

# HEALTHCARE UTILIZATION AND COSTS ASSOCIATED WITH BLUNT AND PENETRATING TRAUMA IN A UNITED STATES MANAGED CARE POPULATION

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## Introduction

Approximately 33.5 million persons in the United States (US) receive treatment for blunt or penetrating trauma each year; 1.3 million of these patients require hospitalization and more than 100,000 die as a result of their injuries.<sup>1</sup> As nearly one quarter of traumatic injuries are covered by managed care<sup>2</sup>, it is important to document the financial consequences of this public health problem to third party payors. No recent study has estimated the direct costs of blunt and penetrating trauma from a managed care perspective.

## Objectives

- Estimate per patient charges for resources utilized by managed care enrollees with inpatient admission for blunt or penetrating trauma.
- Assess incremental financial impact by comparing charges incurred during post-discharge medical encounters to those incurred prior to initial injury.

## Methods

### Study Design

Retrospective analysis of health insurance claims from a large US health plan.

### Data Source

i3 Innovus LabRx database: Enrollment, medical, and pharmacy claims for >24 million lives. All US regions represented, but predominantly Midwest and South.

### Inclusion Criteria

- Primary or non-primary ICD-9-CM diagnosis code consistent with blunt or penetrating trauma, including traumatic brain injury (TBI) or trauma to other body regions between 1/1/2003 and 2/1/2005
- TBI: ICD-9-CM codes, inclusive of 4<sup>th</sup> and 5<sup>th</sup> digits, 800–801.9, 803–804.9, and 850–854.1 regardless of mortality; 873.0–873.9, 905.0, and 907.0 for cases with death.<sup>3</sup>
- Trauma to other body regions: ICD-9-CM codes, inclusive of 4<sup>th</sup> and 5<sup>th</sup> digits, 802, 805–807, 808–809, 860–869, and 900–904.
- Diagnosis required during either inpatient admission or emergency department visit for which hospital admission followed.
- Continuous health plan enrollment for ≥6 months prior to and following initial hospital admission.

### Stratifying Measures

- Trauma type: (1) Isolated TBI; (2) other trauma with TBI (T+TBI); and (3) other trauma without TBI (T-TBI).
- Injury severity: ICDMAP-90 computer software<sup>4</sup> used to assign Injury Severity Score (ISS). ISS categories (1-9, 10-15, 16-24, and 25+) reflect increasing severity.
- Trauma center designation of hospital: Level I, II, III, IV, or “not a trauma center”; determined with linked data from American Hospital Association (AHA) database.

### Outcome Measures

- Per patient charges during 6-month period following initial injury; stratified by index hospitalization and post-discharge medical encounters (including subsequent hospitalizations, outpatient and other ancillary care, and pharmacy).
- Incremental financial impact of trauma: Difference between per patient charges incurred during 6-month period prior to initial injury and charges incurred during post-discharge medical encounters.

## Results

### Patient Characteristics (Table 1)

- 14,841 patients met all study inclusion criteria
- 3,028 (20.40%) had Isolated TBI, 2,726 (18.37%) had T+TBI, and 9,087 (61.23%) had T-TBI.
- T+TBI cohort had a lower mean age (37.53 years) and were more likely to be male (63.39%) compared to patients in the other cohorts.
- In T-TBI, majority (69.59%) had low severity injuries (ISS 1-9)
- In T+TBI cohort, 51.21% had severe (ISS 16-24) or critical (ISS 25+) injuries.
- T+TBI cohort had highest proportion of patients admitted to Level I or II trauma center (54.58%) and lowest proportion admitted to a non-trauma center (41.01%).
- More than half of all study subjects (50.70%) were admitted to a non-trauma center.

