



## Clinical Study

## Independent predictors of mortality following spine surgery



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## ABSTRACT

We investigated the effect of preoperative patient demographics and operative factors on mortality in the 30 day postoperative period after spine surgery. Postoperative mortality from surgical interventions has significantly decreased with progressive improvement in surgical techniques and patient selection. Well-studied preoperative risk factors include age, obesity, emphysema, clotting disorders, renal failure, and cardiovascular disease. However, the prognostic implications of such risk factors after spine surgery specifically remain unknown. The medical records of all consecutive patients undergoing spine surgery from 2008–2010 at our institution were reviewed. Patient demographics, comorbidities, indication for operation, surgical details, postoperative complications, and mortalities were collected. The association between preoperative demographics or surgical details and postoperative mortality was assessed via logistic regression analysis. All 1344 consecutive patients (1153 elective, 191 emergency) met inclusion criteria for the study; 19 (1.4%) patients died in the 30 days following surgery. Multivariable logistic regression found several predictive factors of mortality for all spine surgery patients: operation in the cervical area (odds ratio [OR]: 7.279, 95% confidence interval [CI]: 1.37–42.83,  $p = 0.02$ ), postoperative sepsis (OR: 5.75, 95% CI: 1.16–26.38,  $p = 0.03$ ), operation for neoplastic (OR: 7.68, 95% CI: 1.53–42.71,  $p = 0.01$ ) or traumatic (OR: 13.76, 95% CI: 2.40–88.68,  $p = 0.03$ ) etiology, and age as defined as a continuous variable (OR: 1.05, 95% CI: 1.01–1.10,  $p = 0.03$ ). This study demonstrates predictive factors to help identify and evaluate patients who are at higher risk for mortality from spinal surgery, and potentially devise methods to reduce this risk.

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## 1. Introduction

Postoperative mortality from surgical interventions has significantly decreased with progressive improvement in surgical techniques and patient selection [1–5]. Mortality rates of general surgery have been well-studied, ranging from 0.5% in low-risk, elective procedures to 15.6% in high-risk, emergency surgeries [6,7]. Elevated mortality rates in the various surgery populations are associated with preoperative risk factors that include age, obesity, malnutrition, cardiovascular disease, emphysema, clotting disorders, and renal failure [8–13].

Although major preoperative risk factors for mortality have been identified in other surgical fields, few studies have investigated the impact of these factors on spine surgery patients [14,15]. Such a risk stratification in the spine surgery population is crucial to clinical practice due to the increasing use of surgical intervention for degenerative, neoplastic, and traumatic disease

of the spinal column [16–18]. Furthermore, mortality within 30 days of surgery is not only a critical variable with respect to patient outcomes, but represents a key component of Medicare evaluation of hospital care and reimbursement and understanding ways to reduce mortality has the potential to mitigate the increasing costs of health care [19]. While the rate of spine surgery mortality is clearly a necessary outcome to monitor and improve, existing studies analyze a small or homogenous patient population, potentially missing key demographic trends given by a comprehensive analysis [20–24]. Furthermore, existing studies consider fewer variables in the multivariable model, limiting the analysis of relative importance amongst variables [25,26]. Previous studies have also used national databases, which fail to catch a continuous representation of cases and also provide fewer variables than a chart review, due to unavailable records [27,28]. As such, we designed a retrospective cohort analysis to examine the relation between preoperative patient demographics, intraoperative variables, and complications with mortality in the 30 day postoperative period.

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**Table 1**

Baseline characteristics and comorbidities of 1344 subjects enrolled in a retrospective observational study at a single institution undergoing spine surgery

