Economic Impact of Aging on the Initial Spine Care of Patients With Acute Spine Trauma: From Bedside to Teller

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BACKGROUND: Aging of the population has prompted an escalation of service utilization and costs in many jurisdictions including North America. However, relatively little is known on the economic impact of old age on the management of acute spine trauma (AST).

OBJECTIVE: To examine the potential effects of age on the service utilization and costs of the management of patients with acute spine trauma.

METHODS: This retrospective cohort study included consecutive patients with AST admitted to an acute spine care unit of a Canadian quaternary university hospital between February, 2002 and September, 2007. The study population was grouped into elderly (≥65 yr) and younger individuals. All costing data were converted and updated to US dollars in June/2017.

RESULTS: There were 55 women and 91 men with AST (age range: 16-92 yr, mean age of 49.9 yr) of whom 37 were elderly. The mean total hospital costs for initial admission after AST in the elderly (USD $19 338 ± $4892) were significantly greater than among younger individuals (USD $13 775 ± $1344). However, elderly people had significantly lower per diem total, fixed, direct, and indirect costs for AST than younger individuals. Both groups were comparable regarding the proportion of services utilized in the acute care hospital.

CONCLUSION: Given the escalating demand for surgical and nonsurgical spine treatment in the age of aging population, the timely results of this study underline key aspects of the economic impact of the spine care of the elderly. Further investigations are needed to fulfill significant knowledge gaps on the economics of caring for elderly with AST.

KEY WORDS: Spinal cord injury, Acute spine trauma, Neurotrauma, Elderly, Costs, Health economics

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While the incidence and prevalence of traumatic spinal cord injury (tSCI) are relatively modest, its burden is substantial.[1,2] The estimated lifetime costs per individual with tSCI at the age of 25 yr vary from $1.65 million for incomplete paraplegia to $4.7 million for complete high tetraplegia (in 2017 USD) in the United States.[3] The economic burden based on the total national hospital charges related to tSCI was estimated to be $2.14 billion (in 2017 USD).[4] In Canada, the total direct hospital costs associated with tSCI was estimated to be $45.9 million (in 2017 USD).[5]

ABBREVIATIONS: ASIS, American Spinal Injury Association; **AIS,** ASIA Impairment Scale; **AST,** acute spine trauma; **GDP,** gross domestic product; **SCI,** spinal cord injury; **tSCI,** traumatic spinal cord injury

The impact of the aging of the population on the epidemiological profile of tSCI is seen in the current bimodal distribution in many geopolitical regions where there is a peak of incidence of tSCI, mostly caused by motor vehicle accidents among younger adults, and an escalation of fall-related tSCIs among older individuals.[3,6] Among elderly veterans, tSCI was the most expensive disease among the 29 most costly chronic conditions, followed by renal failure, lung cancer, all dementias, among others.[7] While veterans more commonly developed psychiatric disorders (23.3%), diabetes (18.5%), and substance abuse (13.5%), tSCI accounted for less than 1% of the Veterans Affairs database.[7] Furthermore, tSCI was the most expensive disease with a mean annual cost of USD $49 600 (in 2017) among 29 of the most common chronic conditions among American veterans.[8]

A recent cost-utility analysis revealed that surgical management and rehabilitation of the elderly on a time horizon of 6 mo from tSCI onset are more expensive, but equally effective, when compared with younger adults with similar spinal cord impairment.[9] Given this, an economic study was undertaken to examine the potential effects of age on the service utilization and costs of the management of patients with acute spine trauma (AST) from the perspective of an AST center in a quaternary university hospital in Canada.

METHODS

Participants

The Research Ethics Board approved the research protocol for this study without the need to obtain consent form signed by the participants. This retrospective cohort study included consecutive patients with AST admitted to an acute spine care center in Ontario (Canada) from February, 2002 to September, 2007. The study population was divided into elderly (≥65 yr at the time of trauma) and younger individuals.

Preexisting medical conditions were examined using the Charlson Comorbidity Index, Cumulative Illness Rating Scale, and number of codes from the International Classifications of Diseases, ninth revision.[10-12]

Definitions

Severity of spinal cord injury (SCI) was classified according to the American Spinal Injury Association (ASIA) Impairment Scale (AIS) as follows: (i) motor and sensory complete SCI (AIS A); (ii) motor complete but sensory incomplete SCI (AIS B); (iii) motor incomplete SCI where the majority of the key muscles below the neurological level have muscle grade <3 (AIS C); and (iv) motor incomplete SCI where the majority of the key muscles below the neurological level have muscle grade ≥3 (AIS D).[13] All cases were also grouped into complete tSCI (AIS A/B), incomplete tSCI (AIS C/D), and no/minor tSCI (AIS E).

