Supplementary Online Content

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This supplementary material has been provided by the authors to give readers additional information about their work.

eAppendix. Sample Report Card

SMARTT

Survival Measurement and Reporting Trial for Trauma

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BACKGROUND

The Survival Measurement and Reporting Trial for Trauma (SMARTT) is designed to determine whether providing hospitals with non-public (confidential) information on their risk-adjusted mortality will lead to improved population outcomes. The goal of SMARTT is to inform the development of policies designed to improve the quality of trauma care through the establishment of a national population-based Trauma Report Card. Currently, there is no national report card for measuring the quality of trauma care at individual hospitals. Such a National Trauma Report Card is intended to serve as a catalyst for improving short- and long-term outcomes for trauma patients.

The SMARTT outcomes report is based on the National Trauma Databank. The NTDB contains outcomes data on nearly 3 million patients from nearly 80% of Level I and 70% of Level II trauma centers in the United States. Because your hospital had consistently provided good data to the NTDB, your hospital is one of approximately 125 centers initially selected to receive an annual report on your risk-adjusted mortality comparing. Your performance will be compared to that of other centers included in this study. Both the study investigators and the American College of Surgeons will be blinded to the identity of your hospital. The research consortium will only have access to encrypted hospital identifiers. The ACS will be responsible for sending out the report cards but will not view the content of the individual hospital report cards.

PATIENT POPULATION

All patients with trauma diagnoses are included with the exception of (1) patients who are dead on arrival; (2) patients who are missing age, gender, or outcome information; (3) or patients who were transferred out to another hospital. Patients admitted with burns, or isolated injuries consisting of late effects of injuries, or traumatic complications will also be excluded from the report.

RISK ADJUSTMENT FOR ASSESSING HOSPITAL PERFORMANCE

Patient outcomes are determined in part by quality of care. In order to benchmark hospital quality, risk adjustment must be performed to account for differences in patient casemix and injury severity across hospitals. Hospitals with more severely injured patients are expected to have higher mortality rates. The process of risk-adjustment is intended to "level the playing field" by taking into consideration individual patient injury severity when comparing centers.

Data Quality

NTDB coding practices dictate how missing data, invalid data, and inconsistent data are handled once the data has been transmitted to the NTDB. Data reports submitted by individual hospitals are checked by the NTDB using software edit tools. Incomplete or improperly formatted data are sent back to the reporting institution for correction. Internal consistency is assessed at the NTDB by comparing the values for related data elements.

The accuracy of the NTDB data has not been validated by comparing coded data and information obtained by reabstracting medical records. Some of the differences in hospital "performance" may reflect differences in data quality as opposed to true differences in hospital quality.

TRAUMA MORTALITY PROBABILITY MODEL (TMPM)

Dr. Osler, in collaboration with other members of the research consortium, developed the TMPM to predict in-hospital mortality. (Dr. Osler previously developed ICISS and NISS.) TMPM uses a patient's five most severe injuries as predictors of mortality. Each injury in the AIS and ICD9 lexicon is first mapped to an empiric measure of injury severity estimated using the NTDB, and is then entered into TMPM as a predictor. This is in contrast to ISS, where AIS severity scores were assigned by a panel of experts. Two separate models have been developed: one based on the AIS lexicon (TMPM-AIS) and the other on ICD9-CM codes (TMPM-ICD9). TMPM has been shown to accurately predict mortality for injured patients at all different risk levels. A detailed description of the AIS-based version of TMPM has been published in the Annals of Surgery in 2008 (247 (6): 1041-8). Since the recently adopted NTDB National Trauma Data Standard now mandates the use of ICD-9-CM codes to characterize injury diagnoses, TMPM-ICD9 is now used for risk-adjustment (Annals of Surgery, in press).

In order to measure hospital performance, we have augmented TMPM-ICD9 with age, gender, mechanism of injury, the motor component of the GCS, systolic blood pressure, and whether a patient was transferred in from another facility. Missing values for GCS motor and blood pressure will be imputed using multiple imputation. This approach has been adopted because our research has shown that imputation of missing values leads to more accurate reporting of hospital quality compared to excluding patients with missing values (Annals of Surgery 2009 Jan; 249(1):143-8).

We use hierarchical modeling to measure hospital quality. Hierarchical modeling was selected because it represents the state-of-the art approach for risk-adjustment and provides conservative estimates of hospital quality. Compared to other modeling approaches, hierarchical modeling is less likely to attribute differences in patient outcomes due to random "noise" to quality differences across hospitals.

