HHS Public Access
Author manuscript
World Neurosurg. Author manuscript; available in PMC 2022 February 15.

Published in final edited form as:
World Neurosurg. 2020 September ; 141: e858–e863. doi:10.1016/j.wneu.2020.06.070.

1-Year Mortality and Surgery Incidence in Older US Adults with Cervical Spine Fracture

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Abstract

BACKGROUND: Traumatic cervical spinal cord injuries (SCIs) can be lethal and are especially dangerous for older adults. Falls from standing and risk factors for a cervical fracture and spinal cord injury increase with age. This study estimates the 1-year mortality for patients with a cervical fracture and resultant SCI and compares the mortality rate with that from an isolated cervical fracture.

METHODS: We performed a retrospective cohort study of U.S. Medicare patients older than 65 years of age. International Classification of Diseases (ICD)-9 codes were used to identify patients with a cervical fracture without SCI and patients with a cervical fracture with SCI between 2007 and 2014. Our primary outcome was 1-year mortality cumulative incidence rate; our secondary outcome was the cumulative incidence rate of surgical intervention. Propensity weighted analysis was performed to balance covariates between the groups.

RESULTS: The SCI cohort had a 1-year mortality of 36.5%, compared with 31.1% in patients with an isolated cervical fracture (risk difference 5.4% (2.9%–7.9%)). Patients with an SCI were also more likely to undergo surgical intervention compared with those without a SCI (23.1% and 10.3%, respectively; risk difference 12.8% (10.8%−14.9%)).

CONCLUSIONS: Using well-adjusted population-level data in older adults, this study estimates the 1-year mortality after SCI in older adults to be 36.5%. The mortality after a cervical fracture with SCI was 5 percentage points higher than in patients without SCI, and this difference is smaller than one might expect, likely representing the frailty of this population and unmeasured covariates.

Keywords

Cervical spine; Older adults; Spinal cord injury

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Conflict of interest statement: The authors declare that the article content was composed in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

INTRODUCTION

Traumatic cervical spinal cord injury (SCI) is a devastating neurologic disease in older adults. Although traumatic SCI most commonly occurs in younger adult males, the average age of traumatic SCI patients shifted from 22 years old to 37 years old from 2000 to 2010.[1] This shift likely reflects an aging population, which commonly has risk factors associated with SCI including cervical spondylosis, osteoporosis, falls, and higher frailty scores.[2–5] Consequentially, older adults suffer from significant neurologic injuries from low-energy trauma after ground-level falls.[6,7] These injuries are often complicated by respiratory failure during hospitalization, which is the most common cause of death after SCI in older adult patients.[8] Acute management of SCI typically requires the intensive care unit for monitoring of cardiovascular, respiratory, and neurologic sequela, such as pulmonary embolism, aspiration pneumonia, and neurogenic shock.[9,10] The most common cause of traumatic SCI is fracture of vertebral column structures, facet dislocation, ligamentous injury, or intervertebral disk herniation.[3] Patients typically report localized pain to the site of spinal injury and variable motor and sensory function below the level of the injury. Higher-energy mechanisms, such as motor vehicle collision, are often associated with cerebral trauma and other systemic injuries, such as hemorrhagic shock, that can limit the patient's ability to report pain and complicate the initial neurologic evaluation.[11] Further neurologic injury may be minimized through early surgical decompression.[12] In addition to decompression, early surgical intervention aims to stabilize the spine and/or reduce the fractured elements and early surgical decompression and stabilization may improve outcomes in some patients.[12] Surgery may be delayed in patients who are unstable or when death from other irreversible causes is imminent. Unfortunately, keeping older patients in spinal precautions may limit the efficacy of respiratory care due to the risks of aspiration when flat and the development of pulmonary edema from chest trauma. Delays in surgery can often be interpreted by families as withholding effective treatment when few other treatment options are available. Knowing the expected mortality rates of older adults with SCI would provide valuable knowledge to the surgeon and to families who are required to make these critical decisions.

Reported mortality rates within the first 3 months of an SCI range from 4% to 20%.[3,13–16] Age, level of spinal cord injury, presence of traumatic brain injury, and medical comorbidities play a large role in determining mortality.[16–18] Injuries of the spinal cord occur commonly in the cervical region, which can be the most severe spinal cordinjuries.[19] In our experience, younger patients are willing to take more risks given their resilience and thus even a 20% mortality rate after SCI would not significantly affect decision making in these scenarios. Older adults present more of a conundrum. To our knowledge, there are no data that specifically estimate the long-term risk-adjusted mortality of older patients with cervical SCI. The primary objective of this study is to estimate the 1-year propensity-weighted mortality of traumatic cervical spine fracture in patients without and with spinal cord injury. The secondary objective is to estimate the rate of surgical intervention.