Costing Data

All the hospital costs incurred in the initial admission for management of patients with AST were included. Physician fees that were paid directly by the insurer were excluded. The costs are categorized into total, indirect, and direct costs. Direct costs were broken down into variable and fixed costs. Basically, indirect costs are those that incurred from administrative and support services attributable to patients (eg, hospital administration, information technology, physical plant). Direct costs are associated with medical resource utilization including inpatient services, outpatient services, and pharmaceutical services within the health care delivery system.[14] Variable costs are those that change with output and incur only when the service is provided (eg, medications, test reagents, and disposable supplies).[15] Fixed costs are those that incur regardless whether the service is provided (eg, building and equipment).[15]

Original costing data were converted to USD according to currency exchange rates from the Bank of Canada and updated to June/2017 USD using medical-cost inflation rates from the US Bureau of Labor Statistics.[16,17] Using the same criteria as above mentioned, all published costs were updated to June/2017 USD in order to facilitate comparisons with data from this study.

Data Analysis

Data were analyzed using Student *t*-test or paired *t*-test for continuous variables, and Fisher exact test for categorical variables. Missing data occurred in less than 10% of the data analyses. Multivariate regression analyses were used to identify potential determinants of the total hospital costs and per diem total costs. All data analyses were performed using SAS version 7.12 (SAS Institute Inc, Cary, North Carolina).

RESULTS

There were 146 individuals with AST (55 women and 91 men; mean age of 49.9 yr; age range from 16 to 92 yr) who were admitted to the acute spine care unit. This population was grouped into 109 younger and 37 elderly people (25.3%). Elderly individuals with AST had a significantly greater proportion of women with fall-related trauma, significantly more frequent medical comorbidities, and greater risk for respiratory failure requiring mechanical ventilation, and greater in-hospital mortality rate than their younger counterparts (Table 1). Both groups were statistically comparable regarding their distribution of level and severity of AST (Table 1).

Comparative Group Analyses of the Hospital Costs

Elderly individuals with AST had a significantly longer stay in the acute spine care center and greater total hospital costs than younger individuals with AST (Figures 1A and 1B). However, elderly people with AST had significantly lower per diem total costs, lower per diem fixed costs, lower per diem direct costs, and lower per diem indirect costs than younger individuals with AST (Figures 1C and 1D). There were no significant differences between the groups regarding their per diem variable costs (Figure 1D).

Using multivariate regression analysis, higher total hospital costs were significantly correlated with longer stay in the acute spine care center, complete tSCI, and need for mechanical ventilation (Table 2). Further multivariate regression analysis revealed a significant interaction between longer hospital stay and need for mechanical ventilation ($P < .001$); there was no significant interaction between length of hospital stay and severity of AST ($P > .14$).

In another multivariate regression analysis, higher per diem total costs were significantly associated with shorter stay in the acute spine care center and lumbosacral AST (Table 3). Further multivariate regression analysis revealed that there was no significant interaction between length of stay and level of AST ($P > .39$).

Finally, elderly people with AST were statistically comparable to their younger counterparts regarding their proportions of the hospital services utilized during admission for management of AST (Figure 2). The top 10 most costly services utilized during admission were, in the decreasing order, intensive care unit, ward, operating room, pharmacy, respiratory therapy, imaging, laboratory, occupational therapy, emergency department, and social work (Figure 2).

TABLE 1. Comparisons of Baseline Data Between Younger (Age at the Time of Injury Below 65 yr) and Elderly Individuals With AST

Features	Items	Younger individuals (n = 109)	Elderly individuals (n = 37)	*P* values
Age (years)	Range	16 to 64	65 to 92	
	Mean ± SEM	40.49 ± 1.30	77.81 ± 1.16	
Sex	Females	73 (67%)	18 (48.6%)	
	Males	36 (33%)	19 (51.4%)	.04
Level of trauma	Cervical spine trauma	43 (41%)	17 (50%)	
	Thoracic spine trauma	14 (13.3%)	4 (11.8%)	
	Lumbosacral spine trauma	48 (45.7%)	13 (38.2%)	.65
	(*missing data*)	(*4*)	(*3*)	
Severity of trauma	Complete (AIS A/B)	10 (9.3%)	3 (8.1%)	
	Incomplete (AIS C/D)	40 (37%)	11 (29.7%)	
	No/minor injury (AIS E)	58 (53.7%)	23 (62.2%)	.67
	(*missing data*)	(*1*)	(*0*)	
Cause of trauma	Fall	59 (54.1%)	31 (83.8%)	
	Motor vehicle accident	30 (27.5%)	4 (10.8%)	
	Other causes	20 (18.4%)	2 (5.4%)	<.01
Need for mechanical	Yes	7 (6.4%)	7 (19.4%)	
Ventilation	No	102 (93.6%)	29 (80.6%)	.02
	(*missing data*)	(*0*)	(*1*)	
In-hospital survival	Alive	109 (100%)	32 (88.9%)	
	Dead	0	4 (11.1%)	<.01
	(*missing data*)	(*0*)	(*1*)	
CCI	Range	0 to 2	0 to 5	
	Mean ± SEM	0.24 ± 0.05	1.24 ± 0.19	<.01
Number of ICDs	Range	0 to 10	0 to 12	
	Mean ± SEM	1.51 ± 0.18	4.59 ± 0.44	<.01
CIRS	Range	0 to 22	0 to 27	
	Mean ± SEM	3.13 ± 0.37	10.33 ± 1.05	<.01

