The New York State Trauma System:

2007-2009

New York State Department of Health

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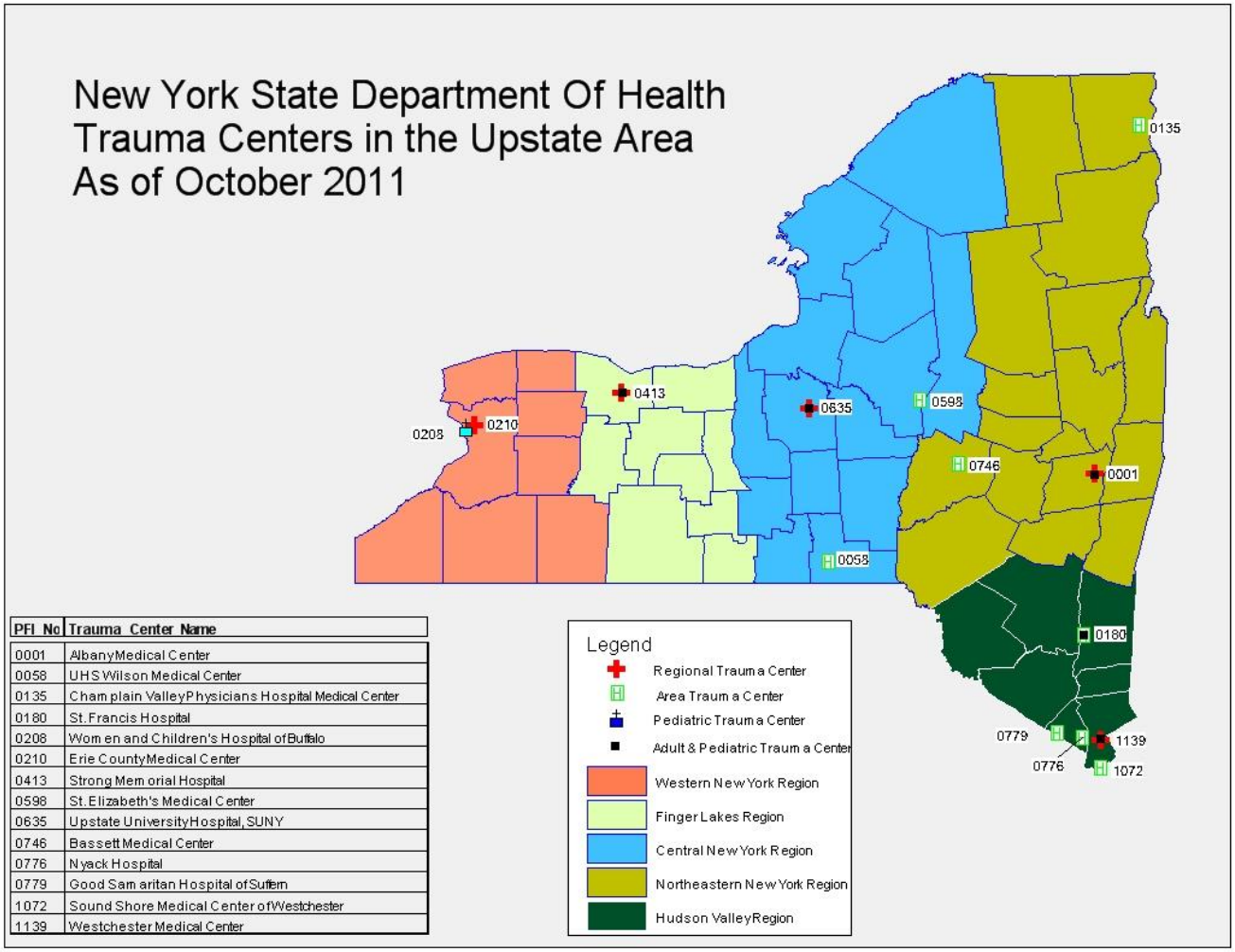
INTRODUCTION

In the past two decades, New York State has worked to improve trauma care in the state. In 1990, the State established minimum standards for trauma centers, and 36 hospitals were subsequently designated as centers.

