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Nationwide secondary overtriage in level 3 and level 4 trauma centers: are these transfers necessary?

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Abstract

Background—Secondary overtriage (SO) refers to the interfacility transfer of trauma patients who are rapidly discharged home without surgical intervention by the receiving institution. SO imposes a financial hardship on patients and strains trauma center resources. Most studies on SO have been conducted from the perspective of the receiving hospital, which is usually a level 1 trauma center. Having previously studied SO from the referring rural hospital's perspective, we sought to identify variables contributing to SO at the national level.

Methods—Using data from the 2008-2012 National Trauma Data Bank, we isolated patients transferred to level 1 trauma centers who were: (1) discharged home within 48 h and (2) did not undergo any surgical procedure. This population was subsequently compared with similar patients treated at and discharged directly from level 3 and 4 centers. Multivariate logistic regression analysis was used to isolate variables that independently influenced a patient's risk of undergoing SO. Injury patterns were characterized by use of subspecialty consultants.

Results—A total of 99,114 patients met inclusion criteria, of which 13.2% were discharged directly from level 3 or 4 trauma centers, and 86.8% of them were transferred to a level 1 trauma center before discharge. The mean Injury Severity Score of the nontransfer and transfer groups was 5.4 ± 4.5 and 7.3 ± 5.7 , respectively. Multivariate regression analysis showed that Injury Severity Score > 15, alcoholism, smoking, drug use, and certain injury patterns involving the head, vertebra, and face were associated with being transferred. In this minimally injured population, factors protective against transfers were: age > 65 y, female gender, systolic blood pressure <80, a head computed tomography scan and orthopedic injuries.

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Disclosures

None of the authors have any disclosures.

Conclusions—SO results from the complex interplay of variables including patient demographics, facility characteristics, and injury type. The inability to exclude a potentially devastating neurologic injury seems to drive SO.

Keywords

Secondary overtriage; CT scan; Triage; Trauma system; Transfers; Rural

Background

In the ideal trauma system, first responders stratify care such that high-acuity patients are triaged toward tertiary care trauma centers, and those without major injuries are seen locally (primary triage). According to the American College of Surgeons Committee on Trauma, a degree of overtriage (25%-35%) is accepted because undertriage can worsen patient outcomes.¹ Secondary triage occurs not at the scene of injury but in a hospital setting. Secondary overtriage (SO) therefore refers to seemingly unnecessary interfacility transfers of minimally injured trauma patients. Although usually not directly detrimental to the patient, SO imposes financial burdens (on average \$5917-\$12,549 per patient^{2,3}) and shifts resources away from those who truly require trauma center care.⁴ The annual cost of trauma care in the United States exceeds \$37 billion,⁵ and consequently, judicious allocation of trauma resources has become a priority. Various authors have reported SO rates of 6.9%-53%.^{2-4,6,7}

Reducing the SO rate necessitates an understanding of the factors that contribute to it. Prior studies have shown that patient demographics, such as age, gender, mechanism of injury, and insurance status may affect transfer decisions and triage accuracy.^{2,8-10} Provider experience may also be important, as it has been reported that appropriate triage of trauma patients by emergency room physicians correlates with the volume of moderate to severely injured patients that the physician treats,¹¹ and case vignette studies have suggested that emergency room physicians may be more likely to undertriage trauma patients than trauma surgeons.¹² Availability of patient care resources, such as neurosurgery services, computed tomography (CT) scanners, residents, and intensive care unit beds at the referring hospital is a third variable that has been reported to affect transfer decisions.^{13,14} Thus, it appears that the interplay of patient demographics, injury patterns, and availability of hospital resources may all contribute to SO.