METHODS

A retrospective cohort study of Medicare claims data from U.S. citizens 65 and older was conducted. The sample was constructed by randomly selecting 20% of fee-for-service beneficiaries with concurrent Medicare Parts A, B, and D coverage for at least 1 month between 2007 and 2014. Our institutional review board approved the study (IRB 16–0533). We defined isolated acute cervical fractures without SCI (no SCI group) as an inpatient hospitalization with a primary, secondary, or tertiary discharge ICD-9 code of 805.0x (closed cervical fracture without SCI). We defined cervical fractures with SCI (SCI group) as an inpatient hospitalization with a primary, secondary, or tertiary discharge code of 806.0x (closed cervical fracture with SCI). Patients were excluded if they had multiple spine fractures or any spinal cord injury in the year before their cervical fracture. Thus the remaining patients were considered to have both isolated and acute/incident fractures. Patients with codes for pathologic fractures, coma, skull fractures, severe brain injury, or skull fractures were excluded. Race and E code variables (indicating circumstance causing injury) were sometimes missing due to the limitations of claims data. Patients with unknown race were grouped with “Other” race, while “No E code” was included for patients without an E code.

The primary outcome was 1-year mortality, and secondary outcome was incidence of surgical intervention. Primary exposures in this study were cervical spine fracture without and with SCI. The 2 groups (no SCI group and SCI group) were analyzed separately and then compared using risk differences (the no-SCI group was used as the reference group). Propensity weighting was used to account for differences in baseline characteristics potentially affecting mortality (i.e., potential confounders). The groups were weighted to the overall population resulting in cohorts without and with SCI having similar distributions of measured risk factors for mortality. Standardized absolute mean differences of <0.1 indicate an acceptable covariate balance. We then estimated cumulative 1-year risks for mortality and surgical intervention in the weighted (pseudo) populations.

RESULTS

There were 7482 patients with a cervical fracture included in the study. Among those patients, 5420 patients (72.4%) had an isolated acute cervical fracture without SCI (no SCI group) and 2062 patients (27.6%) had a cervical fracture with SCI (SCI group).

Crude and weighted covariates shown in Table 1 indicate that, even before weighting, the 2 cohorts had similar risk factors for mortality.

Comparing the patients without SCI with those with SCI, the groups had similar age (81.9 vs. 81.4 years old, respectively), race (90.2% white vs. 88.7% white), and use of prescription medications at the time of injury (58.6% vs. 58.0% on 10+ medications). The no-SCI group had more patients from the Midwest, while the SCI group had more patients from the West. About 32% of patients were on anticoagulants, 31% were on loop diuretics, and around 33% were on a proton pump inhibitor in both groups. Low-energy trauma accounted for a majority of the injuries in both groups, but patients without SCI were less likely to have sustained low-energy trauma compared with the SCI group (76.6% vs. 80.6%). Charleson Comorbidity and frailty indices were similar in the 2 cohorts.

The crude and propensity weighted cumulative incidence of 1-year mortality and surgical intervention by type of injury is displayed in Table 2. For our primary outcome, patients without SCI were less likely to die within 1 year of index fracture compared with the patients with an SCI (31.1% compared with 36.5%, respectively; weighted values). The risk difference, calculated as the absolute difference in mortality, slightly decreases from 5.8 (crude) to 5.4 (weighted) when the data are weighted, indicating some correction of confounding. For our secondary outcome, the rate of surgical intervention was lower in patients without SCI compared with those with SCI in the weighted data (10.1% compared with 23.1%, respectively). The difference slightly decreased in the weighted model from 14.2% (crude) to 12.8% weighted).