### Per patient charges (Tables 3 and 4, Figures 1 and 2)

- In patients with T+TBI, index hospitalization charges were more than three times (\$101,189) those incurred by patients with isolated TBI (\$30,333) and more than double those incurred by T-TBI patients (\$42,509).
- Outpatient and other ancillary services represented the majority of charges incurred for post-discharge medical encounters.
- Subsequent hospitalization charges varied within a narrow range (\$2,847 to \$6,981) across cohorts regardless of trauma center level.
- Outpatient and ancillary charges were substantial and ranged from \$6,485 to \$15,727, with non-trauma centers consistently having the highest charges.
- Pharmacy charges were modest compared to hospital and outpatient charges (\$566-\$1,237), with trauma centers and non-trauma centers having similar charges.
- Overall, charges for post-discharge care were \$9,362 higher per patient than charges incurred over the entire 6-month period prior to initial injury.
- The difference in pre- to post-injury charges, excluding index hospitalization, was greatest (\$17,720) among T+TBI patients.
- T+TBI nearly quintupled (+489%) total healthcare charges when examining incremental charges from 6 months pre- to 6 months post-injury.

Table 3. Mean Total Charges per Patient by Study Cohort

Study Cohort	Index Hospitalization	Post-Discharge Medical Encounters		
		Subsequent Hospitalizations	Outpatient & Other Ancillary	Pharmacy
All Patients	\$50,803	\$5,990	\$10,950	\$964
Isolated TBI	\$30,333	\$4,606	\$7,658	\$764
T+TBI	\$101,189	\$6,018	\$14,599	\$726
T-TBI	\$42,509	\$6,443	\$10,952	\$1,102

Table 4. Pre- to Post-Injury Mean Total Charges

Study Cohort	Total	Inpatient Services*	Outpatient & Other Ancillary	Pharmacy
<b>6 Months Pre-Injury</b>				
All Patients	\$8,542	\$3,215	\$4,558	\$770
Isolated TBI	7,747	3,475	3,598	673
T+TBI	3,623	867	2,209	548
T-TBI	10,283	3,833	5,582	868
<b>Post-Discharge (≤6 months)†</b>				
All Patients	\$17,904	\$5,990	\$10,950	\$964
Isolated TBI	13,028	4,606	7,658	764
T+TBI	21,343	6,018	14,599	726
T-TBI	18,497	6,443	10,952	1,102

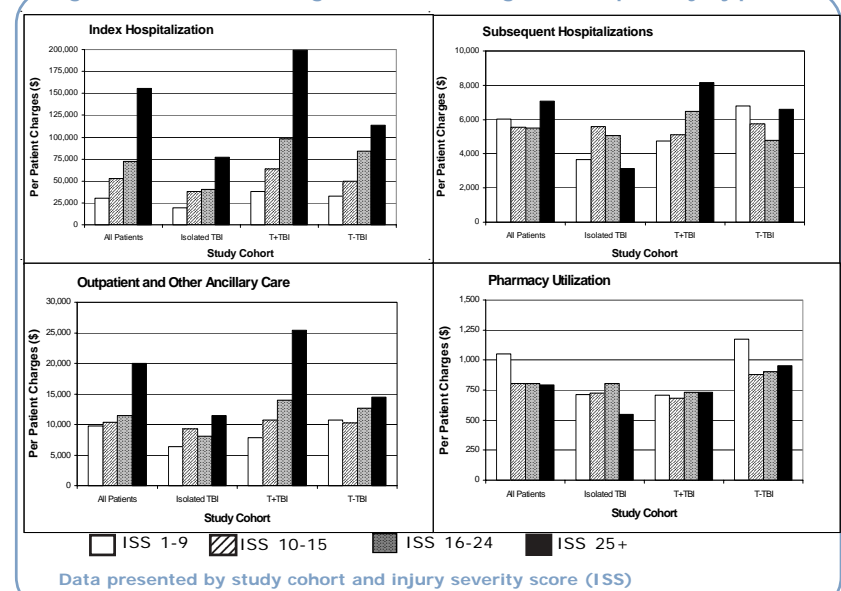
### Increase

All Patients	\$9,362 (+110%)	\$2,775 (+86%)	\$6,392 (+140%)	\$194 (+25%)
Isolated TBI	5,281 (+68%)	1,131 (+33%)	4,060 (+113%)	91 (+14%)
T+TBI	17,720 (+489%)	5,151 (+594%)	12,390 (+561%)	178 (+32%)
T-TBI	8,214 (+80%)	2,610 (+68%)	5,370 (+96%)	234 (+27%)

