Published in final edited form as:
J Trauma Acute Care Surg. 2012 February ; 72(2): 385–389. doi:10.1097/TA.0b013e3182411c67.

Do inclusive trauma systems improve outcomes following renal trauma?

Alex J. Vanni, MD[1], **Jim Hotaling, MD, MS**[1], **Christian Hamlat, MD, MS**[2], **Gregory J. Jurkovich, MD**[2], and **Bryan B. Voelzke, MD**[1,†]

Alex J. Vanni: alexvanni@gmail.com; Jim Hotaling: hojame@uw.edu; Christian Hamlat: chamlat@uw.edu; Gregory J. Jurkovich: jerryj@uw.edu; Bryan B. Voelzke: voelzke@uw.edu

[1]Department of Urology, University of Washington School of Medicine, Harborview Injury Prevention and Research Center

[2]Department of Surgery, University of Washington School of Medicine, Harborview Injury Prevention and Research Center

Abstract

Background—Our aim is to assess state variation in renal trauma outcomes. We hypothesize that states with more hospitals participating in a trauma system will have lower nephrectomy and mortality rates.

Methods—The Heathcare Cost and Utilization Project State Inpatient Database was utilized to conduct a retrospective cohort study of all patients hospitalized with renal injury from partnering states during 2001, 2004, and 2007. State trauma systems were categorized based on the proportion of all acute care hospitals designated as a trauma center (level I-V), with higher proportions correlating to a more inclusive system. Poisson regression for relative risks of inpatient nephrectomy and case fatality were performed adjusting for patient and state level factors.

Results—Patients in states with the "most inclusive" trauma systems had a 30% lower risk of nephrectomy (RR 0.70 95% CI 0.56, 0.88) and a 2.06% lower unadjusted inpatient case fatality rate compared to states with "exclusive" trauma systems. Inpatient case fatality risk varied significantly by trauma system inclusiveness. Patients treated in states with either a "more inclusive" (RR 0.85, 95% CI 0.74, 0.97) or "most inclusive" (0.74, 95% CI 0.64, 0.85) trauma system were independently associated with a lower inpatient case fatality risk compared to states with "exclusive" systems.

Conclusions—A reduced risk of nephrectomy and inpatient case fatality are more common among states that have a higher proportion of acute care hospitals participating as a trauma center (level I-V). Standardization of care may correlate with improved patient outcomes following renal trauma.

Keywords

renal trauma; nephrectomy; outcomes; tiered delivery of trauma care

---

Corresponding Author: Bryan B. Voelzke, MD, Department of Urology, Harborview Medical Center at the University of Washington, 325 9th Ave, Box 359868, Seattle, WA 98104, Voelzke@uw.edu, Tel: 206-744-6384, Fax: 206-744-4709.

†This publication was made possible by Grant Number KL2 RR025015 from the National Center for Research Resources (NCRR), a component of the National Institutes of Health (NIH). Its contents are solely the responsibility of the authors and do not necessarily represent the official view of NCRR or NIH.

This paper was presented at the American Association for the Surgery of Trauma on September 14, 2011 (annual meeting; Chicago, IL; poster presentation).

NIH-PA Author Manuscript
NIH-PA Author Manuscript

Introduction

The incidence of renal injury after trauma is 4.9 per 100,000 persons, with a frequency of 1.2% to 3% in population-based studies[1, 2]. Blunt and penetrating renal injury collectively results in approximately 14,000 patients being hospitalized each year, with the vast majority of these injuries a result of a blunt etiology[3]. Renal trauma management has become increasingly conservative, with even high-grade injuries being managed successfully without operative intervention[4-7].

The degree of variation in healthcare practice has gained greater scrutiny due to its direct relationship to overall healthcare costs and quality[8-10]. Although general guidelines exist for the management of traumatic renal injuries, no data exists concerning variation among states in the delivery of renal trauma care. The treatment of renal trauma is likely subject to the same variation seen in the management of other diseases despite generally agreed upon management strategies[2, 11].