In 1991, a group of trauma care specialists, primarily from New York State, was chosen to serve on a new State Trauma Advisory Committee (STAC). In 1993, New York State created a statewide Trauma Registry. Although this Registry once included almost all hospitals in the state, it now includes only trauma centers. Data in the Registry include trauma-related deaths in the emergency department (DIEs) and trauma inpatient admissions with diagnoses identified by the STAC as having sufficiently high injury severity to be worthy of study. Sufficiently high injury severity is defined by the ICD-9-CM codes in Appendix 1. The trauma centers in New York from 2007-2009 are listed by region and level (regional trauma center, area trauma center) in Appendix 2.

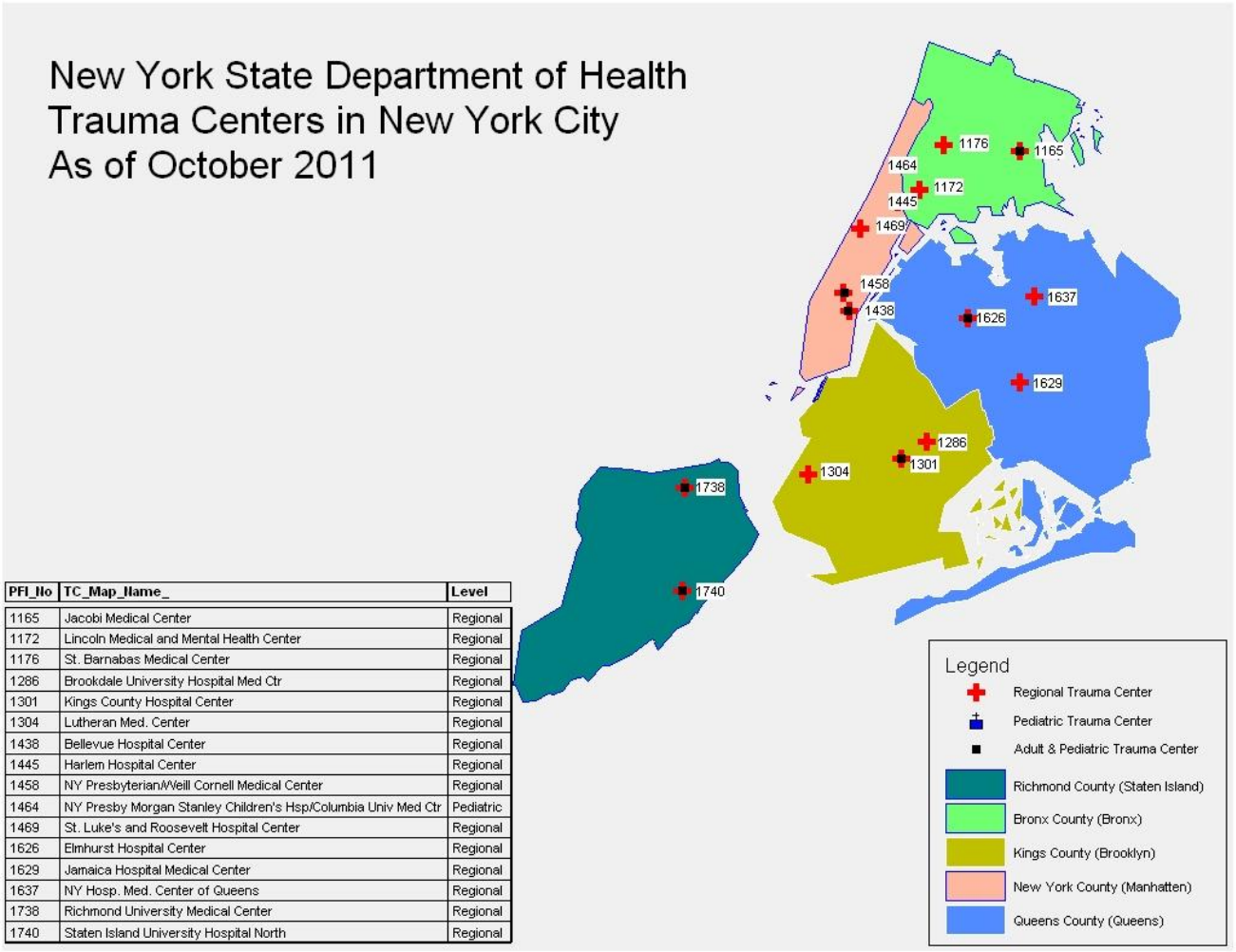
The Registry uses a data entry package [Trauma One or NTRACS v5], to standardize the information obtained from each participating hospital and to facilitate the analysis of the information obtained. Each regional and area trauma center has access to a software package and enters its own data in the system. Some area centers forward their data to regional centers that, in turn, forward the entire region's data to the evaluator at the School of Public Health at the University at Albany, State University of New York (SUNY). Other area centers submit their data directly to the School of Public Health. There are eight regional trauma programs in the state (Central New York, Finger Lakes, Hudson Valley, Nassau, New York City, Northeastern New York, Suffolk, and Western New York); each has at least one regional trauma center; New York City has 17 regional trauma centers. The following two maps show the boundaries of the eight regional systems and the locations of the currently designated trauma centers in New York State.