Data presented by Study Cohort

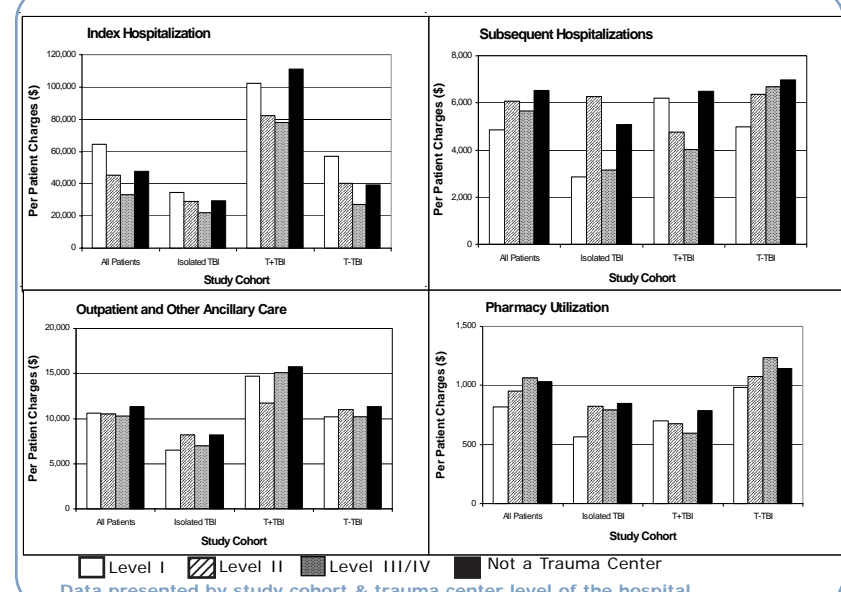
\*Excludes index hospitalization; †Data for inpatient services, outpatient & other ancillary, and pharmacy from Table 3.

Figure 1: Mean total charges incurred during 6-month post-injury period



Data presented by study cohort and injury severity score (ISS)

Figure 2: Mean total charges incurred during 6-month post-injury period



Data presented by study cohort & trauma center level of the hospital

Table 1. Characteristics of the Study Sample

Characteristic	Study Cohort							
	All Patients (N = 14,841; 100%)		Isolated TBI (N = 3,028; 20.40%)		T+TBI (N = 2,726; 18.37%)		T-TBI (N = 9,087; 61.23%)	
	N	%	N	%	N	%	N	%
<b>Age Category</b>								
< 18	2,226	15.00	879	29.03	498	18.27	849	9.34
18 – 39	3,922	26.43	780	25.76	985	36.14	2,157	23.73
40 – 59	4,547	30.63	674	22.26	880	32.29	2,993	32.94
60 – 79	2,511	16.92	426	14.07	256	9.39	1,829	20.13
≥ 80	1,635	11.02	269	8.88	107	3.93	1,259	13.85
Mean Age (Years)	45.35		38.17		37.53		50.09	
<b>Gender</b>								
Female	6,455	43.49	1,270	41.94	997	36.57	4,188	46.09
Male	8,383	56.49	1,758	58.06	1,728	63.39	4,897	53.89
Missing	3	0.02	0	0.00	1	0.04	2	0.02