Trauma systems are an organized, coordinated effort with the local public health system to deliver the full range of care to injured patients in a given geographic region. The American College of Surgeons (ACS)-Committee on Trauma (COT) has published a guide to improve trauma systems and improve the care of injured patients[12]. Inclusive trauma systems encourage regionalization of trauma care by creating a tiered delivery of trauma care. Studies have shown that such systems are associated with greater inpatient survival for severely injured trauma patients compared to those treated in states with few high-level trauma centers (i.e., an exclusive trauma system)[13]. While tiered delivery of trauma care decreases injury-related morbidity and mortality, diversity exists in the number of hospitals that participate in such systems[14-16]. Although evaluation of organized trauma systems has shown improved survival for severely injured patients, it is unclear if similar improvements in morbidity and mortality are seen in patients hospitalized with traumatic renal injury.

The Healthcare Cost and Utilization Project-State Inpatient Database (HCUP-SID) collaborates with states to provide index hospitalization data from all participating hospitals within a respective state. We performed an exploratory analysis to quantify the variation of trauma-related nephrectomy and inpatient case fatality rates among participating states to assess state-variation in renal trauma care. We hypothesize that states with more hospitals participating in a trauma system (inclusive trauma system) will have lower nephrectomy and mortality rates in hospitalized patients with traumatic renal injury.

Materials and Methods

Study Design

We performed a retrospective cohort study of hospitalized patients with traumatic renal injuries (ICD9-CM 866.00-866.19) using the HCUP-SID from selected states during 3 years: 2001, 2004, and 2007. Respective hospitals in the database provided the incident exposure. Nephrectomy (ICD9-CM Procedure Code 55.5) was the primary outcome. Secondary outcomes were inpatient mortality.

Trauma Center Definition

A trauma center is a hospital that is designated by a state/local authority or is verified by the American College of Surgeons. Three to five levels of trauma care are possible, with the lowest number being the most acute and the highest number being the least acute. Level I-III tiered hospitals are possible in all states; however, some states have additional less acute designations (IV-V or V). Level I trauma centers provide the most acute and comprehensive trauma care by having specialties in all fields on call 24 hours a day. Level II trauma centers supplement a level I center by having of all specialties available. Level III and beyond trauma centers do not have full availability of specialists and have transfer agreements with higher trauma centers for severe injuries.

Data Sources

The HCUP-SID was utilized to obtain data on all patients who sustained renal injury and were subsequently hospitalized in 21 partnering states during 2001, 2004, and 2007. The HCUP-SID is sponsored by the Agency for Healthcare Research and Quality and encompasses approximately 90% of all community hospital discharges, making it the largest collection of longitudinal hospital care data in the United States. It contains a core set of clinical and non-clinical information on all patients during their index hospitalization, including persons covered by Medicare, Medicaid, private insurance, and the uninsured. We included only states where HCUP hospital identifiers were included that allowed hospital identification and classification.

The SID encompasses all inpatient discharge abstracts from participating states: 13 states in 2001, 21 in 2004, and 16 in 2007. De-identified data provides a core set of clinical and nonclinical variables on all patients. States that did not have hospital-specific identifiers were excluded.

Each patient's Injury Severity Score (ISS) and Organ System Abbreviated Injury Score (AIS) was calculated using ICD-9 diagnosis codes per previously described techniques and commercially available software[17-19]. ICD-9 renal injury codes were not converted to AAST renal grades. Hospital specific variables included teaching status and urban vs. rural location. They were assigned as defined by the Healthcare Cost and Utilization Project Nationwide Inpatient Sample database[20]. Patient covariates for analysis included: age, blunt vs. penetrating injury mechanism (using ICD9-CM E Codes recorded in SID), sex, insurance status, ISS, presence of pre-existing medical comorbidities (congestive heart failure, peripheral vascular disease, chronic lung disease, diabetes mellitus with/without complications, liver disease, coagulopathy, and hypertension),) and AIS scores including head, chest, face and neck, abdominal, spine and extremity.