Figure 1
Trauma Regions and Upstate Trauma Centers



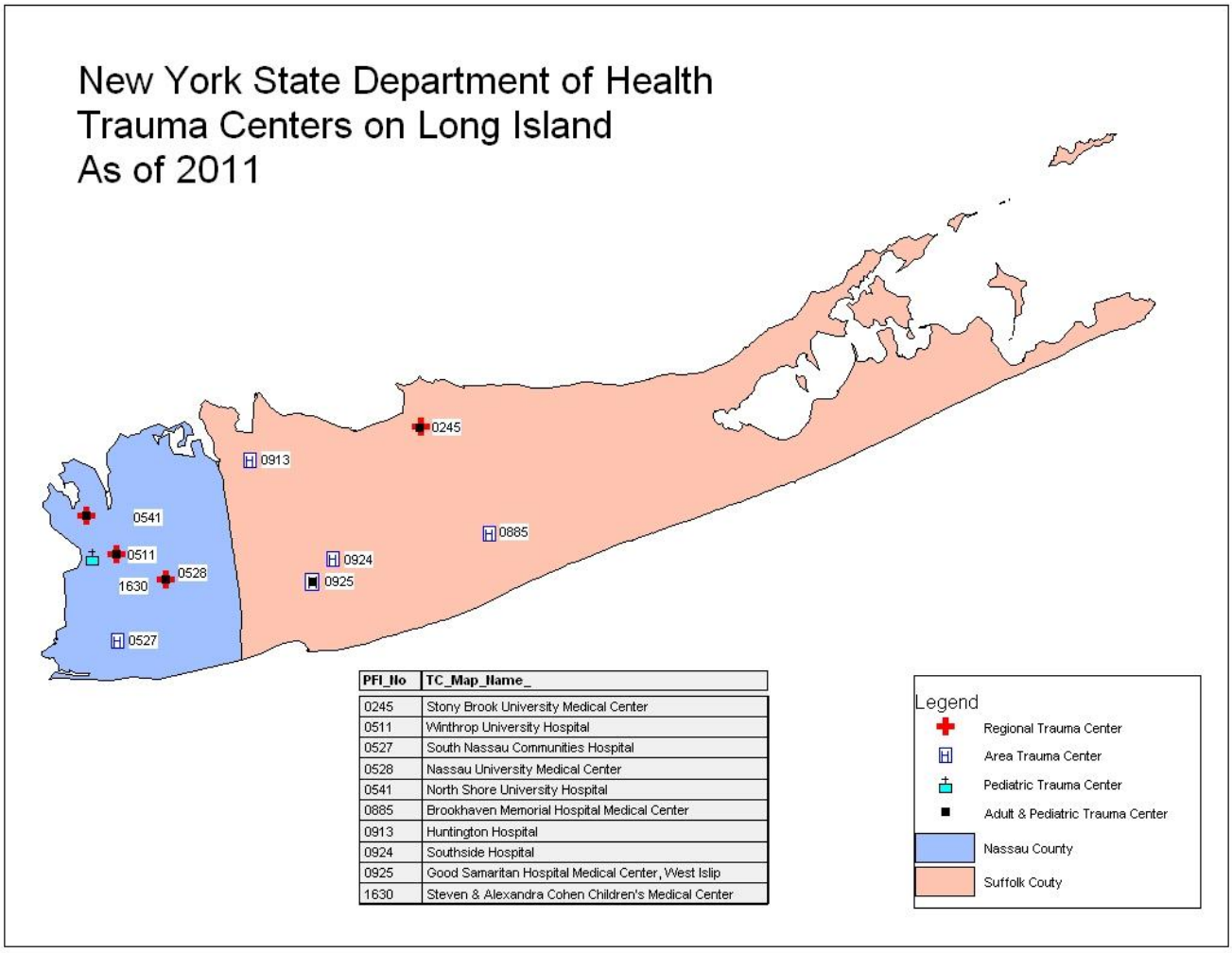
PFI No	Trauma Center Name
0001	Albany Medical Center
0058	UHS Wilson Medical Center
0135	Champlain Valley Physicians Hospital Medical Center
0180	St. Francis Hospital
0208	Women and Children's Hospital of Buffalo
0210	Erie County Medical Center
0413	Strong Memorial Hospital
0598	St. Elizabeth's Medical Center
0635	Upstate University Hospital, SUNY
0746	Bassett Medical Center
0776	Nyack Hospital
0779	Good Samaritan Hospital of Suffern
1072	Sound Shore Medical Center of Westchester
1139	Westchester Medical Center