Although various studies have used different criteria to define SO, common elements include a lack of surgical intervention and rapid discharge by the receiving hospital.^{2-4,7,15} Recently, we published a study on SO from the perspective of the rural hospitals in our state, namely the level 3 and 4 trauma centers. Most authors calculate SO rates using single-institution databases and some variant of Equation 1 (Fig. 1), which defines the SO rate as the fraction of the total transferred trauma patients who met SO criteria (Fig. 1). These definitions exclude the population of patients treated and discharged from level 3 and 4 trauma centers, however our study includes them in the denominator. We used Equation 2 of Figure 1, which compares minimally injured patients who were transferred from level 3 and 4 trauma centers with minimally injured patients discharged from a level 3 or 4 center (Fig. 1). We believe we

were the first ones to directly study the decision these rural hospitals make to transfer a seemingly uninjured patient to a higher level of care.¹⁵ Our calculated SO rate was 9.8% for our rural state.¹⁵

We observed that certain injury patterns, particularly those involving the head and spine, were associated with transfer to tertiary care centers. Middle of the night arrival times and the need for transfusion were also risk factors for transfer. Notably, CT scans at the initial facility were strongly protective against SO, corroborating a Canadian study which reported that nontrauma centers with CT scanners, in addition to general surgery services, had decreased overall rates of transfer to trauma centers.¹³ We sought to confirm that the conclusions we reported within our previous study are applicable at the national level and to explore new factors not previously analyzed. The long-term goal of this research is to facilitate the development of targeted strategies to reduce the SO rate and thereby help alleviate the burden of SO on tertiary center resources and improve patient care.

Methods

Data from the National Trauma Data Bank (NTDB) were combined across 2008-2012. Inclusion criteria were all trauma patients aged older than 18 y, who were discharged home within 48 h, did not undergo a surgical procedure, and were either seen at a level 3 or 4 trauma center or arrived as a transfer to a level 1 trauma center (Fig. 2). Patients who were discharged to a skilled nursing facility, nursing home, or rehabilitation facility were excluded. From this population, we compared patients who were discharged from the level 3 and 4 trauma centers with those who were transferred before their discharge from the level 1 trauma centers (Equation 2 of Fig. 1) to isolate differences between these populations. Our definition of SO therefore presumes that SO patients were transferred from level 3 and 4 centers. Categorical variables were compared using Fisher's exact test, whereas continuous variables were evaluated with the Wilcoxon rank-sum test. Multivariate analysis was conducted to isolate variables of clinical significance that independently correlated with a patient's risk of SO.

Logistic regression models were performed to determine the association between covariates and transfer status. Indicators of an Injury Severity Score (ISS) >15, neurologic injury, vertebral injury, orthopedic injury, facial injury, age >65 y, systolic blood pressure <90, various comorbidities, and having a head CT were included in the logistic model. The NTDB defines head CT scans based on the International Classification of Diseases, Ninth Revision, Clinical Modification code (8703). Lack of a procedure code was assumed to indicate that a procedure did not take place. Injury patterns were characterized by use of subspecialty consultants. As a sensitivity analysis, a generalized linear mixed effects model was performed to control for the variability within facility. This model used residual-type random component that does not affect the mean model but will more accurately estimate variability of odds ratio (OR) estimates. Our analysis was a complete case analysis, which excludes data points for which the variables of interest were not reported.

Results

Descriptive analysis of data set demographics is presented in Table 1. Among the 99,114 patients meeting inclusion criteria, 13,068 (13.2%) were discharged directly from a level 3 or 4 trauma center, and 86,046 (86.8%) were transferred to a level 1 trauma center before discharge. The mean ISS of the non-transfer and transfer groups was 5.4 ± 4.5 and 7.3 ± 5.7 , respectively, and the proportion of patients with an ISS >15 was 4.3% and 12.4%, respectively. Overall, the study population tended to be male, with a greater proportion of nontransfers being female (37.2% *versus* 29.0%), older than 65 years (77.9% *versus* 75.0%), and of white ethnicity (77.9% *versus* 75.0%). Nontransferred patients were seen at level 3 and 4 trauma centers, which typically had fewer than 400 beds, whereas transferred patients were seen at level 1 facilities most of which had greater than 400 beds (Table 2). All chi-square tests and Wilcoxon rank-sum tests were significant at the 0.0001 level.