SEM, standard error of mean; AIS, ASIA Impairment Scale, CCI, Charlson Comorbidity Index, ICD, international classification of diseases; CIRS, cumulative illness ratio scale.

DISCUSSION

The results of this economic study suggest that AST in the elderly is more commonly caused by falls, more often involves women with a greater number of medical co-morbidities who more frequently require mechanical ventilation and show higher in-hospital mortality rate than younger individuals. Furthermore, elderly people with AST usually have a longer initial admission that results in significantly greater total hospital costs than younger individuals. In the multivariate regression analysis, higher total hospital costs were significantly associated with longer hospital stay, greater proportion of complete tSCI, and more frequent need for mechanical ventilation, but total hospital costs were not directly related to the age of the patients. Nonetheless, elderly people had significantly lower per diem total, fixed, direct, and indirect hospital costs than younger individuals after AST. There were no significant differences between the groups regarding the per diem variable costs. Higher per diem total hospital costs were significantly associated with longer stay in the acute spine care center and lumbosacral AST in the multivariate regression analysis. Finally, both groups were comparable regarding their proportions of hospital services utilized during admission for management of AST.

Epidemiology and Injury Characteristics of Spine Trauma in the Elderly

This study included 37 elderly individuals with AST that corresponds to 25.3% of the study population. When compared to younger people with AST, the geriatric group included a greater proportion of women with a greater number of medical co-morbidities who mostly had a fall-related AST. Both age groups were statistically comparable regarding other injury characteristics including level and severity of AST.

The proportion of elderly individuals with AST has been increasing over the past 2 decades as a consequence of aging of the population. Prior studies reported a frequency of spine trauma from 13% to 48.3% among elderly people who typically develop fall-related AST, which is consistent with our findings.[18-22] Prior epidemiologic investigations also documented a higher proportion of women in the geriatric group than younger individuals with AST.[19,22-24] Not surprisingly, elderly individuals

