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Clinical Study

How often are interfacility transfers of spine injury patients truly necessary?

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Abstract

BACKGROUND CONTEXT: Traumatic spine injuries are often transferred to regional tertiary trauma centers from outside hospitals (OSHs) and subsequently discharged from the trauma center's emergency department (ED) suggesting secondary overtriage of such injuries.

PURPOSE: The aim of the study was to investigate the definitive treatment and disposition of traumatic spine injuries transferred from OSH, particularly those without other trauma injuries or neurologic symptoms.

STUDY DESIGN: This was a retrospective study.

PATIENT SAMPLE: Adult patients presenting to a single Level 1 trauma center with spine injuries were included.

OUTCOME MEASURES: The outcome measures considered in the study were appropriateness of transfer, treatment, and cost.

METHODS: Four thousand five-hundred consecutive adult patients presenting to a single Level 1 trauma center with spine injuries (isolated or polytrauma) were reviewed. This consisted of 1,427 patients (32%) transferred from an OSH ED. All OSH, emergency medical services, and receiving institution (RI) patient records and imaging were reviewed.

RESULTS: Patients who were neurologically intact, nonpolytrauma, and without critical medical issues at the OSH (isolated intact spine transfers) comprised 29% of transfers. Helicopters transported 13% of these patients. The most frequent injuries were compression (26%), burst (17%), and transverse process (10%) fractures. Seventy-eight percent were discharged directly from the RI's ED. Similarly, 15% were not given any formal treatment, 13% had surgery, and 72% given orthosis treatment. The average cost for transportation and ED costs for those discharged from the RI ED were $1,863 and $12,895, respectively. Of the isolated intact spine transfers, 42% were considered to be inappropriate to warrant transfer. This was defined as those sent from an OSH with an orthopedic or neurosurgeon on staff and clearly stable injuries with minimal chance of progressing to instability. Isolated intact spine transfers whose OSH spine imaging was not considered unstable was 25% of transfers with a helicopter used to transport 14% of these patients. Eighty-seven percent were discharged from the ED, whereas only 3% went onto surgery.

CONCLUSIONS: This study is the first to investigate interfacility transfers with spine injuries and found high rate of secondary overtriage of neurologically intact patients with isolated spine injuries. Potential solutions include increasing spine coverage in community EDs, increasing direct communication between the OSH and the spine specialist at the tertiary center, and utilization of teleradiology.

Keywords: Overtriage; Transfer; Spine; EMTALA; ED; Trauma

FDA device/drug status: Not applicable.

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EVIDENCE & METHODS

Context
Overtriage of patients with spinal injuries and inappropriate transfers to tertiary care facilities are important concerns for the spine surgical community as a whole. This topic has not been extensively addressed in the literature. The authors performed a retrospective review of the records of a single center to determine the incidence of overtriage in the setting of spinal trauma.

Contribution
Forty-two percent of patients with isolated spinal injuries who were neurologically intact were considered inappropriately transferred by the authors. Eighty-seven percent of these patients were discharged directly from the receiving institution's ED. The cost of transport averaged $1,863, while average ED costs were $12,895.

Implications
The authors present their experience with the phenomenon of overtriage and present some approaches that could be used to redress this issue. All of their postulates, however, remain speculative in nature. It should be emphasized that characterization of overtriage and ''inappropriate transfer'' were based on criteria developed entirely by the authors and may not be representative of a consensus within the medical community as a whole. As the authors appropriately point out, their retrospective design introduces a number of opportunities for bias, and the experience at their facility may not be translatable to other tertiary care centers. While highlighting their own experience with overtriage over a four-year period and raising some interesting points for discussion, their results cannot be generalized to other hospitals and should not be used to inform policy.

—The Editors

Introduction

The Emergency Medical Treatment and Active Labor Act (EMTALA) was created in 1986 to guide the interhospital transfer of patients presenting to the emergency department (ED) [1]. It requires that patients presenting to an ED be stabilized and transferred to a tertiary center if a higher level of care is required. In 2003, further modifications were made that no longer require hospitals to provide 24-hour specialty coverage [2]. Conversely, EMTALA requires tertiary centers to accept the transfer of patients in need of higher levels of care. Such a requirement has the potential to overwhelm regional tertiary referral centers with minimally injured patients and shift the resource of burden to these centers [3].

