE in patients undergoing cervical spine surgery. This lack of progress despite the advancement of surgical techniques, technology, and postoperative care underscores the necessity for clearer patient and/or surgical specific guidelines in VTE prophylaxis for patients undergoing cervical spine procedures.

IMAGES AND TABLES:

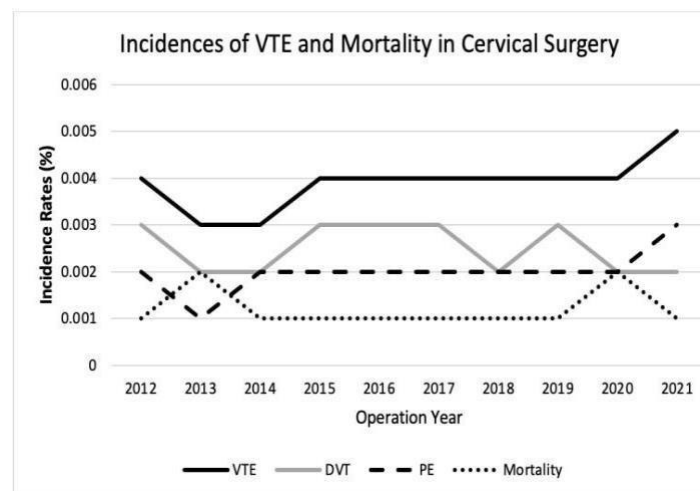Figure 1. Incidences of VTE and Mortality following cervical spine surgery



Table 1. Adjusted Multivariate Regression Analysis for Independent Predictors of VTE

| Variables | Odds Ratio | 95% CI | P-value |
|---|---|---|---|
| **Demographics** | | | |
| Older age | 1.014 | 1.005 - 1.024 | 0.004 |
| Female sex | 0.691 | .558 - .856 | <.001 |
| Black Race | 1.608 | 1.240 - 2.085 | <.001 |
| BMI | 1.04 | 1.027 - 1.053 | <0.001 |
| **Perioperative factors** | | | |
| Operation time | 1.003 | 1.002-1.004 | <0.001 |
| Outpatient surgery | 0.657 | .500 - .864 | 0.003 |
| Length of hospital stay | 1.016 | 1.011 - 1.022 | <0.001 |
| Non-home discharge | 3.457 | 2.623-4.557 | <0.001 |
| **Comorbidities** | | | |
| Current smoker | 0.726 | .547 - .965 | 0.027 |
| Hx of COPD | 1.54 | 1.040 - 2.280 | 0.031 |
| Functional health status | 1.587 | 1.018 - 2.474 | 0.042 |
| **Preoperative lab values** | | | |
| INR | 1.003 | 1.000-1.005 | 0.034 |

CI; Confidence Interval, BMI; Body Mass Index, INR; International Normalized Ratio