Frailty status but not age predicts surgical outcomes in spinal tumors: An NSQIP 2015-19 analysis of 4662 patients

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INTRODUCTION

- The preoperative risk stratification of patients undergoing spinal tumor resection remains challenging
- In recent years, the efforts to look beyond age alone as an outcomes predictor has resulted in the development of measures of physiological reserve (or 'frailty indices').
- The most frequently cited index in spine surgery is the modified frailty index [11-point (mFI-11) or 5-point (mFI-5)].

OBJECTIVES

The objective of the present study was to use a large national registry to evaluate the effect of frailty (as measured by mFI-5) versus age on post-operative outcomes of patients undergoing surgery for spinal tumors.

MATERIALS AND METHODS

- The National Surgical Quality Improvement Program (NSQIP) database was used to collect data for patients undergoing spinal tumor resection from 2015 to 2019 (n = 4662)
- Univariate analysis for age and mFI-5 were performed for the following outcomes: 30-day mortality, major complications, unplanned reoperation, unplanned readmission, hospital length of stay (LOS), and discharge to a non-home destination
- Multivariable modeling of age and mFI-5, controlling for co-variates, was done to define the discriminative ability of each measure
- Effect sizes were summarized by odds ratio (OR) (dichotomous outcomes) or beta coefficients (continuous outcomes) and associated 95% confidence intervals (95% CI)

RESULTS

1. NSQIP clinical variables matched to mFI-5

mFI-5	Maximum Score = 5
Non-independent functional status*	1
Diabetes mellitus with oral agents or insulin	1
COPD	1
Hypertension requiring medication	1
Congestive heart failure	1

*Includes both partial and complete dependance
COPD, chronic obstructive pulmonary disease

The mFI-5 calculated using the five NSQIP variables resulted in an index ranging from 0 (least frail) to 5 (most frail), with a score of 1 as "Pre-Frail", 2 as "Frail", and 3 or more as "Severely Frail" as categorical variables.

2. List of Current Procedural Terminology (CPT), ICD-9, and ICD-10 codes used to extract cases of spinal tumors from NSQIP database-2014-19.

Coding system	Code	Description
CPT	63275-8	Laminectomy for biopsy/excision of extradural spinal neoplasm
	63280–3	Laminectomy for biopsy/excision of intradural extramedullary spinal neoplasm
	63285–7	Laminectomy for biopsy/excision of intradural intramedullary spinal neoplasm
	63290	Laminectomy for biopsy/excision of combined intradural/extradural spinal neoplasm
		Vertebral corpectomy for excision of extradural spinal neoplasm
	63300-3	Vertebral corpectomy for excision of intradural spinal neoplasm
	63304-7	
ICD-9-CM	170.2	Malignant neoplasm of vertebral column excluding sacrum and coccyx
	170.6	Malignant neoplasm of pelvic bones, sacrum, and coccyx
	192.2	Malignant neoplasm of spinal cord
	192.3	Malignant neoplasm of spinal meninges
	198.3-5	Secondary malignant neoplasm of brain and spinal cord
	213.2	Benign neoplasm of vertebral column, excluding sacrum and coccyx
	213.6	Benign neoplasm of pelvic bones, sacrum, and coccyx
	225.3	Benign neoplasm of spinal cord
	225.4	Benign neoplasm of spinal meninges
	239.7	Neoplasm of uncertain behavior other parts of central nervous system
ICD-10-CM	C41.2	Malignant neoplasm of vertebral column
	C72	Malignant neoplasm of spinal cord
	C79.49	Malignant neoplasm of other parts of central nervous system
	D16.6	Benign neoplasm of vertebral column
	D32.1	Benign neoplasm of spinal meninges
	D33.4	Benign neoplasm of spinal cord
	D43.4	Neoplasm of uncertain behavior of spinal cord