It is evident that the establishment of referral trauma centers has substantially reduced injury-related morbidity and mortality [4–6]. Moreover, a trauma system with appropriate triage and transportation is necessary to provide optimum patient care. A key function of such a system is to determine which patients require a tertiary trauma center and which can receive care locally. When this process breaks down, secondary overtriage to higher level trauma centers occurs.

Historically, undertriage was the main concern for the medical community. However, with the ED overcrowding and rising health-care costs receiving more attention, overtriage has begun to be explored. Primary overtriage refers to the transport of patients from the field to hospital, whereas secondary overtriage refers to transfer between hospitals. The extent of secondary overtriage has not been well described up to this point. It has been peripherally investigated in the orthopedic trauma literature, which found an increasing number of inappropriate transfers over the recent years [7,8]. This practice can overwhelm system resources, delay definitive care, and create added burden on patients and their families.

Given that 26% of ED visits in 2010 were over 4 hours long and spine injuries encompass 4.8% (1.8 million) of trauma-related ED visits, an assessment of secondary overtriage of patients with spine injuries is clearly warranted to identify potential areas for reducing costs and improving resource utilization [9]. The purpose of this study was to investigate the definitive treatment (operatively vs. nonoperatively) and disposition (admitted vs. discharged) for ED patients with spine injuries transferred from outside hospital (OSH), especially those without other trauma injuries or neurologic deficits/symptoms. Furthermore, based on these findings, potential solutions to help minimize unnecessary transfers and facilitate the decision-making process for stable spine injuries are explored.

Materials and methods

Institutional review board approval was obtained before initiation of the study. All consecutive patients presenting to a single adult Level 1 trauma center from January 2009 through March 2013 were retrospectively reviewed. All patients with a spine injury (isolated or polytrauma) were identified via *International Classification of Diseases* codes and review of a prospectively spine database at the receiving institution (RI). This resulted in 4,500 patients presenting with a spine injury. Of these, 1,427 patients (31.7%) were transferred from an OSH ED to the RI's ED.

All available OSH, emergency medical services, and RI patient records and imaging were thoroughly reviewed for the 1,427 transferred patients with a spine injury. The reason for transfer, accepting specialty, and patient condition (stable vs. unstable) were recorded from a standardized interfacility transfer form. This form is completed with the help of the RI's transfer center, transferring physician at OSH, and accepting physician at the RI. Insurance status at the time of ED care at the RI was categorized

as follows: commercial/workers compensation/liabilities, military (Champus/Tricare/Veterans Affairs), Medicare, Medicaid, and uninsured/self-pay.

Based on all identified injuries by the OSH ED at the time of transfer, a patient was considered polytrauma if they had any nonspine fracture, head/chest/abdominal/pelvic trauma, or injury requiring other subspecialty consultations. In addition, any nonpolytrauma patient was considered to have active advanced/critical medical issues at the time of transfer if the patient was unstable, septic, or potentially requiring admission to an intensive care unit. Lastly, a patient was considered to have a positive neurologic finding if they had any new neurologic deficit or radicular symptoms at the OSH ED. Both the polytrauma classification and neurologic deficit at the OSH were then compared with those of the RI to investigate consistency (ie, upgrade/more severe or downgrade/less severe). The RI's neurologic examination was based on the spine consultation's assessment. Definitive treatment for the spine injury was also recorded (no treatment required, orthosis/brace, or surgery). For disposition, a patient was counted as discharged from the ED only if the patient was not admitted and subsequently discharged by the ED staff.

For those considered neurologically intact and nonpolytrauma/active critical medical (isolated intact spine transfers), spine injuries were initially categorized as either potentially stable or clearly unstable by the RI senior spine surgeons using only the OSH imaging. OSH imaging was then compared with all RI imaging and treatment plan to evaluate if any crossover occurred in the assessment of stability or need for surgery. Lastly, patients within this isolated intact spine injury cohort were also categorized as appropriate or inappropriate transfers. This was defined as those sent from an OSH with an orthopedic or a neurosurgeon on staff and clearly stable injuries with very minimal chance of progressing to instability that could have been initially managed/triaged by a board-certified residency-trained orthopedic or neurosurgeon.