Figure 2
New York City Trauma Centers



PFI_No	TC_Map_Name_	Level
1165	Jacobi Medical Center	Regional
1172	Lincoln Medical and Mental Health Center	Regional
1176	St. Barnabas Medical Center	Regional
1286	Brookdale University Hospital Med Ctr	Regional
1301	Kings County Hospital Center	Regional
1304	Lutheran Med. Center	Regional
1438	Bellevue Hospital Center	Regional
1445	Harlem Hospital Center	Regional
1458	NY Presbyterian/Weill Cornell Medical Center	Regional
1464	NY Presby Morgan Stanley Children's Hsp/Columbia Univ Med Ctr	Pediatric
1469	St. Luke's and Roosevelt Hospital Center	Regional
1626	Elmhurst Hospital Center	Regional
1629	Jamaica Hospital Medical Center	Regional
1637	NY Hosp. Med. Center of Queens	Regional
1738	Richmond University Medical Center	Regional
1740	Staten Island University Hospital North	Regional

Figure 3
Long Island Trauma Centers



PFI_No	TC_Map_Name_
0245	Stony Brook University Medical Center
0511	Winthrop University Hospital
0527	South Nassau Communities Hospital
0528	Nassau University Medical Center
0541	North Shore University Hospital
0885	Brookhaven Memorial Hospital Medical Center
0913	Huntington Hospital
0924	Southside Hospital
0925	Good Samaritan Hospital Medical Center, West Islip
1630	Steven & Alexandra Cohen Children's Medical Center

Data in the system are derived from three sources: the Prehospital Care Report (PCR), the Emergency Department (ED) record, and information from the referring hospital and final hospital inpatient admissions.

The PCR contains information about the ambulance trip including the time of the call, the time the ambulance arrived at the scene of the injury, the time spent by the Emergency Medical Service (EMS) team at the scene, the travel time to the hospital, and a variety of information about the physiological state of the patient during the course of the ambulance trip.

The ED record includes information about the times the patient entered the ED and was admitted to the hospital, the treatment the patient received in the ED, and the physiological state of the patient at various times in the ED.

The inpatient data include patient demographics, diagnoses, procedures performed and their dates, the admission and discharge dates from the hospital, and the discharge status.

The first year that Registry data were reported and analyzed was 1993. Data from trauma inpatients in 1993 were first subdivided into different mechanisms of injury (motor vehicle crashes, low

falls, etc.). Then, inpatient mortality rates were examined by hospital, region, and level (regional center, area center, and non-center) after adjusting the rates to account for differences in patient risk using known risk factors such as age, gender, injury severity, respiratory rate, systolic blood pressure, and Glasgow Coma Scale.