Data Analysis

A Poisson regression model was used to calculate relative risk of nephrectomy and inpatient mortality. Poisson regression yields adjusted relative risk (not odds ratio) estimates for relatively common outcomes such as nephrectomy where logistic models break down [21].

We accounted for hospital clustering and calculated robust standard error estimates. Based on prior studies and univariate analysis of this dataset, a base model was formed that included: age (<15, 15 to 29, 30 to 44, 45 to 59, 60 to 74, 75+), ISS (<10,10 to 15, 16 to 24, 25+), year of hospitalization (2001, 2004, 2007), high (AAST IV & V) or low (AAST I-III) grade injuries and mechanism of injury (blunt vs. penetrating)[22, 23]. The following covariates were then assessed as potential confounders: abdominal AIS, head AIS, hospital teaching status (teaching vs. non) and hospital location (rural vs. urban). Stepwise and hierarchical model selection was performed, with each covariate added to the base model and a measurement made of the percent change in RR for each exposure group (state). Age, year, mechanism, ISS, Abdominal AIS, and hospital teaching status were retained in the final regression model. The mortality model also included the number of pre-existing medical comorbidities (none, 1, 2+) and primary insurance (Medicare, Medicaid, private, self pay, no charge, other).

A p value <0.05 was considered statistically significant. Stata 11.0 was used for all analysis (Stata Corp., College Station, TX).

To assess the impact of state trauma system inclusiveness on outcomes, states were sorted into tertiles labeled “exclusive systems”, “more inclusive” and “most inclusive” based upon the proportion of hospitals designated as a trauma center of any level that participated in a trauma system (0-13%, 14-37%, and 38-100%, respectively). This was based upon work done by Utter and colleagues, who used the 2001 dataset for this definition[13]. Poisson regression for relative risks of nephrectomy and inpatient mortality was performed with trauma system inclusiveness as the primary exposure variable and multivariate adjustment performed as previously described.

An exemption from the University of Washington IRB was obtained prior to study initiation (#39251).

Results

14,590 patients were hospitalized with a traumatic renal injury. 73% were male with a mean age of 35 and an average ISS of 14 (Table 1).

Unadjusted inpatient nephrectomy rates varied from 5.8% in “exclusive” trauma systems to 4.0% in “most inclusive” systems (Table 2). “Most Inclusive” trauma systems had a 2.06% lower unadjusted inpatient case fatality rate compared to “exclusive” systems (Table 3).

A multivariate analysis was performed to assess risk factors that correlate renal trauma outcome and statewide trauma system inclusiveness. States with the “most inclusive” trauma systems had a 30% lower risk of nephrectomy (RR 0.70, 95% CI 0.56, 0.88) compared to states with “exclusive” trauma systems. There was a decreasing trend for nephrectomy in “more inclusive” trauma systems compared to “exclusive” systems (Table 2).

Inpatient case fatality risk varied by trauma system inclusiveness. Being treated in states with either a “more inclusive” (RR 0.85, 95% CI 0.74, 0.97) or “most inclusive” (RR 0.74, 95% CI 0.64, 0.85) trauma system was independently associated with a lower inpatient case fatality risk compared to states with “exclusive” systems (Table 3).

We analyzed if stratifying trauma etiology by blunt or penetrating was important for outcome. Patients with penetrating renal trauma treated in a “most inclusive” trauma system had a 20% (RR 0.80, 95% CI 0.64, 1.00) lower risk of nephrectomy compared to states with “exclusive” systems. Inpatient fatality following penetrating renal trauma did not correlate with trauma system inclusiveness (Tables 4, 5). Patients with blunt renal injuries had a significantly reduced risk of inpatient fatality if treated in states with either a “more inclusive” or “most inclusive” trauma system (RR 0.81 and 0.71 respectively) (Tables 4, 5).