The cost analyses included the average charges for transportation from an OSH to a RI and ED charges at the RI for all isolated intact spine transfers that were subsequently discharged directly from the RI ED. These costs were the ambulance/helicopter company and hospital charges regardless of the insurance status.

Using SPSS 20.0 software (IBM, Armonk, NY, USA), dichotomous data were compared using Fisher exact tests, whereas independent *t* tests and Mann-Whitney *U* tests were used for comparisons of parametric and nonparametric data, respectively. Statistical significance was set at $p<.05$.

Results

Of the 4,500 patients seen in the ED for spine injuries, 31.7% (1,427 patients) were transferred in from an OSH ED as opposed to the other 68.3% (3,073) of spine injuries that presented directly to the RI's ED. No significant differences were noted in the insurance status between transfers and nontransfers (Table 1). However, two noteworthy differences were seen, a higher percentage of Medicaid in transfers and uninsured/self-pay in nontransfers, although neither was found to be statistically significant.

Of all the interfacility transfers with spine injuries, 60% (861) were polytrauma and 4% (54) had active critical medical issues (Table 2). No transfer was upgraded to a polytrauma after reassessment at the RI ED, whereas six patients (0.7% of polytrauma patients) were downgraded. A neurologic deficit or radicular symptoms were noted at the OSH in 11% (157) of transfers, with 14% (22) of these being downgraded (ie, no symptoms) and 0.6% (one patient) upgraded after RI spine consultation assessment. This patient with a more severe neurologic finding had unilateral upper extremity radicular symptoms noted at the RI that were not noted at the OSH.

Patients who were found to be neurologic intact and not polytrauma or active critical medical issues at the OSH (isolated intact spine transfers) comprised 29% (407) of the transfers (Table 2). A helicopter was used to transport 13% (58) of these patients. Only 22% (91) were admitted, whereas the other 78% (316) were discharged directly from the RI's ED. Again, no patient was upgraded to a polytrauma classification after RI reassessment. A spine consultation was not ordered on 4% (17) of these patients. Similarly, 15% (62) of isolated spine transfers were not given any formal treatment for the spine, whereas 13% (53) had surgery and 72% (292) given nonoperative orthosis treatment.

Isolated intact spine transfers whose OSH spine imaging was not considered clearly unstable by RI spine surgeons

Table 1
Comparison of the insurance status for all spine patients seen at the receiving institution's emergency department as well as transfers and nontransfers with spine injuries

Insurance	All spine patients, n=4,500 (%)	p Value	Transfers, n=1,427 (%)	p Value	Nontransfers, n=3,073 (%)
Commercial/work comp/liabilities	44.5	.691	45.1	.584	44.2
Military (Champus/Tricare/VA)	3.1	.200	3.8	.781	2.8
Medicare	21.0	.500	20.1	.326	21.4
Medicaid	10.7	.207	11.9	.078	10.2
Uninsured/self-pay	20.7	.186	19.1	.069	21.4

Work comp, workers compensation; VA, Veterans Affairs.
Note: p Values shown are for comparisons of neighboring columns.

Table 2
Comparison of patient, injury, transfer, treatment, and disposition characteristics between all spine transfer patients with isolated neurointact spine injuries