### Injury Severity Score (ISS)

1-9	8,569	57.74	1,633	53.93	612	22.45	6,324	69.59
10-15	2,022	13.62	224	7.40	594	21.79	1,204	13.25
16-24	2,319	15.63	871	28.76	811	29.75	637	7.01
25+	1,096	7.38	113	3.73	585	21.46	398	4.38
Unable to Score	835	5.63	187	6.18	124	4.55	524	5.77
Mean ISS	10.88		10.06		18.28		8.90	

### Trauma Level of Admitting Hospital

I	3,708	24.98	799	26.39	997	36.57	1,912	21.04
II	2,766	18.64	560	18.49	491	18.01	1,715	18.87
III/IV	791	5.33	147	4.85	109	4.00	535	5.89
Trauma Ctr,	51	0.34	19	0.63	11	0.40	21	0.23
Level Unknown								
Not Trauma Ctr	7,525	50.70	1,503	49.64	1,118	41.01	4,904	53.97

### Index Hospitalization (Table 2)

- Mean LOS and ICU days were highest (25.38 and 12.82 days, respectively) among the most critically injured patients (T+TBI with ISS 25+).
- LOS and ICU days generally decreased from Level I to Level III/IV trauma centers.
- Addition of TBI to critical injuries (T+TBI and ISS 25+) more than doubled both mean LOS (11.59 to 25.38; +119%) and ICU days (5.52 to 12.82; +132%)

Table 2. Descriptive Summary of Index Hospitalization

	Study Cohort							
	All Patients		Isolated TBI		T+TBI		T-TBI	
	Mean LOS	Mean ICU Days	Mean LOS	Mean ICU Days	Mean LOS	Mean ICU Days	Mean LOS	Mean ICU Days
All Patients	7.82	2.58	5.16	1.73	13.02	5.95	7.15	1.85
<b>ISS at Initial Injury</b>								
1-9	5.56	1.14	3.56	0.77	5.46	1.81	6.08	1.17
10-15	7.60	2.28	5.42	1.21	7.63	2.95	7.99	2.15
16-24	10.43	4.60	6.97	3.08	13.06	5.94	11.81	4.97
25+	20.09	9.78	11.59	5.52	25.38	12.82	14.74	6.53
Unable to Score	8.29	2.97	6.48	2.20	17.63	8.54	6.73	1.94
<b>Trauma Center Level</b>								
I	8.32	3.23	4.99	1.81	11.77	5.77	7.92	2.50
II	7.37	2.35	5.14	1.69	11.67	5.19	6.87	1.76
III/IV	5.90	1.44	4.14	1.12	9.91	4.47	5.56	0.91
Trauma Ctr (Level Unk)	7.63	3.94	3.26	1.58	12.45	7.73	9.05	4.10
Not Trauma Ctr	7.95	2.45	5.37	1.77	15.05	6.59	7.12	1.71

Data presented by Study Cohort, ISS, and Trauma Level of Admitting Hospital

## Limitations

- ICD-9-CM diagnosis codes, if recorded inaccurately, may have caused some patients to be misidentified as having trauma or to be misclassified by ISS.
- Data are from a single health plan; generalizability of results to national managed care is therefore uncertain.
- Cost data represent charges rather than actual payments.
- Discharge status and external injury cause codes (E-codes) are unreliably recorded in the LabRx database; therefore unable to provide additional context.

## Conclusions

- The direct economic burden of blunt and penetrating trauma to third-party payors is substantial
- Sig. higher charges are associated with combined TBI and other trauma (T+TBI), especially among patients with high severity injuries.
- TBI contributes dramatically to trauma patients' injury severity, whether alone or in combination with other trauma.
- Results of this study provide insight regarding the degree to which trauma systems are functioning in a managed care environment.

## References

1. Finkelstein EA et al. Oxford University Press: 2006.
2. NTDB Annual Report 2005 (V 5.0). American College of Surgeons: 2005.
3. Thurman DJ et al. Atlanta, GA: Centers for Disease Control and Prevention (CDC): 1995.
4. The Johns Hopkins University and Tri-Analytics, Inc. ICDMAP-90 Baltimore, MD: 1998.