Discussion

Tiered delivery of trauma care has been shown to decrease injury related morbidity and mortality[14-16]. Severely injured trauma patients treated at inclusive trauma systems have 23% lower odds of death compared to those treated in regions with few high-level trauma centers (exclusive trauma system)[13]. Similar differences in outcomes with regards to traumatic splenic injury exists[23].

Our study is the first to demonstrate that patients hospitalized at “inclusive” trauma systems following traumatic renal injuries have significantly decreased nephrectomy rates and improved overall survival. Additionally, when admitted to a hospital with increasing trauma system “inclusiveness”, a graded effect was noted in terms of overall survival benefit for patients admitted with any type of traumatic renal injury. Similarly, evaluation of patients with blunt renal injuries demonstrated considerable variation in outcomes based on state inclusivity. Patients treated in the “most inclusive” states had a significantlydecreased risk of a trauma-related nephrectomy and death compared to those treated in “exclusive” states. These results are surprising given the vast majority of blunt renal injuries are managed non-operatively.

While general guidelinesexist for the management of renal trauma, our data suggests tremendous state variability in the treatment and outcomes of traumatic renal injuries. It is impossible to determine why a decreased risk of nephrectomy and improved survival was found with increasing trauma system inclusiveness; however, there are a number of possible explanations. Hospital and state specific differences in trauma management have previously been shown to be important for success. “Inclusive” trauma systems designate a large number of hospitals as a trauma center, with cooperation between rural and urban hospitals thought to be critical for success[24]. It may be that severely injured patients are transferred from referring hospitals earlier in inclusive systems, resulting in improved outcomes. Additionally, differences in triage guidelines, transfer agreements, communication systems, transport guidelines, a trauma registry, medical audit processes, and performance improvement programs all likely play arole in overall patient outcomes.

While the majority of renal injuries are managed conservatively, variability in any individual surgeon’s management of high-grade traumatic renal injury may potentially lead to different outcomes. For example, trauma experience, access to diagnostic and therapeutic angiography, access to trauma experts for multi-organ injuries, and level of nursing acuity of the dominant state or regional trauma center can influence renal injury management strategies (i.e., conservative management, angiography/embolization, or surgery). Consequently, nephrectomy rates and overall survival may vary dramatically depending on the individual provider’s decision making. Our results support standardization of renal trauma protocols.

There are limitations to our study. Traumatic renal injury outcomes are best described by AAST grade, as evidence exists that as the grade of injury increases, the rate of nephrectomy does as well[25]. However, traumatic renal injuries are coded in the HCUP database by ICD-9 code. These can be converted to AIS scores, but the codes do not translate well to AAST grade. We accounted for differences in renal injury severity by assigning a high-grade injury to those with the ICD9 code for “complete disruption of kidney parenchyma”. This may be an imprecise way to separate high and low grade injuries; however, by assigning high grade renal injuries to the most extreme renal injuries, we sought to identify patients who may benefit most from management at an “inclusive” trauma system. Despite this, multivariate analysis did not reveal a difference in nephrectomy risk or mortality based on severity of renal injury in any trauma system (data not shown).

Another limitation is that the definition of “inclusive” and “exclusive” trauma systems is arbitrary. While the trauma system components highlighted by the ACS-COT may prove to be a superior definition of an inclusive system, we chose this designation based on previously published trauma data[12, 13]. This classification system allows us to compare systems at the top and bottom of inclusiveness without diluting the data for comparison with superfluous break points. While the number of hospitals participating in a state’s trauma system is one way of measuring “inclusiveness”, there are multiple factors responsible for quality outcomes in “inclusive” systems. Further study is warranted to determine the optimal standards and processes of an “inclusive” trauma system highlighted by the ACS-COT, such as triage guidelines, transfer agreements, communication system, transport guidelines, a trauma registry, medical audit processes, and performance improvement programs[12].