	All transfers to receiving institution's ED with spine injuries	p Value	Neurointact and not polytrauma/advanced medical at OSH	p Value	Neurointact, not polytrauma/advanced medical at OSH and all OSH spine imaging stable
Total number of patients	1,427		28.5 (407)		25.3 (361)
Patient demographics					
Age	51.6±20.8 (16–100)	**.000**	46.4±20.5 (16–97)	1.000	46.4±20.2 (16–97)
Gender (male)	60.8 (867)	.909	60.4 (246)	.768	59.3 (214)
Primary insurance					
Commercial/work comp/liability	45.1 (644)	.910	45.5 (185)	.828	44.6 (161)
Military (Champus/Tricare/VA)	3.8 (54)	.563	4.4 (18)	.462	3.3 (12)
Medicare	20.1 (287)	**.015**	14.7 (60)	.919	15.2 (55)
Medicaid	11.9 (170)	.268	14.0 (57)	1.000	14.1 (51)
Self-pay	19.1 (272)	.321	21.4 (87)	.664	22.7 (82)
Transfer information					
Reason for transfer					
Higher level of care	78.5 (1,120)	**.000**	69.5 (283)	1.000	69.5 (251)
Specialist	18.4 (262)	**.001**	26.3 (107)	.870	23.8 (97)
Other	3.1 (45)	.350	4.2 (17)	.713	3.2 (13)
Accepting specialty					
Emergency department	62.0 (885)	.453	59.9 (244)	.825	60.9 (220)
General surgery trauma	24.3 (346)	**.000**	15.5 (63)	.843	16.1 (58)
Spine (neuro/ortho)	12.5 (179)	**.000**	24.1 (98)	.609	22.4 (81)
Other	1.2 (17)	.278	0.5 (2)	1.000	0.6 (2)
Mode of transportation					
Ambulance	78.0 (1,113)	**.000**	86.7 (349)	.835	86.4 (312)
Helicopter	22.0 (314)	**.001**	13.3 (58)	.835	13.6 (49)
Distance from RI ED (mi)	66.7±40.8 (0.4–594)	1.000	67.0±34.5 (0.4–179)	1.000	66.4±34.6 (0.4–179)
Injury characteristics					
Mechanism of injury					
MVC/MCC	56.8 (811)	.734	55.8 (227)	.942	56.2 (203)
Fall	32.8 (468)	.212	36.1 (147)	1.000	36.3 (131)
Pedestrian	2.0 (28)	**.044**	0.5 (2)	1.000	0.6 (2)
Other, N/A	8.4 (120)	.683	7.6 (31)	.782	6.9 (25)
Patient condition unstable	25.6 (366)	**.000**	13.3 (54)	1.000	13.3 (48)
Active advanced medical issues at OSH	3.8 (54)	—	—	—	—
Polytrauma patient at OSH	60.3 (861)	—	—	—	—
Upgrade in polytrauma classification at RI	0 (0)	—	0 (0)	—	0 (0)
Downgrade in polytrauma classification at RI	0.4 (6)	—	—	—	—
Neurologic deficit/symptoms at OSH	11.0 (157)	—	—	—	—
Upgrade in deficit at RI	0.07 (1)	.395	0.2 (1)	1.000	0 (0)
Downgrade in deficit at RI	1.5 (22)	—	—	—	—
General surgery trauma evaluation at RI	66.4 (947)	**.000**	12.8 (52)	.134	9.1 (33)
Spine consultation obtained at RI	88.6 (1,264)	**.000**	95.8 (390)	.729	95.3 (344)
Area in injury					
Cervical	40.6 (580)	**.017**	47.4 (193)	.612	45.4 (164)
Thoracic	17.4 (248)	.710	16.5 (67)	.696	16.3 (59)
Lumbar	30.4 (434)	.154	29.5 (120)	.184	31.3 (113)
Multiple	8.2 (117)	.347	6.6 (27)	.887	6.9 (25)
Treatment					
Spine surgery	17.5 (250)	**.034**	13.0 (53)	**.000**	2.8 (10)
Nonoperative brace treatment	57.8 (825)	**.000**	71.8 (292)	**.007**	80.3 (290)
No spine surgery or brace treatment	24.7 (352)	**.000**	15.2 (62)	**.002**	16.9 (61)
Disposition					
Discharged from ED	25.9 (369)	**.000**	77.6 (316)	**.001**	87.3 (315)
Admitted to RI	74.1 (1,058)	**.000**	22.4 (91)	**.001**	12.7 (46)

ED, emergency department; OSH, outside hospital; Work comp, workers compensation; VA, Veteran Affairs; RI, receiving institution; N/A, not available; MVC, motor vehicle collision; MCC, Motorcycle collision.