Comorbidities that could potentially confound a neurologic examination were investigated, and patients who were current smokers and patients who misused drugs or alcohol were at increased risk for SO in a univariate model. Diabetes, cirrhosis, cerebrovascular accidents and major psychiatric illnesses were not associated with increased risk of SO (Table 3). The distribution of injuries is summarized in Table 4. Injuries to the head, which may require neurologic (39.2%) or facial (29.2%) specialists, were the most common injuries requiring consultation. Neurologic (41.1% *versus* 26.6%), vertebral (16.6% *versus* 9.1%), and facial (29.8% *versus* 25.3%) injuries were more common in the transfer population than in the nontransfer population. Orthopedic injuries were more common among those not transferred (35.3% *versus* 21.2%).

Results of our multivariate logistic regression analysis are presented in Table 5. The most strongly predicative variable for transfer was ISS >15 (OR = 2.51). Female gender (OR = 0.74) and age greater than 65 y (OR = 0.62) were protective for SO. Alcoholism, drug use, and smoking were also associated with increased risk of SO by multivariate analysis. Certain injury patterns such as neurologic (OR = 2.10), vertebral (OR = 2.29), and facial (OR = 1.14) injuries, increased risk of SO, whereas orthopedic injuries were protective (OR = 0.60). Head CT (OR = 0.50) was protective against SO. The sensitivity analysis using generalized linear mixed effects model is not presented because no significant changes in either confidence interval or *P* value were observed, which indicates that the intrafacility variability did not affect overall variability of the parameter estimates to a significant degree.

Discussion

Demographics

Our population had the expected characteristics of a male predominant, minimally injured trauma population. The incidences of hypotension (systolic blood pressure < 90) and impaired neurologic status (Glasgow Coma Score < 13) were low in both transfers and nontransfers. The mean ISS was also low in both the groups; however, the proportion of patients with an ISS >15 was surprisingly high, particularly in the transfer population (12.4%). This suggests that clinicians at referring facilities are correctly identifying the more severely injured patients who could potentially overwhelm their facility's capabilities. We

did not calculate a national rate of SO from the NTDB because the data bank is skewed by having most data contribution come from level 1 and 2 trauma centers and is thus not representative of the nation as a whole.

Interestingly, age >65 y was protective against transfers in the NTDB, whereas it was a risk factor for SO in our statewide study.¹⁵ The precise etiology of this discrepancy is unclear, but a variety of explanations are possible. First, our statewide study was completed in West Virginia, which has one of the oldest populations of any state according to the US census (15.3% of the population are age >65 y compared with 12.4% of the national population). Conversely, the NTDB data set is disproportionally skewed by data from level 1 and 2 trauma centers, which are often found in urban areas where the population may be more youthful. Therefore, these two populations are likely not equal. That said, it is clear that age can affect transfer status in the trauma population as a whole; a meta-analysis of trauma transfer practices found that transferred trauma patients were younger than those directly admitted.¹⁶ Elderly trauma patients are at increased risk of undertriage¹⁷ because signs of shock may be masked by medications such as beta blockers, and seemingly low traumatic mechanisms may lead to underrecognition of serious injuries. However, these explanations likely do not apply to our minimally injured population, and there may be other factors influencing the transfer rate in the elderly population that have yet to be identified.