Variable	Combined cohort (n = 1344)	Mortality cohort (n = 19)	No mortality cohort (n = 1325)	Significance, p value
<i>Preoperative variables</i>				
Age >60 years	617 (45.9%)	12 (63.2%)	605 (45.7%)	0.119
Male	652 (48.5%)	11 (57.9%)	641 (48.4%)	0.398
American Indian	7 (0.5%)	0 (0.0%)	7 (0.5%)	0.745
Asian	15 (0.1%)	0 (0.0%)	15 (0.1%)	0.632
Black	251 (18.7%)	5 (26.3%)	246 (18.6%)	0.377
Multiracial	4 (0.3%)	0 (0.0%)	4 (0.3%)	0.806
Other race	14 (0.1%)	0 (0.0%)	14 (0.1%)	0.644
Obese	550 (40.9%)	5 (26.3%)	545 (41.1%)	0.181
Diabetes	243 (18.1%)	2 (10.5%)	241 (18.2%)	0.377
Chronic steroid use	124 (09.2%)	3 (15.8%)	121 (09.1%)	0.307
Chronic obstructive pulmonary disease	27 (02.0%)	0 (0.0%)	27 (02.0%)	0.519
Congestive heart failure	42 (03.1%)	1 (05.3%)	41 (03.1%)	0.580
Coronary artery disease	160 (11.9%)	2 (10.5%)	158 (11.9%)	0.848
Atrial fibrillation	61 (04.5%)	3 (15.8%)	58 (04.4%)	0.015*
Prior deep venous thrombosis	17 (01.3%)	1 (05.3%)	16 (01.2%)	0.107
Hypertension	689 (51.3%)	8 (42.1%)	681 (51.4%)	0.409
Hypercholesteremia	144 (10.7%)	2 (10.5%)	142 (10.7%)	0.978
Myocardial infarction	25 (01.9%)	0 (0.0%)	25 (01.9%)	0.535
Connective tissue disease	19 (01.4%)	0 (0.0%)	19 (01.4%)	0.590
Prior pulmonary embolism	15 (01.1%)	1 (05.3%)	14 (01.1%)	0.076
Blood thinner use	58 (04.3%)	3 (15.8%)	55 (04.2%)	0.011*
Prior stroke	17 (01.3%)	1 (05.3%)	16 (01.2%)	0.107
<i>Intraoperative variables</i>				
Operative time >5 hours	305 (22.7%)	8 (42.1%)	297 (22.4%)	0.037*
EBL >2 L	83 (06.2%)	0 (0.0%)	83 (06.3%)	0.248
UOP >2 L	32 (02.4%)	1 (05.3%)	31 (02.3%)	0.395
Cervical location	465 (34.6%)	11 (57.9%)	454 (34.3%)	0.027*
Thoracic location	97 (07.2%)	3 (15.8%)	94 (07.1%)	0.136
Lumbar location	780 (58.0%)	5 (26.3%)	775 (58.5%)	0.004*
CT junction location	102 (07.6%)	3 (15.8%)	99 (07.5%)	0.163
Minimally invasive	290 (21.6%)	0 (0.0%)	290 (21.9%)	0.018*
Fusion	1154 (85.9%)	18 (94.7%)	1136 (85.7%)	0.251
Laminectomy	603 (44.9%)	11 (57.9%)	592 (44.7%)	0.238
Laminoplasty	6 (0.4%)	0 (0.0%)	6 (0.5%)	0.763
Anterior approach	315 (23.4%)	4 (21.1%)	311 (23.5%)	0.800
Posterior approach	974 (72.5%)	17 (89.5%)	957 (72.2%)	0.087
Lateral approach	183 (13.6%)	0 (0.0%)	183 (13.8%)	0.074
Trauma	81 (06.0%)	6 (31.6%)	75 (05.7%)	0.000*
Deformity	374 (27.8%)	3 (15.8%)	371 (28.0%)	0.227
Neoplasm	110 (08.2%)	6 (31.6%)	104 (07.8%)	0.000*
Degenerative disease	778 (57.9%)	4 (21.1%)	774 (58.4%)	0.001*
Drain placed	635 (47.2%)	15 (78.9%)	620 (46.8%)	0.004*
Durotomy	69 (05.1%)	0 (0.0%)	69 (05.2%)	0.295
Intraoperative steroid use	527 (39.2%)	4 (21.1%)	523 (39.5%)	0.094
PRBC transfusion	266 (19.8%)	9 (47.4%)	257 (19.4%)	0.002*

\* Statistically significant.

CT = cervico-thoracic, EBL = estimated blood loss, PRBC = packed red blood cells, UOP = urine output.

## 2. Materials and methods

This retrospective analysis assessed the importance of several key risk factors in the prediction of the primary outcome measure, postoperative mortality within 30 days of spine surgery. For this study, mortality was defined as death occurring during postoperative hospitalization, postoperative hospital readmission, a phone call from a family member informing us of death, or a phone call after missed postoperative clinic appointment within 30 days after the surgery informing us of death. All adult patients who underwent spine surgery at our institution during the study period (2008–2010) were evaluated. The inclusion criteria were (1) age greater than or equal to 18 years, (2) anterior and/or posterior spinal surgery, (3) documented preoperative variables in hospital charts, and (4) follow-up observation for  $\geq 30$  days from index surgery. All adult patients who underwent surgery at our institution during the study period met the inclusion criteria, thus no patients were excluded from the analysis. If patients underwent revision surgery during the study period (n = 2), only the more recent operation was included in the analysis.

Clinical variables were collected for each patient by extensive chart review with a focus on medical notes. These variables included age, sex, body mass index (BMI), diabetes, insulin use, prior stroke, hypertension, hypercholesterolemia, chronic obstructive pulmonary disease (COPD), coronary artery disease, peripheral vascular disease, tobacco use, chronic steroid use, atrial fibrillation, congestive heart failure, prior deep vein thrombosis, prior myocardial infarction (MI), connective tissue disorder, prior pulmonary embolism, anticoagulant use, and race (white, black, other).

Operative variables assessed by chart review included surgical etiology (trauma, neoplasm, degenerative, deformity), type of surgery (fusion, laminectomy/fusion), estimated blood loss, surgical approach (anterior, posterior, lateral, combined approaches, minimally invasive technique), intraoperative steroid use, blood transfusion, surgical location (cervical, thoracic, lumbar, lumbosacral), length of stay greater than 7 days, and operation time greater than 5 hours. Postoperative variables that were analyzed included superficial surgical site infection, deep surgical site infection, postoperative deep vein thrombosis, postoperative pulmonary embolism, postoperative MI, postoperative pneumonia,

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