Note: The second column represents only those patients considered neurologically intact and nonpolytrauma/active critical medical (isolated intact spine transfers) at the OSH. The third column is isolated intact spine transfers whose OSH spine imaging was not considered clearly unstable by RI spine surgeon. p Values shown are for comparisons of neighboring columns.

Values are expressed as percentage (absolute number) or mean±standard deviation (range). Bold values are statistically significant ($p < .05$).

Table 3
Disposition and injury characterization of isolated, neurointact spine transfers

	Neurointact and not polytrauma/critical medical at OSH	p Value	Neurointact and not polytrauma/critical medical at OSH and all OSH spine imaging stable
Total number of patients	407		361
Outside hospital staff			
Orthopedic/neurosurgeon	92.9 (378)	.890	92.5 (334)
Spine surgeon	62.9 (256)	.881	62.3 (225)
Admission characteristics			
Admitted	22.4 (91)	**.001**	12.7 (46)
Admission service			
Spine (neuro/ortho)	9.8 (40)	**.000**	3.3 (12)
General surgery trauma	7.6 (31)	.071	4.4 (16)
Medicine/geriatrics/MICU	4.4 (18)	1.000	4.4 (16)
Other	0.5 (2)	1.000	0.6 (2)
Reason for admission			
Spine surgery	13.0 (53)	**.000**	2.8 (10)
Overnight observation	3.2 (13)	.843	3.6 (13)
Pain control	1.2 (5)	1.000	1.1 (4)
Geriatric age	4.9 (20)	.870	5.3 (19)
Spine fracture			
Occipital condyle	1.0 (4)	1.000	1.1 (4)
C1 ring	5.9 (24)	1.000	6.1 (22)
Odontoid	9.3 (38)	1.000	9.1 (33)
C2 body	1.0 (4)	1.000	1.1 (4)
C2 traumatic spondylolisthesis	2.2 (9)	1.000	1.9 (7)
Facet	9.1 (37)	.359	7.2 (26)
Perched/jumped	2.5 (10)	**.002**	0 (0)
Lateral mass	4.7 (19)	.867	5.0 (18)
Lamina	3.4 (14)	.848	3.9 (14)
Anterior avulsion	2.0 (8)	.807	2.2 (8)
Compression	26.3 (107)	.333	29.6 (107)
Burst	16.7 (68)	.923	17.2 (62)
MRI not obtained	8.1 (33)	.795	8.9 (32)
MRI obtained	8.6 (35)	.898	8.3 (30)
Pedicle	0.7 (3)	1.000	0.8 (3)
Spinous process	2.7 (11)	.831	3.0 (11)
Transverse process	10.3 (42)	.565	11.6 (42)
Unstable 3-column fracture (excluding burst)	5.2 (21)	**.000**	0 (0)
No fractures/unstable ligamentous injury/spine lesion	1.5 (6)	1.000	1.7 (6)

OSH, outside hospital; MRI, magnetic resonance image; MICU, medical intensive care unit.
Note: Values expressed as percentage (absolute number). Bold values are statistically significant ($p < .05$).

consisted of 25% (361) of all transfers with a helicopter used to transport 14% (49) of these patients. Eighty-seven percent (315) of these patients were discharged home from the RI's ED after transfer. A spine consultation was not obtained on 6% (17) of these patients, and only 3% (10) went on to have spine surgery at that time.

The most frequent spine injuries found in isolated intact spine transfers were compression (26%), burst (17%), and transverse process (10%) fractures (Table 3). Furthermore, 11% (46) of injuries in this cohort were determined to be unstable based only on the OSH imaging (Table 4), which consisted mainly of unstable three-column injuries in 5% (21) and perched or jumped cervical facets in 3% (10). Of the 361 isolated spine transfers whose OSH spine imaging was not considered clearly unstable by RI spine surgeons, 3% (10) went on to have spine surgery (Table 4). These included four burst fractures with posterior ligamentous complex disruption on magnetic resonance images obtained at the RI and four burst fractures in patients who had significant pain and kyphosis with upright trial in brace before ED discharge. Two odontoid fractures also went to surgery: a Type 2 in which the patient was strongly desired surgery in place of prolonged collar or halo wear and a Type 2 that displaced on upright X-ray films before discharge. Of note, this Type 2 odontoid patient remained neurologically intact throughout the workup and treatment course.