Interpreting the Hospital Mortality Odds Ratio

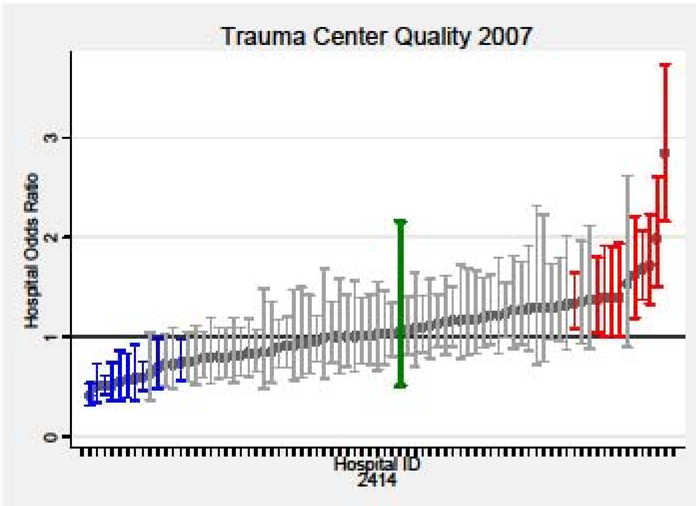
Hospital quality is measured using an odds ratio which represents the odds that a patient treated at a specific hospital will die compared to a patient treated at an "average" hospital, after controlling for patient risk. A hospital with an odds ratio close to 1 has outcomes similar to the "average" hospital. In this report, each hospital odds ratio will be presented along with a 95% confidence interval. Hospitals whose odds ratio is significantly less than 1 (95% confidence interval does not include 1) have outcomes that are "better" than the average hospital, whereas hospitals with an odds ratio significantly greater than 1 have outcomes that are "worse" than the average hospital.

The hospital odds ratio reflects the quality of care delivered to trauma patients at individual hospitals. However, several factors other than quality may affect hospital quality measurement. First, it is possible that chance alone will cause a hospital's odds ratio to be substantially different than 1. Hierarchical modeling and the use of 95% confidence intervals adjusts for the fact that hospitals with lower patient volumes are more likely to exhibit extreme outcomes rates. Second, hospitals may differ in how they code patients who are dead on arrival (DOA). Differences in hospital quality may be partly related to differences in how hospitals define patients as being DOA. Third, differences in hospital coding of injuries, blood pressure, and GCS measurement may also contribute to differences in quality measurements across hospitals. With the adoption of the National Trauma Data Standard for the NTDB, we anticipate that variability in hospital coding practices will decrease over time. Fourth, quality measurement may be inaccurate if the baseline risk of mortality is not adequately captured by TMPM due to the omission of important risk factors. The research consortium does not believe that this is an important factor given the overall excellent predictive accuracy of TMPM.

Although quality measurement is not perfect, benchmarking information presented in this report may prove valuable to hospitals in their efforts to improve patient outcomes by allowing them to compare their risk-adjusted outcomes to that of other centers. The goal of SMARTT is to determine whether providing hospitals with non-public (confidential) information on their risk-adjusted mortality will lead to improved population outcomes.

RISK-ADJUSTED OUTCOMES

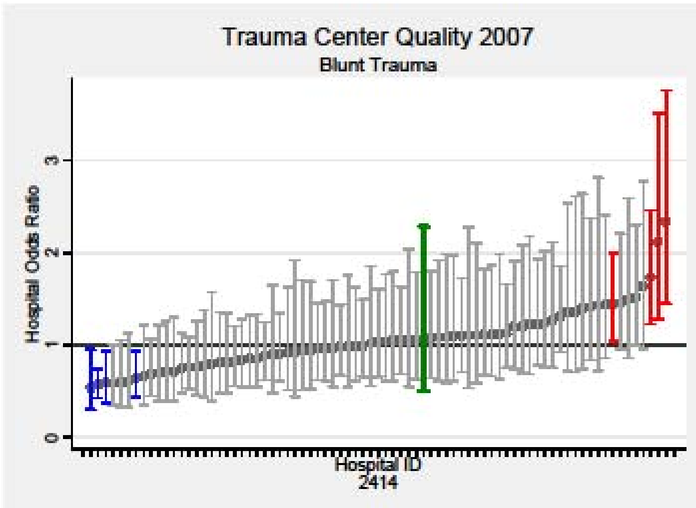
Figure 1. Hospital Odds Ratio based on all Trauma Cases.



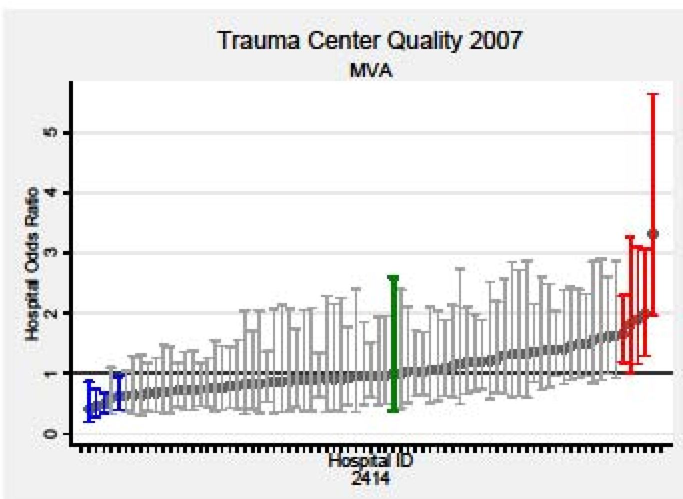
Vertical bars represent the 95% confidence interval. Hospitals whose quality is below average are in red, and hospitals with above-average quality are in blue. Your facility is shown in green.