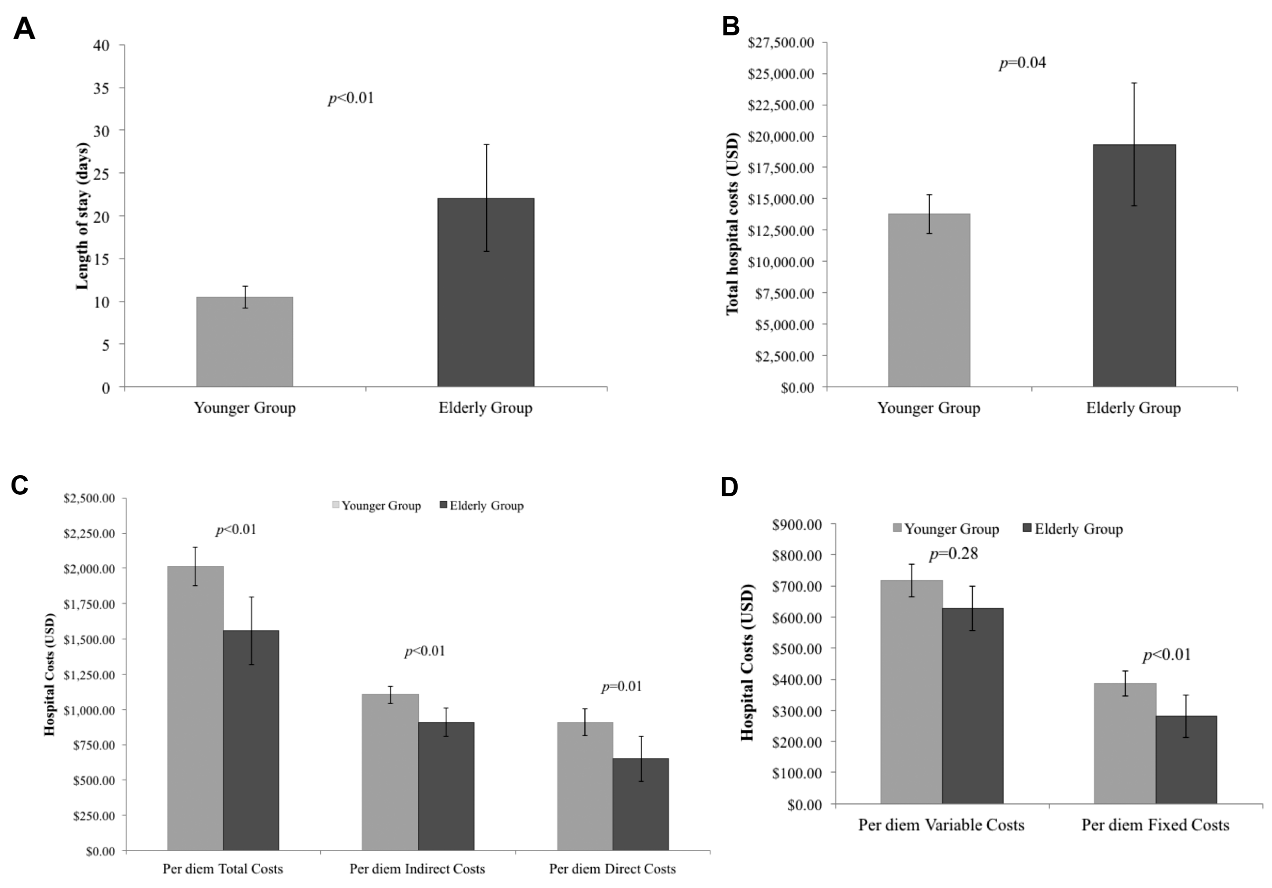

FIGURE 1. *Comparisons between elderly and younger individuals with AST with regards to their length of stay in the acute spine care center and total hospital costs* **A** *and* **B***, as well as per diem total, fixed, variable, direct, and indirect costs* **C** *and* **D***.*

usually have a greater number of medical co-morbidities than younger people with AST.[22,25,26] Falls were also consistently reported in the literature as the leading cause of AST among older people.[6,18-24,27-29] Numerous prior studies revealed conflicting results regarding the distribution of level and severity of AST in the younger and elderly groups and, in this context, our results are also consistent with some of the prior studies.[9,20-23,25,28-31] Altogether, our cohort of individuals can be considered a fair representation of the AST populations from many other jurisdictions with respect to their demographics and injury characteristics.

Clinical Outcomes and Costing Analyses in the Elderly with Spine Trauma

The geriatric group in our study was associated with a higher frequency of respiratory complications requiring mechanical ventilation, and higher in-hospital mortality rate than younger individuals after AST. Previous studies also documented that elderly individuals have a higher chance of developing respiratory complications requiring mechanical ventilation.[19,32] Numerous prior publications also reported higher mortality rates among elderly individuals after AST.[6,19-21,24-26,30,33]

Our results suggest that length of stay in the acute spine care center for the elderly is approximately double the length of stay among younger individuals after AST (22.05 ± 6.24 d vs 10.46 ± 1.27 d, respectively). While many prior investigations reported that older people with AST had more prolonged hospital stay than younger individuals[22,34,35], even though several other studies suggested that elderly individuals with tSCI had similar hospital length of stay to younger people.[28,31,36,37] The reasons why older people have more prolonged stay in the AST center remains partially understood. A recent Canadian retrospective study indicated that elderly individuals had a significantly longer waiting time from admission to surgery and longer stay in an acute care hospital than younger people after tSCI.[38] In another Canadian study, delay in transferring to a spine trauma center was found to be significantly associated with longer stay in the acute

TABLE 2. Results of the Multivariate Regression Analysis for the Model With Total Hospital Costs as the Dependent Variable (F-Value = 69.67, $R^2 = 0.86$, $P < .001$)