The impact of race on transfer decisions has been repeatedly investigated by numerous authors with mixed results.^{2,18} In our NTDB analysis, whites made up a smaller fraction of the transferred group than the nontransferred group (75.0% *versus* 77.9%), whereas nonwhites made up a slightly greater fraction of the transferred group than the nontransferred group (19.5% *versus* 11.5%). Given the small effect size seen with descriptive analysis, race was excluded from the multivariate model. The effects of gender are likewise somewhat controversial, as some authors reported that trauma patient transfer rates did not vary by gender,² yet other studies observed that female trauma patients were significantly less likely to be transferred (OR = 0.85) and more likely to be undertriaged.¹⁹ Our findings suggest that female gender was protective against SO (OR = 0.74). We speculate that the protective effect of gender on SO rates may arise from potential differences in mechanism of injury and providers' biases in perceptions of injury severity in female patients. Patients with government insurance, those who self-paid, and those with unknown insurance types were all at increased risk of transfer relative to those with private insurance (OR = 1.25, 1.52, and 2.83, respectively). This differs from the findings of other authors, who reported no difference in payer status mix among patients transferred to a level 1 trauma center versus those directly admitted to the center²⁰ but is in accordance with other studies showing increased risk of SO among patients with Medicare or Medicaid.⁷

The effects of comorbid medical conditions on SO have been very sparsely studied. We observed that alcoholism, drug misuse, and current tobacco use were all associated with increased risk of SO by multivariate analysis. Alcoholism and drug use may result in a temporary but significant neurologic impairment, mimicking or masking a potentially devastating neurologic injury. This could lead physicians to transfer to err on the side of safety. Tobacco use may complicate the management of some patients with rib fractures or pulmonary contusions, increasing the risk that smokers with minor thorax injuries may

undergo SO. Chronic conditions such as major psychiatric illness, cirrhosis, and history of cerebrovascular accident did not affect SO risk. Further studies investigating how comorbidities impact SO are needed.

Injury patterns

Prior studies by our group and others have suggested that SO relates in part to a paucity of surgical specialists at referring institutions.^{14,15,20} In keeping with this, injury patterns were strongly predictive of SO in our study. Head and neck injuries were the most common cause of SO in a study by Sorensen,⁷ whereas orthopedic injuries and neurologic trauma were common reasons for overall transfer in other studies.^{3,20} Interestingly, neurosurgical, orthopedic, spine, and facial surgical services at nontrauma centers have been associated with increased risk of “undertriage” in Medicare patients at some centers.¹⁴

Orthopedic injuries were the only injuries requiring a specialist protective against SO in the NTDB data set (OR = 0.60), which was also found in our statewide study. These injuries may be isolated to a single extremity and therefore be considered less life threatening.¹⁵ Furthermore, transferred orthopedic injuries may be more likely to require operative management and would therefore not meet criteria for SO. Finally, the vast majority of US hospitals (96%) have both an orthopedic surgeon and CT scanner at their disposal and are thus equipped to handle uncomplicated orthopedic injuries without the need for transfer.¹⁴ The availability of orthopedic surgeons at referring hospitals and the fact that operative management of orthopedic injuries excludes many patients from our analysis may contribute to the protective effect of orthopedic injuries against SO.

Among the injury types, those involving the spine had the highest association with transfers (OR = 2.29). This supports a recent study in which 42% of transfers with isolated spinal trauma without neurologic deficit were inappropriate, and 87% of such transfers were discharged directly from the receiving institution’s emergency department (ED).⁸ Neurosurgical injuries were also associated with increased risk of SO (OR = 2.10). This may reflect a lack of neurosurgical specialists at many EDs as it has been reported that fewer than 60% of one state’s EDs had on-call neurosurgical coverage.²¹ A paucity of available subspecialists and primary provider discomfort in assessing neurologic injuries may prevent differentiation between those with minor injuries and those with potentially devastating ones.

Radiology

Our analysis of the NTDB suggests that CT scans at the referring facility were protective against transfer (OR = 0.50). This is consistent with an earlier study of Canadian hospitals and our prior state-level study.^{13,15} There may be several explanations for the observed effect. A negative head CT for any pathology may enhance provider comfort in discharging the patient, and patients identified as transfer candidates may have had their imaging studies completed at the receiving facility. Furthermore, CT scans of head and abdomen were commonly obtained for SO patients after transfer,² and some patients were transferred because no radiologist was available to read the scans.²² Although most hospitals have a CT scanner, up to 82% of private hospitals rely on teleradiology for night shift coverage.^{14,23}

Continued maturation of teleradiology could enhance the comfort level of primary providers in discharging patients appropriately.