In the first report, in addition to looking at differences across all patients with a given mechanism of injury, risk-adjusted mortality was also calculated for subgroups of patients (e.g., head-injured patients, older patients, patients with injuries to the front of the neck and thorax) to determine if any regions had particularly high or low outcome rates for each subgroup. This information was then communicated to the regional centers so that regions with high or low risk-adjusted mortality for subgroups of patients could explore the processes of care for these patients in relation to the processes in place in other regions of the state.

The second report, based on 1994-1995 data, profiled trauma patients in the state with respect to the mechanisms of injury they sustained and the relationship between demographics (age and gender) and the mechanisms of injury. It also examined the location of trauma patients and trauma patient deaths, both by region and by care location (on arrival to hospital, in hospital emergency department or as an inpatient). The tendency of trauma patients to be admitted to trauma centers vs. non-centers by region was also reported. In addition, changes in the volume and mortality rates of trauma patients over previous years were reported on both a statewide and regional basis.

To the best of our knowledge, this was the first state-issued report on trauma care that evaluated relative outcomes among regions of the state and among different levels of inpatient care (regional trauma centers, area trauma centers and non-centers). This was done by developing a statistical model for each mechanism of injury that was then used to calculate risk-adjusted mortality rates for regions of the state and for levels of care. The report included comparisons of these risk-adjusted rates by region and level.

The third report, covering the time period 1996-1998, was similar to the 1994-1995 report and updated all of the information that was presented in the 1994-1995 report.

The fourth report, covering the time period 1999-2002, was similar to the second and third reports except for the fact that it is limited primarily to information on trauma centers, since the Registry no longer contained information from non-centers. Also, the 1999-2002 report, for the first time, included comparisons of risk-adjusted mortality rates for individual hospitals.

The fifth report, covering the time period 2003-2006, was based on the analysis of trauma center data from all trauma centers in New York State. As in the 1999-2002 report, regional, level and individual hospital outliers were presented. Also, as was done in the earlier report, comparisons to United States data for three types of injuries (motor vehicle crashes, falls, and firearms injuries) were presented. A new section of the 2003-2006 report showed trends in numbers of cases and mortality rates during the eight-year time period 1999-2006.

This report covers the years 2007-2009 and is very similar to the previous report except that the sole measure of adverse outcome is inpatient mortality (since the quality of reporting of emergency department mortality was judged to be untrustworthy).

The New York State Department of Health and the STAC hope that these analyses and reports serve hospitals and EMS agencies throughout the state in their efforts to improve the care of injured patients. The statewide Registry and the risk-adjusted statistical methods that have been developed under the auspices of the Bureau of EMS provide a tool for monitoring these efforts and documenting improvements in outcome.

