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Title

Patient characteristics, injury types, and costs associated with over-triage of isolated cervical spine fractures

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INTRODUCTION

- Approximately 5.7% of blunt traumas involve cervical spine (C-spine) injuries.¹
- While spine fractures are often stable and treated non-operatively, lack of access to spine specialty care results in transfer to tertiary care facilities, placing substantial financial burden on both hospitals and patients.^{2,3}
- Thus, identifying patient and injury characteristics associated with operative treatment of C-spine fractures may help reduce over-triage.

OBJECTIVES

The goal of this study is to identify factors and describe costs associated with operative versus non-operative treatment in the acute setting among patients transferred with isolated C-spine fractures.

METHODS

All patient transfers from January 1, 2015 to September 1, 2020 to the ED of our Level 1 trauma center were identified using the neurosurgery trauma and orthopaedic spine surgery consult records.

Dens fracture characteristics

Dens displacement and angulation were measured using a previously published technique (**Figure 1**).⁴



Figure 1. Standard measurement technique for dens displacement (red) and angulation (blue) established by the Spine Trauma Study Group.

Cost data

Total hospital costs were obtained through review of hospital billing records.

RESULTS

Table 1: Final multivariate regression models of demographic and injury variables associated with operative treatment for isolated cervical spine fractures. Model 1 for demographic and Models 2 and 3 for injury variables were performed separately.

Model 1: Assessment of demographic variables associated with operative treatment

Demographic Variable	OR	95% CI	p-value
BMI	1.515*	1.088-2.108	0.014
Smoking status			
Never smoker (reference)	--	--	--
Previous smoker	0.82	0.289-2.333	0.711
Not assessed	0.491	0.098-2.440	0.384
Current smoker	5.397	1.978-14.736	0.001

Model 2: Assessment of injury variables associated with operative treatment

Injury Variable	OR	95% CI	p-value
Any neurological deficit	15.387	4.330-54.679	<0.0001
Post-transfer MRI	2.80	1.212-6.472	0.016

Model 3: Assessment of injury variables associated with operative treatment, excluding all cord level deficits

Injury Variable	OR	95% CI	p-value
Isolated root injury	9.52	2.43-37.35	0.001
Post-transfer MRI	2.68	1.15-6.25	0.022

OR = odds ratio; CI = confidence interval; BMI = body mass index; *indicates increase in odds ratio per 20% increase in BMI.

Table 1 shows multivariate model results.

- Current smoking status was the only significant demographic associated with surgical treatment in multivariate modeling (OR = 5.397).
- Neurologic injuries including both spinal cord and isolated spinal nerve root injuries (OR = 9.52), as well as patients undergoing cervical spine MRI after transfer (OR = 2.68), were significantly associated with surgical treatment.

Table 2: Charges to patients and total expenses incurred to hospital for select studies and services utilized in the workup of patients transferred for isolated cervical spine fractures.

Item/service	Total charge to patient	Total hospital expense
Patients treated non-operatively*	\$90,733.55 (\$70,696-\$115,671)	\$12,131 (\$8438-\$18,588)
Patients treated operatively*	\$380,890 (\$321,463-\$464,301)	\$55,115 (\$40,797-\$70,310)
Laboratory workup estimate	\$3008	\$272
CT scan cervical spine	\$5286	\$306
MR imaging cervical spine	\$10,419	\$590
CT angiogram neck	\$10,201	\$280
MR angiogram neck	\$6086	\$487
Cervical spine radiographs	\$1368	\$142
CT scan thoracic spine	\$5709	\$203
CT scan lumbar spine	\$5517	\$203
Trauma service transfer fees	\$20,007	\$272

*costs reported as median and interquartile ranges

Table 2 shows cost analysis results.

- Patients treated surgically were charged a median of \$380,890 and patients treated non-operatively were charged a median of \$90,733.55.
- All patients accepted as trauma transfers incurred additional trauma transfer fees exceeding \$20,000.

CONCLUSIONS

- Nearly 75% of patients transferred for C-spine fractures were subject to secondary over-triage, as they were treated non-operatively.
- Injury characteristics, such as the presence of neurologic deficits and dens fracture pattern, are the most important determinant of need for surgical intervention.
- Having complete pre-transfer workup, including imaging, may reduce unnecessary transfers.
- Over 97% of transfers were accepted by general surgery, 99% of which were managed non-operatively. Thus, involving a spine surgeon in pre-transfer patient assessment may better inform whether a patient actually needs to be transferred.
- Over-triaging of isolated C-spine fractures substantially increases hospital resource expenditures and financial burden on patients.

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