Effort was taken to minimize confounding variables that could impact our outcomes. We adjusted for ISS, abdominal AIS, head AIS, mechanism of trauma, payer status, grade of renal injury, teaching hospital status, and medical comorbidities. It is possible that despite these efforts, other explanations for our data may exist. We acknowledge that our data may be confounded by unmeasured variables that either led to nephrectomy or death.

There is inadequate reporting of the reason for nephrectomy in the HCUP dataset and the temporal relationship at which this occurs during the hospitalization. It is possible that some hospitals may lack Interventional Radiology capacity and experience to perform angioembolization, resulting in early operative intervention where the risk of nephrectomy is increased. Also, it may be that some of these patients had failed angioembolization leading to subsequent nephrectomy. Unfortunately, the answer to these questions cannot be answered with this dataset. It is also impossible to determine the number of nephrectomies in our dataset that were a result of damage control secondary to more urgent concomitant injuries. We sought to minimize this potential confounder by adjusting our multivariate model for ISS, head AIS, and abdominal AIS scores.

Lastly, we do not have any data on these patients following index hospitalization and cannot comment on long-term sequelae after discharge. To answer questions about renal trauma outcomes following discharge, multi-institutional study is required, as national datasets are poorly equipped.

Despite these limitations, the HCUP dataset offers considerable strengths. The HCUP dataset provides information that cannot be attained from other datasets such as the National Trauma Data Bank (NTDB). The NTDB is the largest trauma registry, but is limited to trauma centers. In contrast, HCUP is the largest longitudinal care dataset in the country, providing in-depth medical data on all community and teaching hospitals. Therefore, this is the only data set available to compare state-to-state variation in trauma outcomes pertaining to all hospitals.

Each state independently decides their level of trauma care coordination. As such, HCUP provides geographically diverse data, allowing examination of regional variation in traumatic renal outcomes. Further analysis of trauma systems and regional variation of traumatic renal injuries is required to further standardize management of renal injury with the aim of improving outcomes.

Conclusions

A reduced risk of nephrectomy and a lower inpatient case fatality rate are more common among states that have a higher proportion of acute care hospitals participating in tiered trauma care (level I-V). Further development of statewide inclusive trauma centers and standardization of care may correlate with improved patient outcomes following renal trauma.

All authors of this manuscript provided substantive efforts to allow analysis and publication of findings.

References

1. Wessells H, Suh D, Porter JR, et al. Renal injury and operative management in the United States: results of a population-based study. J Trauma. 2003; 54:423. [PubMed: 12634519]
2. Santucci RA, Wessells H, Bartsch G, et al. Evaluation and management of renal injuries: consensus statement of the renal trauma subcommittee. BJU Int. 2004; 93:937. [PubMed: 15142141]

3. Voelzke BB, McAninch JW. The current management of renal injuries. Am Surg. 2008; 74:667. [PubMed: 18705565]

4. Danuser H, Wille S, Zoscher G, et al. How to treat blunt kidney ruptures: primary open surgery or conservative treatment with deferred surgery when necessary? Eur Urol. 2001; 39:9. [PubMed: 11173932]

5. Hammer CC, Santucci RA. Effect of an institutional policy of nonoperative treatment of grades I to IV renal injuries. J Urol. 2003; 169:1751. [PubMed: 12686825]

6. Matthews LA, Smith EM, Spirnak JP. Nonoperative treatment of major blunt renal lacerations with urinary extravasation. J Urol. 1997; 157:2056. [PubMed: 9146579]

7. Roberts RA, Belitsky P, Lannon SG, et al. Conservative management of renal lacerations in blunt trauma. Can J Surg. 1987; 30:253. [PubMed: 3607638]

8. Fisher ES, Wennberg DE, Stukel TA, et al. The implications of regional variations in Medicare spending. Part 1: the content, quality, and accessibility of care. Ann Intern Med. 2003; 138:273. [PubMed: 12585825]