Conclusion

SO is associated with increased costs of patient care and strains the ability of trauma centers to care for the severely injured. Our study suggests that multiple factors contribute to SO, including provider and hospital characteristics, injury patterns, and also the patient's demographics and comorbidities. It appears that the common theme driving SO is inability to rule out a potentially devastating neurologic injury, either because of the injury pattern or because of neurologic impairment from alcohol or substance abuse.

Trauma education outreach programs might help decrease SO. The primary goals of the Rural Trauma Team Development Course are standardization of care and early identification of severely injured patients requiring prompt transfer. Additional training and resources may be required for some level 3 and 4 trauma centers to differentiate potentially serious neurologic injuries from minor ones. Telemedicine and teleradiology may help alleviate the effects of subspecialist shortage. Smith found that use of even rudimentary telemedicine decreased SO rates while improving patient care.²⁴ Others have reported that neurosurgical teleconsulting decreased the rate of unnecessary transfers of patients with neurologic injuries by 44%, while allowing consulting neurosurgeons to make recommendations for the care of patients who were not transferred.²⁵ Plastic surgery teleconsulting was shown to increase referring physicians' confidence in in-house management of injuries and access to specialty units at the receiving institution.²⁶

Our study has several limitations besides from being retrospective. First, data contribution to the NTDB is heavily skewed toward level 1 and level 2 trauma centers and is not representative of the nation as a whole. We therefore were unable to calculate a meaningful "national overtriage rate" to compare to the rate we obtained from our statewide study. Second, there may be patients transferred to level 1 trauma centers who did not come from level 3 and 4 trauma centers. We assume that are nondesignated trauma centers, and other referring facilities share similar characteristics with level 3 and 4 trauma centers in that they do not have all the resources to provide trauma care that a level 1 center does. It is hoped that our findings will help lead to the development of targeted intervention strategies to reverse patterns of unnecessary transfers, sparing patients with minor injuries financial hardship, and preserving trauma center resources for those who most need them.

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	<i>Transferred</i>	<i>Not Transferred</i>
Did not meet inclusion criteria* <i>N</i> = 473,081	A <i>N</i> =384,730	B <i>N</i> =88,351
Met inclusion criteria* <i>N</i> = 99,114	C <i>N</i> = 86,049	D <i>N</i> = 13,068

* Inclusion criteria: Adult trauma patients discharged home within 48 hours without undergoing a surgical procedure.

Equation 1: Historical SO Rate Calculation:

$$SO_{rate} = \frac{C}{C + A}$$

Equation 2: Alternate SO rate calculation:

$$SO_{rate} = \frac{C}{C + D}$$

Fig. 1.
Secondary overtriage rate calculation.

Fig. 2.
Secondary overtriage population.

Table 1

Univariate descriptive analysis of data set demographics.

Demographic	Not transferred	Transferred	Total
NTotal *	13,068 (13.2)	86,046 (86.8)	99,114
Age †	48 (30-65)	43 (27-59)	
Age > 65 *	3117 (23.9)	15,044 (17.5)	18,161 (18.3)
% Female *	4862 (37.2)	24,962 (29.0)	29,824 (30.1)
Race *			
White	10,178 (77.9)	64,541 (75.0)	74,719 (75.4)
Black	901 (6.9)	6571 (7.6)	7472 (7.5)
Other	614 (4.7)	10,262 (11.9)	10,876 (11.0)
Not known	1375 (10.5)	4672 (5.4)	6047 (6.1)
Government insurance *	4393 (33.62)	25,756 (29.93)	30,149 (30.4)
Self-payer *	2219 (16.98)	19,168 (22.28)	21,387 (21.6)
Unknown insurance *	959 (7.34)	13,218 (15.36)	14,177 (14.3)
Private insurance *	5497 (42.06)	27,904 (32.43)	33,401 (33.7)
ISS †	4 (2-9)	5 (4-10)	
ISS > 15 *	567 (4.3)	10,631 (12.4)	11,198 (11.3)
Glasgow Coma Score < 13 *	384 (3.3)	3488 (4.4)	3872 (4.3)
Systolic blood pressure < 90 *	147 (1.2)	439 (0.5)	586 (0.6)
Any CT *	4238 (32.4)	21,066 (24.5)	25,304 (25.5)
Head CT *	3730 (28.5)	17,989 (20.9)	21,719 (21.9)