Of the isolated intact spine transfers, 42% (170) were considered to be inappropriate to warrant transfer. Again, transfers were considered to be inappropriate if the patient was sent from an OSH with an orthopedic or a neurosurgeon on staff and a clearly stable injury with minimal chance of

Table 4
Isolated intact spine transfers found to be unstable using only imaging performed at OSH, for the 10 patients not noted to be obviously unstable on OSH and underwent spine surgery after further workup and discussion at RI

Neurointact, nonpolytrauma/critical medical, *unstable* on outside hospital imaging (n=46)
37: Instability noted on single midline sagittal CT slice
10: Cervical 3-column injury
10: Thoracic 3-column injury
9: Lumbar 3-column injury
6: Cervical anterolisthesis/jumped facet
2: Displaced odontoid
9: Instability noted on off-midline sagittal CT slices
6: Perched facets
2: C2 traumatic spondylolisthesis
1: C1 ring and odontoid
Neurointact, nonpolytrauma/critical medical, *stable* on outside hospital imaging patients undergoing *spine surgery* (n=10)
4: Thoracolumbar burst with PLC disruption on MRI
4: Thoracolumbar burst with significant pain and kyphosis when upright
1: Type 2 odontoid in which patients strongly desired surgery opposed to collar/halo
1: Type 2 odontoid that displaced on upright X-ray films

OSH, outside hospital; RI, receiving institution; CT, computed tomography; MRI, magnetic resonance imaging; PLC, posterior ligamentous complex.

progressing to instability that could have been initially managed/triaged by the board-certified residency-trained orthopedic or neurosurgeon. Injuries counted as such included isolated lamina, anterior avulsion/osteophyte, compression (without any concern for being a burst), spinous process, transverse process, or unilateral pedicle fractures, along with any patient not found to have any fracture/unstable ligamentous injury/spine lesion. Although no significant differences in the insurance status between transfers and nontransfers were found, a higher percentage of inappropriate isolated intact spine transfers with Medicaid was found compared with those considered appropriate (Table 5).

For the isolated intact spine transfers that were discharged directly from the RI after transfer, the average cost of transportation for transfer was $1,863±4,710 ($217–$30,030). The average cost of air transportation was $19,569±3,743 ($14,680–$30,030), whereas the average cost of ground transportation was $665±241 ($217–$1,316). The average ED costs at the RI before discharge was $11,895±10,093 ($616–$50,636).

Table 5
Insurance status of appropriate (58.2%) versus inappropriate (41.8%) transfers in neurointact and nonpolytrauma/critical medical patients (n=407)

Insurance	Appropriate (n=237), % (n)	p Value	Inappropriate (n=170), % (n)
Medicaid	10.5 (25)	.021	18.8 (32)
Self-pay	21.1 (50)	.903	21.8 (37)

Note: Inappropriate transfers were defined as those sent from an OSH with an orthopedic or a neurosurgeon on staff and those with clearly stable injuries that could have been initially managed/triaged by the board-certified residency-trained orthopedic or neurosurgeon).

Discussion

Proper triage of patients visiting the ED is essential in optimizing the balance between quality patient care and health-care resource utilization. Undertriage is associated with potentially increased cost and worse outcomes for selected injuries. Conversely, overtriage can overwhelm system resources and delay definitive care. Although EMTALA may protect the acute stabilization of patients, it does not address the definitive treatment in patients. Consequently, inappropriate transfers of stable patients occur, switching a financial and resource burden to tertiary referral centers and their surrounding communities.