NEW YORK STATE TRAUMA SYSTEM POPULATION PROFILE

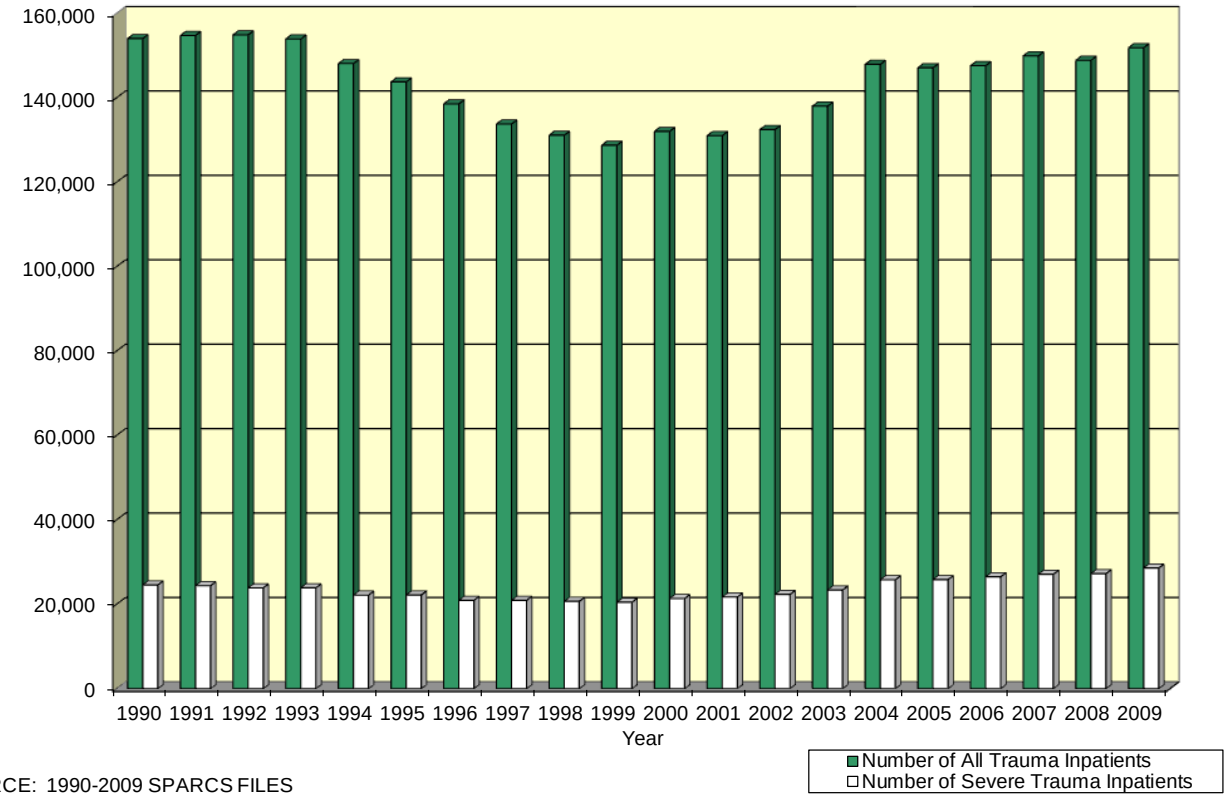
According to New York's Statewide Planning and Resource Cooperative System (SPARCS), the total number of trauma patients admitted to New York State hospitals declined between the years 1990 and 1999 and then increased between 1999 and 2009, although not in every year (see Chart 1). A total of 151,855 trauma patients were admitted to New York State hospitals in 2009, a decrease of 1.4 percent from the 154,054 trauma inpatients admitted in 1990.

When it was initially established in 1993, the New York State Trauma Registry (NYSTR) was designed to include data on trauma inpatients who are identified by the State Trauma Advisory Committee (STAC) to be at significant risk of dying in the hospital subsequent to their injuries. These data were collected from all hospitals in New York State – regional and area trauma centers as well as from non-centers. Due to funding cuts, since 1999, the NYSTR contains complete data for trauma centers only.

The list of the ICD-9-CM diagnostic codes that identify severe trauma patients, effective with January 1, 2007 discharges, is presented in Appendix 1. The number of patients qualifying for inclusion in the New York State Trauma Registry in 2009 was 28,602, or 4,038 more patients than in 1990 (24,564 patients – see Chart 1). It should be noted that since the Registry's inception in 1993, the trauma coordinators, after thorough review of the medical record, have been able to exclude records from the Registry that had qualified for inclusion based on ICD-9-CM codes. Since no 1990-1992 records were reviewed for exclusion, the 1993-2009 exclusions have been disregarded in Chart 1 to best capture trends in trauma patient admissions. The numbers show a slight downward trend from 1990 through 1999 and a slight upward trend since 1999. Since the Registry was not instituted until 1993, the patient volumes in the years prior to 1993 represent those patients who would have qualified for the Registry. Per year, approximately 119,000 SPARCS patients with a trauma diagnosis do not qualify for the Registry. The average mortality rate for these patients between 1990 and 2009 is 2.06 percent.