All *P* values less than 0.0001.

* N (Percentage).

† Median (interquartile range).

Table 2

Univariate descriptive analysis of facility characteristics. *

Bed size	Not transferred	Transferred	Total
200	5278 (40.4)	1781 (2.1)	7059 (7.1)
201-400	5701 (43.6)	18,276 (21.2)	23,977 (24.2)
401-600	1610 (12.3)	29,206 (33.9)	30,816 (31.1)
>600	479 (3.7)	36,783 (42.8)	37,262 (37.6)

All *P* values less than 0.0001.

* N (Percent).

Table 3

Univariate regression analysis of the effect of patient comorbidities.

Comorbidity	Odds ratio	95% confidence interval	P value
Diabetes	0.788	(0.74-0.84)	<0.001
Current smoker	2.165	(2.02-2.32)	<0.001
Cerebrovascular accident/ residual neurologic deficit	1.085	(0.89-1.26)	0.536
Cirrhosis	1.425	(0.69-2.95)	0.340
Drug abuse/ dependence	2.95	(2.11-4.13)	<0.001
Major psychiatric illness	1.154	(0.94-1.42)	0.172
Alcoholism	1.472	(1.37-1.59)	<0.001

Table 4

Univariate descriptive analysis of injury characteristics.*

Injury type	Not transferred	Transferred	Total
Neurologic injury	3478 (26.6)	35,340 (41.1)	38,818 (39.2)
Vertebral injury	1184 (9.1)	14,241 (16.6)	15,425 (15.6)
Ortho injury	4641 (35.5)	18,199 (21.2)	22,840 (23.0)
Facial injury	3308 (25.3)	25,634 (29.8)	28,942 (29.2)
Other injury	7559 (57.8)	49,480 (57.5)	57,039 (57.6)

All *P* values less than 0.0001.*
N (Percent).

Table 5

Multivariate regression analysis of factors associated with transfer.

	Odds ratio	95% C.I.	P value
Female <i>versus</i> male	0.79	(0.75-0.82)	<0.0001
ISS > 15	2.48	(2.26-2.72)	<0.0001
Age > 65	0.67	(0.63-0.71)	<0.0001
Systolic blood pressure < 90	0.48	(0.39-0.59)	<0.0001
Government insurance <i>versus</i> private insurance	1.25	(1.19-1.32)	<0.0001
Self Payer <i>versus</i> private insurance	1.52	(1.44-1.61)	<0.0001
Unknown insurance <i>versus</i> private insurance	2.83	(2.62-3.05)	<0.0001
Head CT	0.49	(0.46-0.51)	<0.0001
Diabetes	0.92	(0.86-0.99)	0.0227
Current smoker	2.01	(1.90-2.19)	<0.0001
Alcoholism	1.09	(1.01-1.18)	0.0346
Drug abuse/dependence	1.95	(1.38-2.76)	0.0002
Neurologic injury	2.12	(2.02-2.22)	<0.0001
Vertebral injury	2.33	(2.18-2.49)	<0.0001
Facial injury	1.11	(1.06-1.16)	<0.0001
Orthopedic injury	0.59	(0.57-0.62)	<0.0001