The results of this study found a high occurrence of secondary overtriage to a single tertiary referral trauma center for isolated spine injuries. Of the spine transfers that were neurologically intact and nonpolytrauma/critical medical (isolated intact spine transfers), 78% were discharged from the RI's ED after transfer with an average transportation cost of $1,863 and ED cost of $11,895. Furthermore, 16% of those patients discharged were transferred via helicopters at an average cost of $19,569, along with the risk of a potential helicopter accident. The safety and risks of helicopter transport for patients and crews have recently been challenged owing to an increase in medical helicopter–related accidents [10]. In 2012, there were 4.83 accidents per 100,000 flight hours for US civil helicopters [11,12].

Further evidence of overtriage is that 42% of isolated intact spine transfers were found to be inappropriate. Inappropriate transfers refer to patients with injuries that most general orthopedic or neurosurgeons taking call at a local ED could easily manage and a very minimal chance of leading to acute instability. These findings remain consistent with prior studies assessing the inappropriate transfers of upper extremity injuries/infections (53%) and orthopedic injuries (17%) [7,8], all of which report a high rate of secondary overtriage.

Insurance status as a potential predictor of patient transfer to tertiary trauma centers has been extensively studied with mixed results. A study from the American College of Surgeons National Trauma Registry found that patient-payer mix did not differ between transferred and nontransferred patients [3]. Conversely, both Koval et al. [13] and Nathans et al. [14] found insurance status to be significant predictors of transfer. Looking specifically at appropriateness of transfer for orthopedic injuries, Thakur et al. [15] noted a larger percentage of inappropriate transfers were uninsured. This finding is consistent with that of our present study. Although no significant differences in the insurance status between transfers and nontransfers were found, a higher percentage of inappropriate isolated intact spine transfers with Medicaid was found compared with those considered appropriate (Table 5).

One potential solution to help remedy the overtriage problem of spine patients is improving spine call coverage in community EDs. However, given the unpredictable hours, increased liability, and decreased compensation, many spine specialists may choose to opt out of such coverage. This leaves community EDs uncovered, causing them to transfer many stable spine injuries to the regional tertiary trauma center no matter the distance. Furthermore, even when a community ED can get coverage, surgical specialties sometimes provide a poor response rate to the ED's request for assistance. A survey of California ED physicians found 23% and 18% of those surveyed had trouble with neurosurgery and orthopedic surgery response, respectively [16]. Another potential method of decreasing inappropriate transfers would be to increase the frequency in which the OSH transferring ED physician talks directly with the spine surgeon on call at the RI opposed to another ED physician. Similar to the findings by Tanker et al. for orthopedic trauma transfers, we found that ED physicians (65%) as opposed to spine surgeons (14%) accepted a significant majority of the inappropriate spine transfers.

Given many surgeons' concerns on relying exclusively on an OSH or nighthawk image reading, the ability for remote viewing of images could potentially increase their comfort level in arranging close follow-up as an outpatient instead of having the patient (and family) transferred across the state solely to make a treatment decision using OSH imaging. The idea of a teleradiology and/or teleconsultation is not a new idea as studies have consistently shown its ability to reduce unnecessary transfers, especially in patients with neurosurgical injuries [17–19]. Furthermore, telephone-based teleradiology systems have been recently developed and have been found to be accurate and efficient in remotely making the diagnosis and determining acute management of orthopedic and spine injuries [20]. Even if only a limited amount of data are able to be transmitted to a mobile device, it could still decrease the number of inappropriate transfers. Of the 46 isolated intact spine transfers with unstable injuries on OSH imaging, 37 of them could be determined to be unstable using only a single midline sagittal slice from the OSH CT, whereas the other nine patients instability could be determined using bilateral midfacet sagittal slices.

Realizing that proper, streamlined care of the vast number of spine injuries is an essential part of reducing overtriage in this patient population, the findings of this study were used to help build an algorithm to facilitate the decision-making process when encountering a spine injury (Figure). Understandably, it is not meant to be an all-encompassing definitive treatment pathway, but rather one that may be used during the triage of a patient with a spine injury in a community ED.