Parameters	Estimate	Standard error	t value	*P* value	95% confidence limits	
Intercept	24 486.71	4837.18	5.06	<.001	14 913.32	34 060.09
Age (years)	−61.67	46.04	−1.34	.18	−152.79	29.45
Sex						
Female	−2650.74	1556.00	−1.70	.09	−5730.26	428.78
Male (reference*)	*	*	*	*	*	*
Length of stay in the AST center (days)	687.42	36.14	19.02	<.001	615.89	758.96
Charlson Co-morbidity Index	−244.81	1002.77	−0.24	.81	−2229.42	1739.80
Severity of spinal cord trauma						
Complete SCI	6193.19	3021.20	2.05	.04	213.87	12 172.52
Incomplete SCI	902.14	1605.62	0.56	.58	−2275.59	4079.87
No or minor SCI (reference*)	*	*	*	*	*	*
Cause of spinal cord trauma						
Motor vehicle accident	2999.54	2312.23	1.30	.20	−1576.66	7575.73
Fall	574.70	2091.98	0.27	.78	−3565.58	4714.98
Other causes (reference*)	*	*	*	*	*	*
Level of spinal cord trauma						
Cervical spinal cord trauma	800.025	2291.17	0.35	.73	−3734.49	5334.54
Lumbosacral spinal cord trauma	1233.67	2259.85	0.55	.59	−3238.85	5706.19
Thoracic spinal cord trauma (reference*)	*	*	*	*	*	*
Need for mechanical ventilation						
No	−18 778.22	3294.80	−5.70	<.001	−25 299.04	−12 257.41
Yes (reference*)	*	*	*	*	*	*

care hospital after tSCI.[39] When analyzing the decision-making process of treatment of acute tSCI, the results of a recent study suggest that older age at the time of tSCI was associated with more prolonged waiting time for transfer to an acute spine care center and longer waiting time period from injury to surgery even after adjusting for injury severity, neurologic level, and trauma severity.[38] The actual reasons for the delays in the treatment decisions have not been completely studied, even though ageist attitudes are among the potential explanations.[40] Moreover, the results of a recent review of the literature that suggested there is considerable variation in the definitions and methods used to determine length of hospital stay after tSCI.[41]

The mean total hospital costs (±standard error of mean) for initial management of elderly individuals with AST (USD $19 338 ± $4892) were significantly higher than younger individuals with AST (USD $13 775 ± $1344) in this study. Using data from an administrative database, the mean hospital cost for acute inpatient care was estimated to be $37 209 (in 2017 USD) in Ontario, Canada.[42] Their costs of the initial admission for management of acute tSCI were 29.5% of the overall healthcare costs up to 1 yr following discharge from the index admission.[42] While those investigators included only individuals with tSCI, our study comprised cases of AST (ie, tSCI and spine trauma with no/minor SCI). Furthermore, administrative databases are subjected to miscoding that can mislead any data analyses.[43] Using American costing data from the National SCI Statistical Center, the mean annual charges of caring for individuals with tSCI were estimated to be $94 210 (in 2017 USD).[44]. Those results differ from our hospital costs because the former represented actual costs of treating individuals with AST, whereas the other study included hospital charges for management of tSCI.[44]

The results of our multivariate regression analysis suggested that higher total hospital costs were significantly correlated to longer stay in the acute spine care center, complete tSCI, and need for mechanical ventilation, but the total hospital costs were not associated with patient age. Similarly, the results of multivariate regression analysis by Munce et al[42] suggested that higher overall healthcare costs for management of individuals with tSCI were significantly associated with longer stay in the acute primary hospital, in-hospital complications, among other factors (but not related to level of tSCI or medical co-morbidities). In opposite to our findings, Munce et al[42] reported that higher overall healthcare costs for management of individuals with tSCI were significantly associated with older age (≥70 yr) and female sex.[42] Those discrepancies are likely related to differences in jurisdictions and study methodology; for example, the other study included overall healthcare costs (ie, costs of the initial admission and all readmissions in the acute care hospitals, inpatient rehabilitation costs, outpatient visit costs, and home care costs) in Ontario, whereas our single-institution study included only costs of the initial admission for management of individuals with AST. In another retrospective study, the need for mechanical ventilation was significantly associated with high-cervical, complete tSCI.[45]

TABLE 3. Results of the Multivariate Regression Analysis for the Model With Per Diem Total Hospital Costs as the Dependent Variable (F-Value = 3.35, $R^2 = 0.23$, $P \leq .001$)