9. Fisher ES, Wennberg DE, Stukel TA, et al. The implications of regional variations in Medicare spending. Part 2: health outcomes and satisfaction with care. Ann Intern Med. 2003; 138:288. [PubMed: 12585826]

10. Sirovich BE, Gottlieb DJ, Welch HG, et al. Variation in the tendency of primary care physicians to intervene. Arch Intern Med. 2005; 165:2252. [PubMed: 16246991]

11. Corso P, Finkelstein E, Miller T, et al. Incidence and lifetime costs of injuries in the United States. Inj Prev. 2006; 12:212. [PubMed: 16887941]

12. Regional trauma systems: Optimal elements, integration, and assessment. Systems Consultation Guide. American College of Surgeons-Committee on Trauma. 2008:1–66.

13. Utter GH, Maier RV, Rivara FP, et al. Inclusive trauma systems: do they improve triage or outcomes of the severely injured? J Trauma. 2006; 60:529. [PubMed: 16531850]

14. Mann NC, Mullins RJ, MacKenzie EJ, et al. Systematic review of published evidence regarding trauma system effectiveness. J Trauma. 1999; 47:S25. [PubMed: 10496607]

15. Nathens AB, Jurkovich GJ, Cummings P, et al. The effect of organized systems of trauma care on motor vehicle crash mortality. JAMA. 2000; 283:1990. [PubMed: 10789667]

16. Nathens AB, Jurkovich GJ, Rivara FP, et al. Effectiveness of state trauma systems in reducing injury-related mortality: a national evaluation. J Trauma. 2000; 48:25. [PubMed: 10647561]

17. MacKenzie EJ, Steinwachs DM, Shankar B. Classifying trauma severity based on hospital discharge diagnoses. Validation of an ICD-9CM to AIS-85 conversion table. Med Care. 1989; 27:412. [PubMed: 2649755]

18. MacKenzie, EJS.; D, M.; Shankar, BS. An ICD-9CM to AIS conversion table; development and application. Presented at the American Association of Automotive Medicine. Proceedings, 30th Annual Conference; Montreal, Quebec. 1986.

19. Long WB, Sacco WJ, Copes WS, et al. An evaluation of expert human and automated Abbreviated Injury Scale and ICD-9-CM injury coding. J Trauma. 1994; 36:499. [PubMed: 8158710]

20. AHRQ: HCUP NIS Description of Data Elements. 2009; 2009

21. McNutt LA, Wu C, Xue X, et al. Estimating the relative risk in cohort studies and clinical trials of common outcomes. Am J Epidemiol. 2003; 157:940. [PubMed: 12746247]

22. Hotaling JM, Sorensen MD, Smith TG 3rd, et al. Analysis of diagnostic angiography and angioembolization in the acute management of renal trauma using a national data set. J Urol. 2011; 185:1316. [PubMed: 21334643]

23. Hamlat CA, Arbabi S, Koepsell TD, et al. National Variation in Outcomes and Costs for Splenic Injury and the Impact of Trauma Systems. Annals of Surgery. accpeted for publication, in press.

24. Position paper on trauma care systems. J Trauma; Third National Injury Control Conference; April 22-25, 1991; Denver, Colorado. 1992. p. 127

25. Santucci RA, McAninch JW, Safir M, et al. Validation of the American Association for the Surgery of Trauma organ injury severity scale for the kidney. J Trauma. 2001; 50:195. [PubMed: 11242281]

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 1

Patient Characteristics

Characteristic		Measure
N		14,590
Mean age in years (SD)		35 (.17)
Female (%)		25.3
Blunt Mechanism (%)		90.1
Mean ISS (SD)		14.6 (.09)
Comorbidities* (%)		
	None	77.9
	1	16.4
	2+	5.7
Abdominal AIS (%)		
	2	79.5
	3	5.6
	4	11.3
	5	3.6
Renal Injury Severity (%)		
	High Grade	4.1
	Low Grade	95.9