DISCUSSION

The estimated 1-year mortality was 36.5% in our study population with acute traumatic cervical spine fractures with associated SCI. This mortality rate was 5 percentage points higher than the mortality rate among those with an acute isolated cervical spine fracture without SCI (see Table 2). Patients with SCI were more likely than those without SCI to receive surgical treatment. Although patient characteristics that may account for variation in outcome did not differ between the 2 groups, the type of trauma leading to the cervical fracture did differ. Interestingly, the patients with SCI were more likely to have suffered low-energy trauma. This counterintuitive finding correlates with recent literature, which indicates that geriatric patients sustaining high-energy trauma were more likely to be walking and living independently within 1 year when compared with patients who sustained low-energy trauma.[20] Thus patients who sustained higher-energy trauma likely had higher functional status at baseline, which is a positive prognostic indicator and may be protective against spinal cord injury after cervical fracture. Another explanation is that patients sustaining high-energy trauma and an SCI were more likely to have also sustained other fatal injuries, such as traumatic brain injuries leading to immediate death before presentation, and thus are not included in the study or carrying those diagnoses, which were excluded in our cohort. Finally, the Charlson Comorbidity Index has been shown to reliably predict hospital mortality in SCI patients.[21] However, our results indicate mean Charlson Comorbidity Index was not significantly different between the 2 groups.

A 1-year mortality rate of 36.5 per 100 patients is double the mortality of hip fractures in a similar population.[22] Hip fractures, which are also associated with ground-level, low-energy falls, carry a 1-year mortality rate of 21% (or 21 per 100),[22] which is much lower than the 36.5% 1-year mortality rate for acute isolated cervical fractures with SCI found in the present study. Falls are the most common cause of SCI in the elderly, and most of those falls occur at the patient's home due to slipping, tripping, or falling from beds, chairs, or toilets.[23,24] Steps that may reduce the risk of falls include ensuring adequate lighting for visibility, avoiding uneven walking surfaces, properly positioned hand rails, and safe beds, chairs, and toilets. The Centers for Disease Control emphasizes exercise, adequate vitamin D level, vision checks, and multidisciplinary approaches to prevent falls.[25] Additionally, over half of older adults in 2013 were on a drug increasing the risk of falls.[26] Women were more likely to be on medications that were linked to falls like opioids and benzodiazepines.[26] To address this issue the Centers for Disease Control developed the Stopping Elderly Accidents, Deaths, and Injuries initiative to train nurses and health care providers to reduce the risk of falls. These approaches will reduce not only the incidence and costs associated with SCI but also the incidence of hip fractures and other traumatic injuries in the elderly population caused by minor ground-level falls.

The burden of SCI in older adults is significant. In our study population, a large proportion of medical expenses are incurred at the end of life. Likely related to this finding is that the patients with the highest expected mortality were also more likely to undergo surgical intervention. This is not to say that surgical intervention in these cases is futile because the objective of this study was not to estimate the effectiveness of surgery but rather to provide a real-world estimate of mortality after SCI in the elderly, regardless of treatment. The more striking proportion is the 76.9% of patients with a cervical fracture and SCI that *did not* have surgery. Using the available data sources, it is impossible to know the severity of the SCI of these patients, but cervical spinal cord injuries are only rarely treated nonsurgically in younger patient populations. The most significant consequences of not operating are ascending myelopathy (possibly affecting respiration), pain, and vertebral artery injury. We expected the rate of surgery to be much higher. This could indicate that a large number of surgeons and patients are choosing to defer surgical intervention likely in the face of a high expected mortality rate regardless of the intervention and a focus on quality of life. Alternatively, this could represent a limitation in the granularity of the data, which precludes detailed analysis of the surgical indication in each case and thus introduces unmeasurable bias into our results.

This study has several limitations. It is retrospective with reliance on the accuracy of coding within the Medicare database and diagnostic classification is restricted by the ICD system. This system does not take into account surgical considerations relevant to each disease, which limited the conclusions that can be drawn from the estimated rate of surgical intervention in this cohort. Furthermore, the complications and complexity of each patient are not represented through real-word data like vital signs, laboratory data, and pathology reports.[27] While we attempted to exclude patients with certain confounding factors or comorbidities and balanced a large number of mortality risk factors, inaccurate or incomplete coding could introduce bias. The similarity of cohorts without and with SCI before weighting limits the potential for residual confounding, however, and is therefore reassuring. Despite these limitations, with a large population-based cohort and a strong propensity model to balance differences in groups, the reported estimate of 1-year mortality is believed to represent the actual mortality rate experienced in patients over this period of time.

CONCLUSION

The estimated 1-year mortality after acute isolated cervical fracture with SCI was 36.5%, slightly higher than the mortality in patients without SCI (31.1%) and higher than most lethal traumatic injuries in older adults. Public health measures should be taken to improve the living environments of older adults in order to reduce the risk for falls.