Parameters	Estimate	Standard error	t value	*P* value	95% confidence limits	
Intercept	2928.27	774.81	3.78	<.001	1394.83	4461.71
Age (years)	−12.53	7.38	−1.70	.09	−27.13	2.06
Gender						
Female	209.19	249.24	0.84	.40	−284.08	702.46
Male (reference*)	*	*	*	*	*	*
Length of stay in the AST center (days)	−19.82	5.79	−3.42	<.001	−31.28	−8.36
Charlson Co-morbidity Index	201.42	160.62	1.25	.21	−116.47	519.31
Severity of AST						
Complete SCI	−754.69	483.93	−1.56	.12	−1712.45	203.06
Incomplete SCI	−293.55	257.18	−1.14	.26	−802.55	215.45
No or minor SCI (reference*)	*	*	*	*	*	*
Cause of spinal cord trauma						
Motor vehicle accident	160.68	370.37	0.43	.67	−572.33	893.68
Fall	27.82	335.09	0.08	.93	−635.36	691.00
Other causes (reference*)		*	*	*	*	*
Level of spinal cord trauma						
Cervical spinal cord trauma	−159.34	361.98	−0.44	.66	−875.73	557.06
Lumbosacral spinal cord trauma	779.69	366.99	2.12	.04	53.36	1506.01
Thoracic spinal cord trauma (reference*)		*	*	*	*	*
Need for mechanical ventilation						
No	−493.17	527.75	−0.93	.35	−1537.66	551.31
Yes (reference*)	*	*	*	*	*	*

Overall, the mean per diem total hospital costs were USD $1897 for the entire cohort in our study, which is similar to previous data from veterans with SCI/disease ($1479 in 2017 USD).[46] While the total hospital costs of initial admissions for caring elderly with AST were greater than younger individuals, elderly people with AST had significantly lower per diem total, fixed, direct, and indirect costs than younger individuals with spine trauma in this study. This suggests that higher total hospital costs of the elderly with AST are related to longer hospitalization rather than increased per diem costs, when compared with younger individuals. The fact that most categories of the per diem hospital costs among the younger individuals with AST were significantly greater than the geriatric group could be theoretically explained by a common hospital costing phenomenon. The first days of admission in a primary care hospital are commonly more expensive because patients utilize more services (eg, investigations, professional evaluations, and intensive care); subsequently, the mean per diem hospital costs usually decreases as the patient becomes clinically more stable. While the relationship between length of stay and daily hospital costs has not been reported in the literature on AST, economic studies in other medical areas have documented this link.[47] Interestingly, our multivariate regression analysis suggested that higher per diem total costs were significantly associated with shorter hospital stay.

In this study, elderly people had similar proportions of the utilized services when compared to younger individuals with AST. The top 10 most costly services utilized by younger and older individuals with AST were intensive care unit, ward, operating room, pharmacy, respiratory therapy, imaging, laboratory, occupational therapy, emergency department, and social work. In prior investigations of the components of the health care costs of veterans with SCI/disease, the proportion of inpatient care costs varied from 50.6% to 80.4% of the overall health care costs, whereas the proportion of the outpatient care costs varied from 13% to 43.5%, and the proportion of outpatient pharmacy costs varied from 2.1% to 10.3%.[8,48-50] Using data from the American general population, another study documented that the estimated proportion of inpatient tSCI care charges after first-year was 80.2%, followed by outpatient tSCI care charges (15%) and outpatient pharmacy charges (4.8%).[44] In another study on American veterans, nursing services comprised the highest proportion of the inpatient costs, followed by other costs, pharmacy, surgery, radiology, and laboratory costs.[50] Therefore, the variability in the definitions and classificatory criteria of the components of hospital costs in different jurisdictions make challenging comparisons among the studies.

Overall, the initial hospitalization for management of the elderly is usually longer and more costly than younger individuals after AST due to the frequency and severity of medical complications of tSCI instead of age and preexisting medical comorbidities per se. The shorter hospital stays among younger individuals are commonly associated with higher per diem hospital costs than older people following AST. Finally, there are no significant age-related differences regarding the proportion of