*congestive heart failure, peripheral vascular disease, chronic lung disease, diabetes mellitus with or without complications, liver disease, coagulopathy, and hypertension

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 2

Inpatient Overall Case Nephrectomy Rate Differences by Trauma System Inclusiveness

	Nephrectomy (%)			Relative Risk		
Trauma System	**No**	**Yes**	**Total (N)**	**RR[#]**	**95% CI**	
Exclusive[*]	4652 (94)	285 (5.8)	4937	Ref	Ref	Ref
More Inclusive[**]	6292 (95)	366 (5.5)	6658	0.80	0.80	1.04
Most Inclusive[***]	2827 (96)	118 (4.0)	2945	0.70	0.56	0.88
Total	13,771 (95)	769 (5.3)				

[*] State list: FL, MA, NC, NV, RI, UT, AR, ME

[**] State list: AZ, CA, KY, MD, NJ, NY, VT, WV, MI

[***] State list: CO, IA, OR, WA, WI, SC

[#] Adjusted for Age, ISS, Year, Renal injury severity, Comorbidity, Mechanism, Head AIS, Teaching hospital, Insurance

Table 3

Inpatient Overall Case Fatality Differences by Trauma System Inclusiveness

	Died (%)			Relative Risk		
Trauma System	**No**	**Yes**	**Total (N)**	**RR[#]**	**95% CI**	
Exclusive[*]	93.86	6.14	4,935	Ref	Ref	Ref
More Inclusive[**]	95.04	4.96	6,654	0.85	0.74	0.97
Most Inclusive[***]	95.92	4.08	2,944	0.74	0.64	0.85
Total	94.82	5.18	14,533			

[*] State list: FL, MA, NC, NV, RI, UT, AR, ME

[**] State list: AZ, CA, KY, MD, NJ, NY, VT, WV, MI

[***] State list: CO, IA, OR, WA, WI, SC

[#] Adjusted for Age, ISS, Year, Renal injury severity, Comorbidity, Mechanism, Head AIS, Teaching hospital, Insurance

NIH-PA Author Manuscript
NIH-PA Author Manuscript

Table 4

Inpatient Case Nephrectomy Rate Differences by Trauma System Inclusiveness in Patients Stratified by Trauma Mechanism

	Penetrating			Blunt		
Trauma System	**RR#**	**95% CI**		**RR#**	**95% CI**	
Exclusive*	Ref	Ref	Ref	Ref	Ref	Ref
More Inclusive**	0.93	0.77	1.13	0.90	0.76	1.07
Most Inclusive***	0.80	0.64	1.00	0.69	0.52	0.92

*State list: FL, MA, NC, NV, RI, UT, AR, ME

**State list: AZ, CA, KY, MD, NJ, NY, VT, WV, MI

***State list: CO, IA, OR, WA, WI, SC

#Adjusted for Age, ISS, Year, Renal injury severity, Comorbidity, Mechanism, Head AIS, Teaching hospital, Insurance

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 5

Inpatient Case Fatality Rate Differences by Trauma System Inclusiveness in Patients Stratified by Trauma Mechanism

	Penetrating			Blunt		
Trauma System	RR#	95% CI		RR#	95% CI	
Exclusive*	Ref	Ref	Ref	Ref	Ref	Ref
More Inclusive**	1.12	0.74	1.69	0.81	0.70	0.93
Most Inclusive***	0.99	0.59	1.66	0.71	0.63	0.80

*State list: FL, MA, NC, NV, RI, UT, AR, ME

**State list: AZ, CA, KY, MD, NJ, NY, VT, WV, MI

***State list: CO, IA, OR, WA, WI, SC

#Adjusted for Age, ISS, Year, Renal injury severity, Comorbidity, Mechanism, Head AIS, Teaching hospital, Insurance