The odds of a trauma patient dying in your hospital are 1.04 compared to the average hospital (95% confidence interval: 0.50, 2.16). The likelihood that your hospital is a low-quality hospital (OR > 1) is 55%. The likelihood that your hospital is a very-low quality hospital (OR > 1.2) is 35 %.

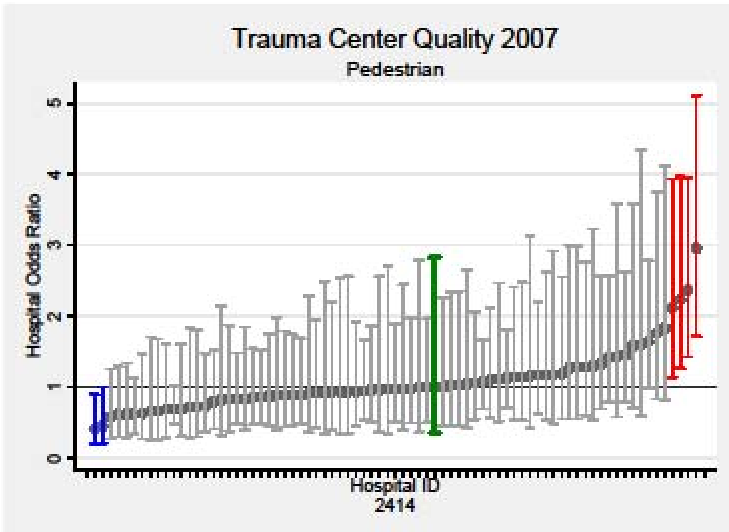
Figure 2. Hospital Odds Ratio based on Mechanism of Trauma.



The odds of a blunt trauma patient dying in your hospital are 1.07 (95% confidence interval: 0.50, 2.29) compared to the average hospital.



The odds of a MVA trauma patient dying in your hospital are 1.00 (95% confidence interval: 0.38, 2.59) compared to the average hospital.



The odds of a pedestrian trauma patient dying in your hospital are 0.99 (95% confidence interval: 0.35, 2.81) compared to the average hospital.

eTable 1. Summary Statistics by Year

	Overall	2006	2007	2008	2009	2010
Institutions	44	44	44	44	44	44
Cases	326,206	58,115	68,658	67,198	65,353	66,882
Demographics						
Age, years (median)	40	39	38	40	42	43
Sex						
Male	66.3	66.4	67.3	66.8	65.7	65.1
Female	33.7	33.6	32.7	33.2	34.3	34.9
Transfer from other hospital						
Transferred	23.8	20.6	22.0	23.7	25.3	27.0
Not transferred	76.2	79.4	78.0	76.3	74.7	73.0
Glasgow Coma Scale Motor						
GCS motor = 1	5.63	6.14	5.67	5.67	5.31	5.40
GCS motor = 2	0.24	0.26	0.23	0.25	0.21	0.24
GCS motor = 3	0.30	0.33	0.31	0.30	0.28	0.31
GCS motor = 4	1.10	1.26	1.13	1.08	0.98	1.08
GCS motor = 5	2.44	2.77	2.42	2.30	2.41	2.36
GCS motor = 6	87.0	85.5	86.8	86.8	87.5	88.4
missing	2.19	3.77	3.49	3.64	3.37	2.27
Systolic BP						
0 - 30	1.05	1.57	1.09	1.04	0.82	0.79
31-60	0.25	0.24	0.24	0.28	0.23	0.25
61-90	2.20	2.26	2.24	2.32	2.15	2.05
91-160	79.2	79.1	79.4	79.3	79.1	79.1
161-220	15.0	14.6	14.0	14.7	15.7	16.2
> 220	0.45	0.40	0.40	0.44	0.49	0.52
missing	1.82	1.82	2.58	1.99	1.50	1.19
Mechanism of Trauma						
Blunt	42.0	40.7	39.0	49.9	40.2	40.3
Motor Vehicle Crash	22.6	28.4	25.7	13.9	23.1	22.4
Gunshot	5.94	6.54	5.97	5.94	5.83	5.50
Stab	5.01	1.45	5.65	5.87	5.67	5.91
Pedestrian trauma	9.99	10.4	9.07	10.2	9.74	9.75
Low-fall	14.5	12.6	13.7	14.2	15.5	16.1
Mortality	4.19	4.62	4.24	4.20	3.89	4.05

Abbreviations: GCS motor – motor component of the Glasgow coma scale; SBP – systolic blood pressure in the emergency department eTable 2. Hospital Characteristics

	Hospital Cohort (n = 44)
Trauma certification status*	
I	19 (43)
II	19 (43)
III	4 (9)
IV	2 (5)
Number of Hospital Beds	
≤200	3 (6.8)
201-400	17 (39)
401-600	16 (36)
>600	8 (18)
Teaching Status	
University	21 (48)
Community	16 (36)
Nonteaching	7 (16)
Geographic Region	
Northeast	7 (16)
South	17 (39)
Mid-West	7 (16)
West	12 (27)
missing	1 (2)
Profit status	
Nonprofit	43 (98)
For profit	1 (2)

* Certification status based on ACS and state designation