This study does hold several noteworthy limitations with the first being its retrospective design and the inherent recall bias associated with it. Although electronic copies of OSH

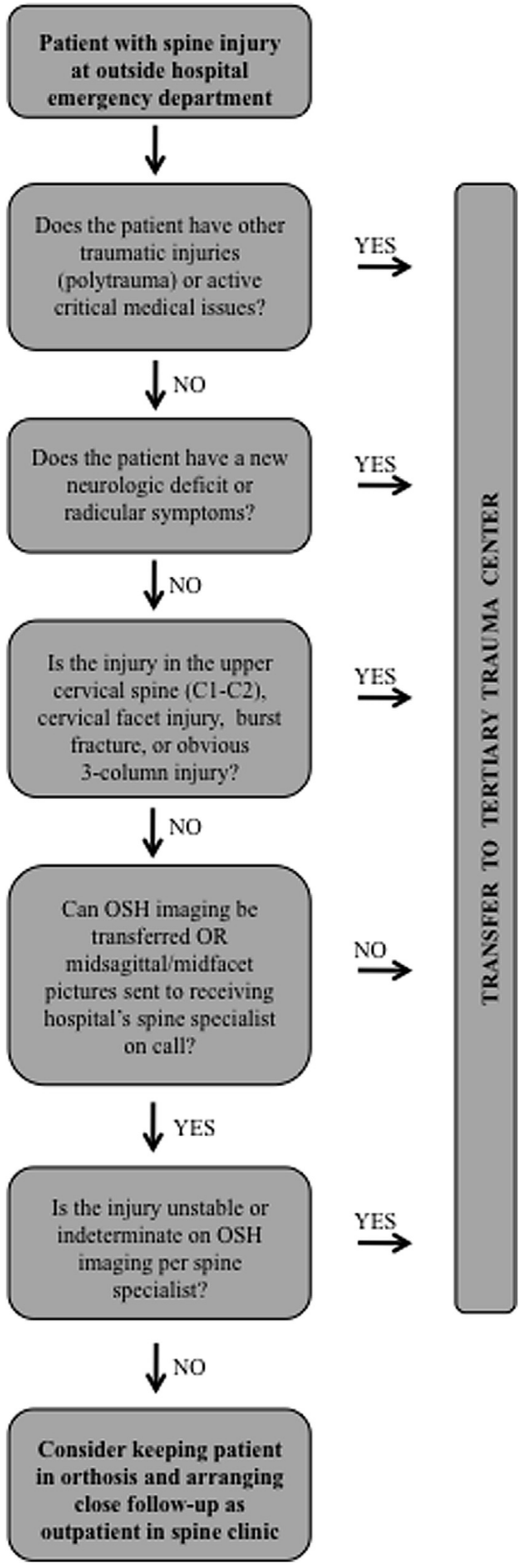

Figure. Flowchart for the decision-making process for a patient with a spine injury at an outside hospital who is being considered for transfer to a regional tertiary trauma center. OSH, outside hospital.

ED records were reviewed, this provides limited insight into the transferring physician's decision-making process and what involvement if any an OSH orthopedic/neurosurgeon may have had with the patient. However, prospective questioning of OSH providers could potentially lead to a change in their normal transfer practice because of the Hawthorne effect. The second major limitation is that it only encompasses a single institution, which cannot be assumed to be representative of all other tertiary centers, thereby limiting the external validity of this study. Lastly, this study does not address the potential medicolegal risks associated with denying transfer of a spine patient or just arranging outpatient follow-up. There is no doubt that the fear of litigation drives the transfer of many spine patients, whether it is unwillingness to trust another practitioner's neurologic examination or inability to view imaging themselves. However, the large direct and indirect costs associated with this prime example of defensive medicine must be considered, especially in setting of inherently stable spine injuries.

This study is the first to investigate interfacility transfer of patients with spine injuries and found a high rate of secondary overtriage of neurointact patients with isolated spine injuries. These inappropriate transfers can become a burden on the receiving tertiary care center and lead to unnecessary increases in health-care costs and ineffective resource utilization. Some potential solutions to improve the triage process and prevent overtriage of these patients include increasing spine coverage in community EDs and ensuring direct communication between OSH and referral's center spine specialists. Finally, utilization of teleradiology with spine specialists could potentially allow safe outpatient follow-up to be coordinated in place of the inappropriate transfer of stable spine injuries.

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