Chart 1

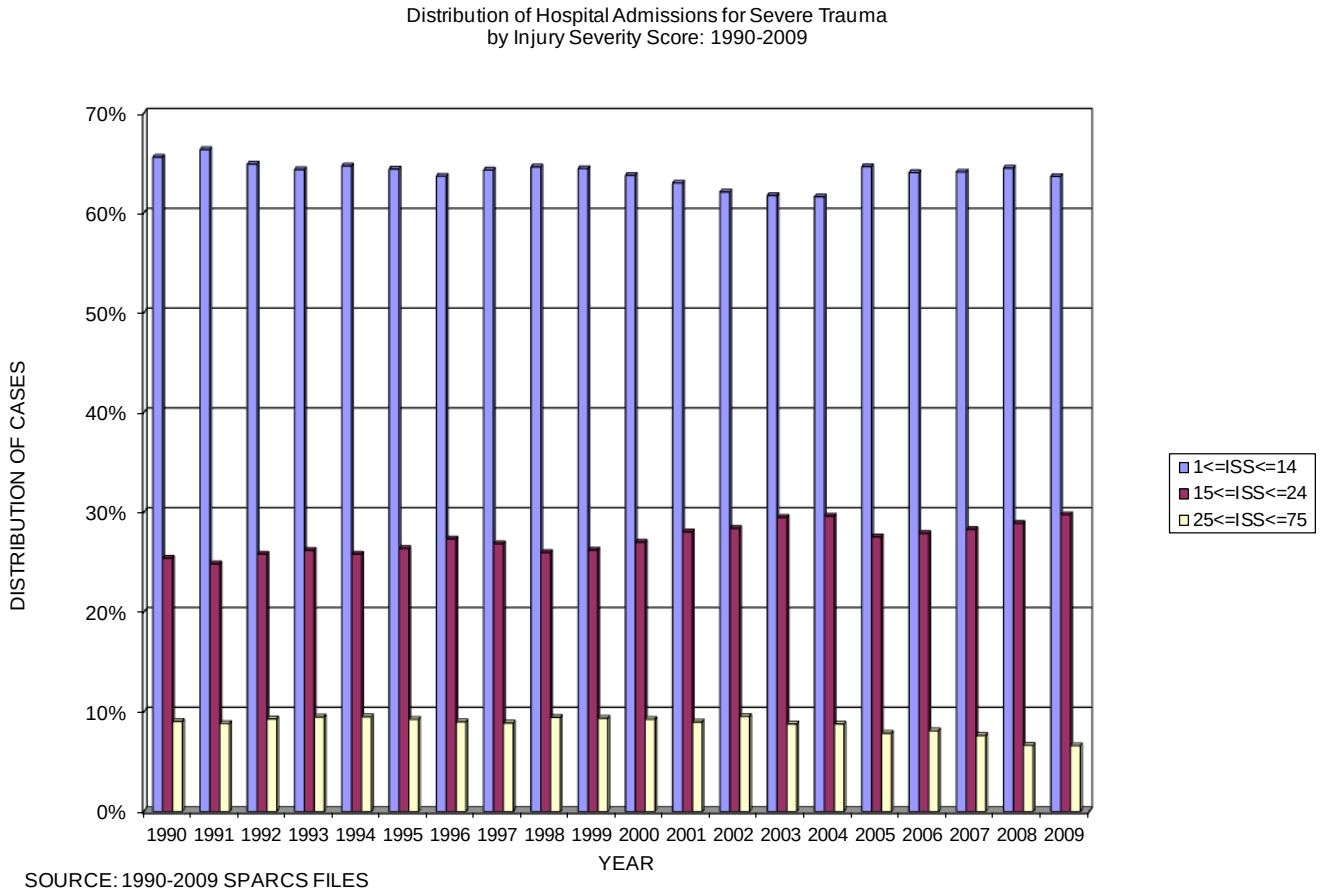
1990-2009 Statewide
Number of Trauma Inpatients and Number of Severe Trauma Inpatients



SOURCE: 1990-2009 SPARCS FILES

Chart 2 presents the number of severe trauma admissions, cases that qualify for the Registry, grouped by Injury Severity Score (ISS). Records with an ISS of 99 (undeterminable ISS) are excluded from this chart. The ISS, a measure of the severity of a patient's injury, has been found to be strongly related to patient outcome. The severity of each trauma injury is graded from one to six, with six being the most severe. Each region of the body is assigned a score equal to the highest score in that region. The scores for the three highest scoring regions are then squared and summed. For example, if the three regions with the highest scores have scores of 3, 4 and 4, then the ISS is $3^2+4^2+4^2=41$. A score of six in any region generates the maximum ISS score of 75.