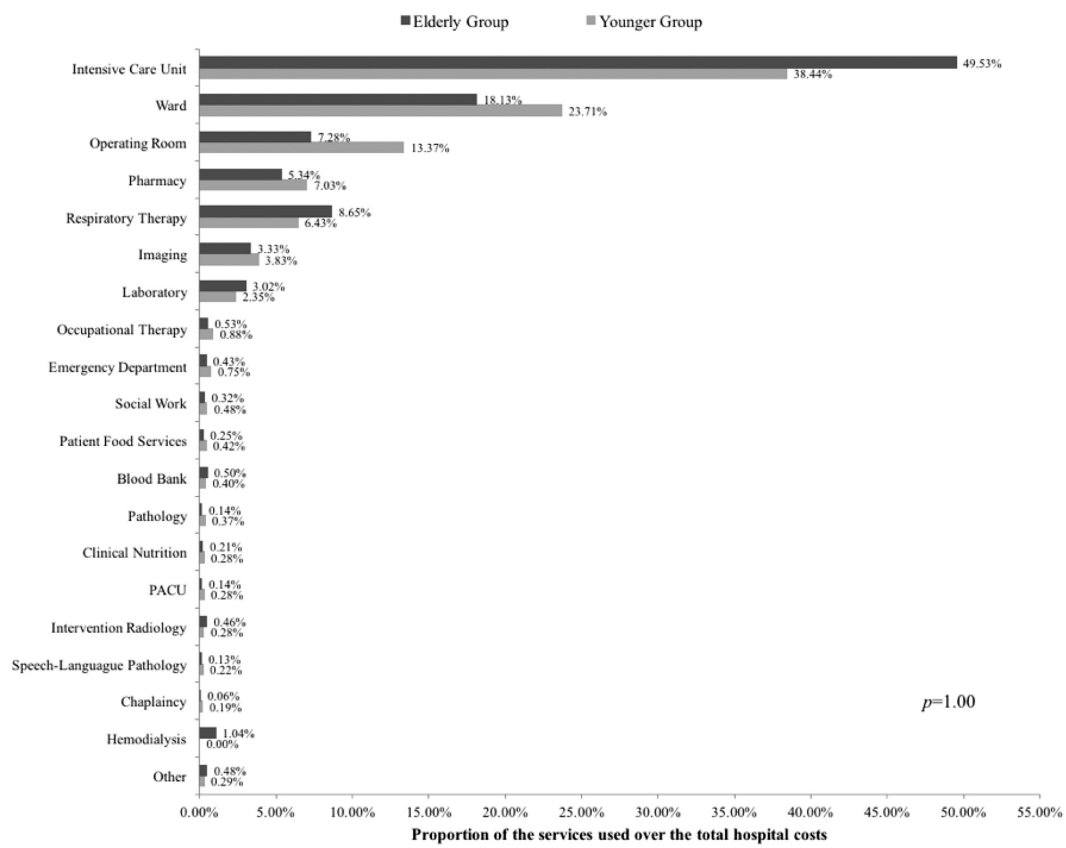

FIGURE 2. *Comparisons between elderly and younger individuals with AST with regards to their hospital service utilization.*

services utilized during the initial hospitalization for management of AST.

The Study Results in the Context of the American Health Care System

This economic analysis is focused on the actual hospital costs from the perspective of a publicly funded health care system and, hence, its results should be interpreted with caution when applied to other jurisdictions such as United States where hospital charges are most commonly reported.

Likewise, there are several differences between the Canadian and American health care systems that can influence the implications of this study results in the American context. While the Canadian "no 2-tier approach" carries the concept of social equity, the Americans favor individual rights.[51] These philosophic differences profoundly influence the way Canadians and Americans organize, manage, deliver, and finance their health care systems.[51] The consequences of those structural differences are enormous including effects on their costs. For instance, Himmelstein et al[52] estimated that the hospital administrative costs accounted for 25.3% of the total hospital expenditures in the United States when compared to 12.1% in Canada. The costs of processing health insurance eligibility and claims in the United States are also substantially greater than in Canada.[51] The Canadian health care system is a tax-supported, universal hospital and physician health plan under the Canada Health Act that covers approximately 30% of the nation's healthcare expenditures; the remaining 60% is paid covered by out-of-pocket money or supplementary private health insurance.[51] The Americans have a multipayer health care system where the majority of the population is covered by private health insurance, whereas a portion of the elderly population is insured by Medicare and approximately 32 million Americans (10.3% of the population in 2014) remain uninsured even after the Affordable Care Act (2010), which aimed to improve the quality of care, reduce costs, and expand access to care.[51]

The American and Canadian health care systems are also distinct in terms of their population outcomes and economic burden. The results of a systematic review suggest that all-cause mortality in Canada appears to be lower than that of the United States, but the large variability in the study results precludes firm conclusions from the pooled data.[53] The most consistent results favor Canada over the United States with regards to survival from end-stage renal disease.[53] According to the World Health Organization Global Health Expenditure database, the health expenditure per capita was estimated to be USD $5292 in Canada (10.4% of the gross domestic product [GDP]) vs USD $9403 in the United States (17.1% of the GDP) in 2014.[54] The hospital reimbursement in a Canada follows the activity-based funding model, whereas American hospitals are reimbursed primarily using a diagnostic-related group.[51] The later may not properly represent the actual treatment costs of certain diagnoses such as spine disease. A recently published study that analyzed the bundled payment model factors in the United States showed substantial variation of the hospital costs for the individuals who underwent cervical or lumbar spine surgery depending upon the type of spinal procedure, preexisting medical co-morbidities, complications, and postdischarge hospital readmission.[55] In addition, the incentives for the waiting times for transfers from an acute care hospital to a rehabilitation facility in a primarily private-insurance driven market such United States are probably very distinct from a publicly funded health care system like in Canada. With all those uncertainties, further investigations using costing data from American hospitals are needed to validate the results of our study in this other jurisdiction.