Abbreviations and Acronyms

ICD: International Classification of Diseases

SCI: Spinal cord injury

REFERENCES

1. Devivo MJ. Epidemiology of traumatic spinal cord injury: trends and future implications. Spinal Cord. 2012;50:365–372. [PubMed: 22270188]
2. Myers ER, Wilson SE. Biomechanics of osteoporosis and vertebral fracture. Spine. 1997;22(suppl 24):25S–31S. [PubMed: 9431641]
3. Sekhon LH, Fehlings MG. Epidemiology, demographics, and pathophysiology of acute spinal cord injury. Spine. 2001;26(suppl 24):S2–S12. [PubMed: 11805601]
4. Cheng M-H, Chang S-F. Frailty as a risk factor for falls among community dwelling people: evidence from a meta-analysis. J Nurs Scholarsh. 2017;49: 529–536. [PubMed: 28755453]
5. Kim DH, Schneeweiss S, Glynn RJ, Lipsitz LA, Rockwood K, Avorn J. Measuring frailty in medicare data: development and validation of a claims-based frailty index. J Gerontol A Biol Sci Med Sci. 2018;73:980–987. [PubMed: 29244057]
6. Bub LD, Blackmore CC, Mann FA, Lomoschitz FM. Cervical spine fractures in patients 65 years and older: a clinical prediction rule for blunt trauma. Radiology. 2005;234:143–149. [PubMed: 15564392]
7. Kannus P, Palvanen M, Niemi S, Parkkari J. Alarming rise in the number and incidence of fall-induced cervical spine injuries among older adults. J Gerontol A Biol Sci Med Sci. 2007;62: 180–183. [PubMed: 17339643]
8. Daneshvar P, Roffey DM, Brikeet YA, Tsai EC, Bailey CS, Wai EK. Spinal cord injuries related to cervical spine fractures in elderly patients: factors affecting mortality. Spine J. 2013;13: 862–866. [PubMed: 23453576]
9. Management of acute spinal cord injuries in an intensive care unit or other monitored setting. Neurosurgery. 2002;50(suppl 3):S51–S57. [PubMed: 12431287]
10. Jia X, Kowalski RG, Sciubba DM, Geocadin RG. Critical care of traumatic spinal cord injury. J Intensive Care Med. 2013;28:12–23. [PubMed: 21482574]
11. Hasler RM, Exadaktylos AK, Bouamra O, et al. Epidemiology and predictors of cervical spine injury in adult major trauma patients: a multicenter cohort study. J Trauma Acute Care Surg. 2012; 72:975–981. [PubMed: 22491614]
12. Burke JF, Yue JK, Ngwenya LB, et al. Ultra-early (<12 hours) surgery correlates with higher rate of American Spinal Injury Association Impairment Scale conversion after cervical spinal cord injury. Neurosurgery. 2018;6:309.
13. Lenehan B, Street J, Kwon BK, et al. The epidemiology of traumatic spinal cord injury in British Columbia, Canada. Spine. 2012;37:321–329. [PubMed: 22337075]
14. Daverat P, Dartigues JF, Mazaux JM, Barat M. Initial factors predicting functional performance in patients with traumatic tetraplegia. Paraplegia. 1990;28:414–419. [PubMed: 2250983]
15. Claxton AR, Wong DT, Chung F, Fehlings MG. Predictors of hospital mortality and mechanical ventilation in patients with cervical spinal cord injury. Can J Anaesth. 1998;45:144–149. [PubMed: 9512849]
16. Tee JW, Chan PCH, Gruen RL, et al. Early predictors of mortality after spine trauma: a level 1 Australian trauma center study. Spine. 2013;38: 169–177. [PubMed: 22691920]
17. Schoenfeld AJ, Belmont PJ, See AA, Bader JO, Bono CM. Patient demographics, insurance status, race, and ethnicity as predictors of morbidity and mortality after spine trauma: a study using the National Trauma Data Bank. Spine J. 2013;13: 1766–1773. [PubMed: 23623634]

18. Varma A, Hill EG, Nicholas J, Selassie A. Predictors of early mortality after traumatic spinal cord injury: a population-based study. Spine. 2010; 35:778–783. [PubMed: 20228715]

19. Torretti JA, Sengupta DK. Cervical spine trauma. Indian J Orthop. 2007;41:255–267. [PubMed: 21139776]

20. Shah J, Titus AJ, O'Toole RV, et al. Are geriatric patients who sustain high-energy traumatic injury likely to return to functional independence? J Orthop Trauma. 2019;33:234–238. [PubMed: 30640296]