3. Study sample characteristics

Variable	Cohort (n = 4662)
Age (median + IQR)	59 (47-68) years
M/F	2470 (53%)/2192 (47%)
BMI (median + IQR)	18.99 (16.26-22.05)
Tumor location	
Extradural	2177 (46.7%)
Intradural extramedullary	1918 (41.1%)
Intramedullary	567 (12.2%)
Tumor type	
Primary	1755 (37.6%)
Secondary	2020 (43.3%)
Unknown	887 (19%)
Length of stay (median + IQR)	5 (3-9) days
Operative time (median + IQR)	187 (133-261) hours
Mortality	53 (1.6%)
Readmission	435 (9.3%)
Reoperation	239 (5.1%)
Distribution of frailty (mFI-5)	
Not frail	2351 (50.4%)
Pre-frail	1608 (34.8%)
Frail	614 (13.2%)
Severely frail	89 (1.9%)
Preop clinical status/comorbidities	
Functionally dependent	340 (7.3%)
Diabetes mellitus	639 (13.7%)
COPD	171 (3.7%)
CHF	18 (0.4%)
Current smoker	793 (17%)
Dyspnea	177 (3.8%)
Hypertension	1944 (41.7%)
Disseminated cancer	1344 (28.8%)
Open wound	63 (1.4%)
Steroid use	459 (9.8%)
Weight loss	136 (2.9%)
Bleeding disorders	164 (3.5%)
Preop transfusion	50 (1.1%)
Preop SIRS	180 (3.9%)
Major post-operative complications	495 (10.6%)
Prolonged intubation (≥ 48 hr)	5 (0.1%)
Unplanned re-intubation	57 (1.2%)
Sepsis	91 (2%)
Septic shock	30 (0.6%)
Pneumonia	107 (2.3%)
DVT/Thrombophlebitis	94 (2%)
Pulmonary embolism	63 (1.4%)
CVA/stroke with neurological deficit	21 (0.5%)
Acute renal failure	9 (0.2%)
Myocardial infarction	18 (0.4%)
Cardiac arrest requiring CPR	17 (0.4%)
Superficial SSI	63 (1.4%)
Deep incisional SSI	31 (0.7%)
Organ space SSI	52 (1.1%)
Wound disruption	28 (0.6%)
Minor post-operative complications	726 (15.6%)
Intra-/post-operative blood transfusion	588 (12.6%)
Renal insufficiency	9 (0.2%)
Urinary tract infection	163 (3.5%)
Discharge destination	
Home	3000 (64.4%)
Non-routine (including expired, rehab, SNF, and others)	1624 (34.8%)
Unknown	38 (0.8%)

4. Univariate analysis for age and mFI-5 on outcomes after surgery in patients with spinal tumors from NSQIP database 2015-19

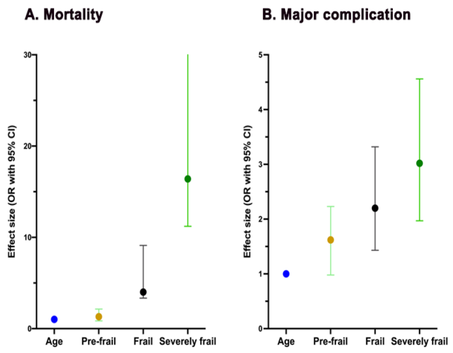
Variable	Mortality	Major complication	Unplanned readmission	Reoperation	Hospital LOS	Discharge to non-home destination
Age	1.02 (0.99-1.04)	1.003 (0.996-1.01)	0.99 (0.989-1.003)	0.99 (0.981-1.00)	0.02 (0.011-0.03)	1.026 (1.02-1.03)
mFI-5						
Pre-frail	1.38 (0.71-2.7)*	1.58 (0.92-2.72)*	1.29 (1.03-1.62)*	1.39 (1.04-1.84)*	1.24 (1.09-1.67)*	1.56 (1.36-1.79)*
Frail	5.73 (3.12-10.52)*	2.14 (1.27-3.61)*	1.77 (1.33-2.34)*	1.10 (0.73-1.68)	1.89 (1.32-2.13)*	2.52 (2.10-3.02)*
Severely frail	20.2 (9.40-43.4)*	3.09 (1.86-5.16)*	1.78 (0.92-3.4)*	2.13 (1.005-4.53)*	3.01 (2.15-4.35)*	2.00 (1.30-3.07)*

5. Multivariate analysis for age and mFI-5 on outcomes after surgery in patients with spinal tumors from NSQIP database 2015-19.

The multivariate model was controlled for co-variates: sex, BMI, tumor location, tumor type, and operative time

Variable	Mortality	Major complication	Unplanned readmission	Reoperation	Hospital LOS	Discharge to non-home destination
Age	1.014 (0.91-1.020)	1.001 (0.96-1.011)	1.001 (0.976-1.012)	0.91 (0.85-0.96)	0.018 (0.013-0.025)	1.018 (0.98-1.025)
mFI-5						
Pre-frail	1.31 (0.85-2.15)*	1.62 (0.98-2.23)*	1.23 (1.01-1.59)*	1.32 (1.01-1.82)*	1.21 (1.01-1.39)*	1.52 (1.33-1.75)*
Frail	4.01 (3.34-9.12)*	2.20 (1.43-3.32)*	1.74 (1.21-2.04)*	1.06 (0.83-1.54)	1.91 (1.42-2.19)*	2.48 (2.15-2.98)*
Severely frail	16.4 (11.21-35.44)*	3.02 (1.97-4.56)*	1.76 (0.88-3.7)*	2.07 (1.001-4.17)*	2.94 (2.32-4.21)*	1.91 (1.25-2.88)*

6. Effect sizes with associated 95% confidence intervals (95% CI) of age and mFI-5 on mortality (A) and major complication (B) based on multivariate modeling



SUMMARY & CONCLUSIONS

- Regression analysis demonstrated that mFI-5 but not age was significantly predictive of 30-day mortality, major complication, unplanned readmission, unplanned reoperation, hospital LOS, and discharge to non-home destination
- Increasing frailty, as measured by mFI-5, and not increasing age, is an independent risk factor for poor surgical outcomes in spinal tumors patients. The mFI-5 may be used for pre-operative risk stratification of these patients.