Study Limitations

While this original economic analysis addresses potential effects of age at the time of AST on the acute care hospital costs and service utilization, there are limitations that should to be taken into consideration before generalizing the results. Firstly, all clinical data were obtained from a single institution where spine surgeons endorse the use of methylprednisolone and early decompression of spinal cord (if surgical treatment is indicated) in the acute stage of tSCI that may not reflect the overall variability of neurosurgical practice. Secondly, all costing data came from only one institution that is funded by a single public payer. Those costing data represent real costs for the health care system and society in contrast to charges in some of the prior studies. Furthermore, the costs in our study can substantially differ from other jurisdictions due to discrepancies in health care policy and efficiency, and economic politics. Thirdly, clinical and costing data comprised in this study were obtained from an in the acute spine care center in a quaternary university hospital, which may not represent the reality of other hospitals such as general hospitals in the community. Fourthly, the physician fees paid directly to surgeons and clinicians were not available and, hence, they were not included in this economic analysis. Finally, this study has inherent limitations such as missing data and restrictions of available data due to its retrospective nature.

CONCLUSION

This economic study, for the first time, examined the potential influence of the age at the time of trauma on the acute care hospital costs and service utilization in the management of adults with AST. The results of this retrospective study suggest that the total hospital costs for the initial admission for management of AST among elderly individuals are significantly higher than younger people. The most significant drivers of the elevated total hospital costs were longer hospital stay, complete tSCI, and need for mechanical ventilation during initial hospitalization. Nonetheless, the elderly have significantly lower per diem total, fixed, direct, and indirect costs than younger individuals with AST, but both groups had statistically similar per diem variable costs. Longer hospital stay and lumbosacral tSCI were the most significant drivers of the greater per diem total costs among younger individuals with AST. Given the escalating demand for surgical and nonsurgical spine treatment with aging of the population, the results of this study timely underline key aspects the economic impact of the spine care of the elderly.[56,57] Future investigations are still needed to further explain the age-related differences in the clinical and economic outcomes of AST.

Disclosures

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COMMENTS

Even in the relatively short time that I have been a part of the neurosurgical community I have seen a clear upwards shift in the age at which people are being considered for surgery and otherwise aggressive care. "Ageism" is more frequently discussed. Both single and multi-payer systems are under increasing financial stress and understanding the costs associated with care of the elderly is increasingly and unfortunately important. At least as important is understanding what the investment in care of the elderly is or is not achieving as compared with younger individuals.

The authors present us with granular data from a retrospective study performed at a single Canadian institution. Total cost associated with the treatment of acute spine injuries was higher in the elderly as compared to younger patients. They report that elderly patients had longer hospital stays but lower daily health care expenditures. The elderly were more likely to require ventilator support. Despite its granularity this is valuable information which inspires further study.

This valuable contribution to the literature left me wanting more, however. A cost per QALY analysis would have helped us to understand the relative value of healthcare dollar expenditure in the elderly. The influence of withdrawal of care is unclear as is the specific impact of osteoporosis. There was a lack of detail on surgical costs and costs following discharge from acute care. Many of these issues and costs are undoubtedly unique to the practice patterns of the institution so the extent to which these results are relevant to other hospitals is not certain. Hopefully the authors and other groups can address these important points in future studies.

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Although the design of this submission is retrospective (overall Class III, low level evidence), this concise comparative study of financial costs of the elderly (age > 65) with spinal cord injury is worth publishing. The study is single-center, Canadian, and from a tertiary care center much involved with SCI. The group is relatively aggressive in managing SCI by using methylprednisolone and believing in early decompression of patients with SCI aimed at improving outcome. The aforementioned statement itself implies that the center must have 24 hours availability of CT and MRI which may add substantially to the intensity of management of the elderly with SCI. The findings of this research may very well be applied to the American economy. The investigators compared financial utilization of 37 elderly patients as compared to 109 younger group of SCI victims. Applying detailed univariate and multivariate statistical analysis the investigators discovered that the main drivers of economic utilization in the elderly is total hospital and intensive care stay (22 vs 10 days), evidence of complete spinal cord injury and need for extended ventilator support. It is interesting that the per diem cost of the older subjects was less than the younger patients. The paper is concise, direct, to the point and informative. The investigators explicitly have answered an important question. The data are solid, analysis is credible, interpretation of the data sensible, and conclusions important. The submission has been well written in the English language. The only weakness that I can see, which seems trivial, is if the findings could be applied to the American medicine.

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