21. Furlan JC, Kattail D, Fehlings MG. The impact of co-morbidities on age-related differences in mortality after acute traumatic spinal cord injury. J Neurotrauma. 2009;26:1361–1367. [PubMed: 19275470]

22. Okike K, Chan PH, Paxton EW. Effect of surgeon and hospital volume on morbidity and mortality after hip fracture. J Bone Joint Surg Am. 2017;99: 1547–1553. [PubMed: 28926384]

23. Chen Y, Tang Y, Allen V, DeVivo MJ. Aging and spinal cord injury: external causes of injury and implications for prevention. Top Spinal Cord Inj Rehabil. 2015;21:218–226. [PubMed: 26363588]

24. Buczak-Stec E, Gorynski P. Fall related hospital admissions among seniors in Poland in 2010. Przegl Epidemiol. 2013;67:57–62, 141–144. [PubMed: 23745377]

25. A CDC Compendium of Effective Fall Interventions: What Works for Community-Dwelling Older Adults. July 2015:1–216. Available at: https://www.cdc.gov/homeandrecreationalsafety/pdf/falls/CDC_Falls_Compendium-2015-a.pdf. Accessed January 12, 2020.

26. Haddad YK, Bergen G, Luo F. Reducing fall risk in older adults. Am J Nurs. 2018;118:21–22.

27. Ghaferi AA, Dimick JB. Practical guide to surgical data sets: Medicare claims data. JAMA Surg. 2018; 153:677–678. [PubMed: 29617541]

Table 1.

Unweighted and Weighted Incident Cervical Fracture Population Characteristics by Spinal Cord Injury (SCI) Status

	Unweighted			Weighted		
Patient Characteristics*	**No SCI (N = 5420)**	**SCI (N = 2062)**	**SAMD**	**No SCI (N = 5419)**	**SCI (N = 2061)**	**SAMD**
Age, mean (SD)	81.9 (8.14)	81.4 (8.00)	0.072	81.8 (8.13)	81.8 (8.03)	0.006
Race						
Other	259 (4.8%)	111 (5.4%)	0.028	270 (5.0%)	104 (5.1%)	0.003
White	4888 (90.2%)	1,829 (88.7%)	0.048	4865 (89.8%)	1851 (89.8%)	0.001
Black	273 (5.0%)	122 (5.9%)	0.039	284 (5.2%)	106 (5.1%)	0.004
Region						
Northeast	1188 (21.9%)	459 (22.3%)	0.008	1196 (22.1%)	454 (22.0%)	0.001
Midwest	1499 (27.7%)	433 (21.0%)	0.156	1398 (25.8%)	532 (25.8%)	0.001
South	1992 (36.8%)	779 (37.8%)	0.021	2007 (37.0%)	763 (37.0%)	0.000
West	741 (13.7%)	391 (19.0%)	0.144	818 (15.1%)	312 (15.1%)	0.000
Mechanism						
High energy	753 (13.9%)	259 (12.6%)	0.039	731 (13.5%)	277 (13.4%)	0.002
Low energy	4150 (76.6%)	1663 (80.6%)	0.100	4210 (77.7%)	1600 (77.6%)	0.002
No E Code	517 (9.5%)	140 (6.8%)	0.101	478 (8.8%)	185 (9.0%)	0.005
Outpatient office visits						
0	394 (7.3%)	139 (6.7%)	0.021	387 (7.1%)	146 (7.1%)	0.001
1–6	1818 (33.5%)	699 (33.9%)	0.008	1822 (33.6%)	697 (33.8%)	0.004
7–12	1519 (28.0%)	578 (28.0%)	0.000	1520 (28.0%)	580 (28.1%)	0.002

Patient Characteristics*	Unweighted No SCI (N = 5420)	Unweighted SCI (N = 2062)	Unweighted SAMD	Weighted No SCI (N = 5419)	Weighted SCI (N = 2061)	Weighted SAMD
13+	1689 (31.2%)	646 (31.3%)	0.004	1690 (31.2%)	638 (31.0%)	0.005
Home health claims						
0	3950 (72.9%)	1496 (72.6%)	0.007	3941 (72.7%)	1496 (72.6%)	0.004
1	730 (13.5%)	278 (13.5%)	0.000	731 (13.5%)	278 (13.5%)	0.001
2+	740 (13.7%)	288 (14.0%)	0.009	748 (13.8%)	288 (14.0%)	0.005
Hospital days						
<1 week	4089 (75.4%)	1617 (78.4%)	0.071	4130 (76.2%)	1572 (76.3%)	0.001
1−<2 weeks	693 (12.8%)	197 (9.6%)	0.103	643 (11.9%)	238 (11.5%)	0.010
2+ weeks	638 (11.8%)	248 (12.0%)	0.008	646 (11.9%)	251 (12.2%)	0.009
SNF stays						
0	4510 (83.2%)	1759 (85.3%)	0.058	4537 (83.7%)	1723 (83.6%)	0.004
1	587 (10.8%)	198 (9.6%)	0.041	569 (10.5%)	215 (10.4%)	0.002
2+	323 (6.0%)	105 (5.1%)	0.038	314 (5.8%)	124 (6.0%)	0.009
DME claims						
0	2793 (51.5%)	1073 (52.0%)	0.010	2795 (51.6%)	1055 (51.2%)	0.008
1	698 (12.9%)	238 (11.5%)	0.041	679 (12.5%)	259 (12.6%)	0.001
2+	1929 (35.6%)	751 (36.4%)	0.017	1945 (35.9%)	747 (36.2%)	0.007
ED visits						
0–1	2087 (38.5%)	832 (40.3%)	0.038	2108 (38.9%)	793 (38.5%)	0.008
2–5	2847 (52.5%)	1038 (50.3%)	0.044	2816 (52.0%)	1073 (52.1%)	0.002

Patient Characteristics[*]	Unweighted			Weighted		
	No SCI (N = 5420)	SCI (N = 2062)	SAMD	No SCI (N = 5419)	SCI (N = 2061)	SAMD
6+	486 (9.0%)	192 (9.3%)	0.012	495 (9.1%)	195 (9.4%)	0.010
Medication prescriptions						
0–4	714 (13.2%)	278 (13.5%)	0.009	716 (13.2%)	271 (13.2%)	0.001
5–9	1529 (28.2%)	589 (28.6%)	0.008	1535 (28.3%)	586 (28.4%)	0.002
10+	3177 (58.6%)	1195(58.0%)	0.013	3168 (58.5%)	1204 (58.4%)	0.001
Anticoagulants	1721 (31.8%)	668 (32.4%)	0.014	1730 (31.9%)	657 (31.9%)	0.001
Bisphosphonates	861 (15.9%)	281 (13.6%)	0.064	823 (15.2%)	303 (14.7%)	0.014
Loop diuretics	1703 (31.4%)	627 (30.4%)	0.022	1686 (31.1%)	642 (31.1%)	0.001
PPI	1834 (33.8%)	671 (32.5%)	0.028	1818 (33.6%)	694 (33.7%)	0.002
CCI, mean (SD)	3.6 (2.65)	3.7 (2.62)	0.030	3.6 (2.66)	3.6 (2.58)	0.004
Frailty score, mean (SD)	0.4 (0.30)	0.4 (0.30)	0.000	0.4 (0.30)	0.4 (0.30)	0.011

SAMD, standardized absolute mean difference; SD, standard deviation; SNF, sklled nursing facility; DME, durable medical equipment; ED, emrgency department; PPI, proton pump inhibitor; CCI, Charlson Comorbidity Index.

[*] Additional weighted baseline characteristics included in model: specific medications (angiotensin-converting enzyme inhibitors, antiarrhythmics, beta blockers, calcium channel blockers, nonsteroidal antiinflammatory drugs) and individual Charlson comorbidity and Frailty Score component variables.

Table 2.

1-Year All-Cause Mortality and Proportion with Surgery in Medicare Patients with Incident Cervical Fracture without and with Spinal Cord Injury (SCI)

Cohort	Analysis	No SCI	SCI	Risk Difference
Mortality (%)	Crude	31.2 (29.9–32.4)	37.0 (34.9–39.1)	5.8 (3.4–8.3)
	Weighted	31.1 (29.8–32.3)	36.5 (34.3–38.6)	5.4 (2.9–7.9)
Surgery (%)	Crude	10.1 (9.3–10.9)	24.3 (22.4–26.1)	14.2 (12.2–16.2)
	Weighted	10.3 (9.5–11.1)	23.1 (21.2–25.0)	12.8 (10.8–14.9)

CCI, Charlson Comorbidity Index; STEADI, Stopping Elderly Accidents, Deaths, and Injuries.