Chart 2



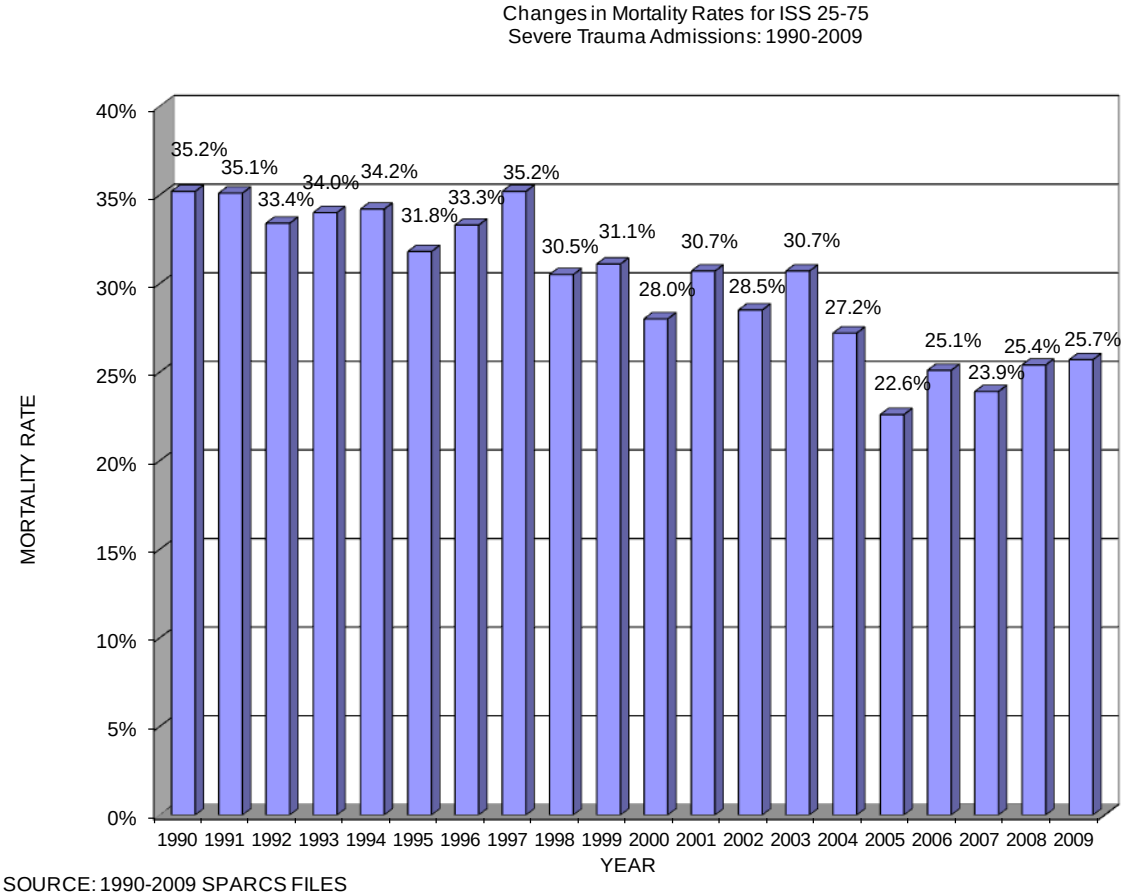
SOURCE: 1990-2009 SPARCS FILES

Changes in Mortality Rates by ISS Group for Severe Trauma Admissions: 1990-2009

Chart 4 demonstrate the changes in in-hospital mortality rates between 1990 and 2009 for three ISS groups (25-75, 15-24, 1-14). Two charts are presented because if these mortality rates were presented on one chart, the most seriously injured group would mask the decline in mortality in the other groups. Records with an ISS of 99 are excluded.

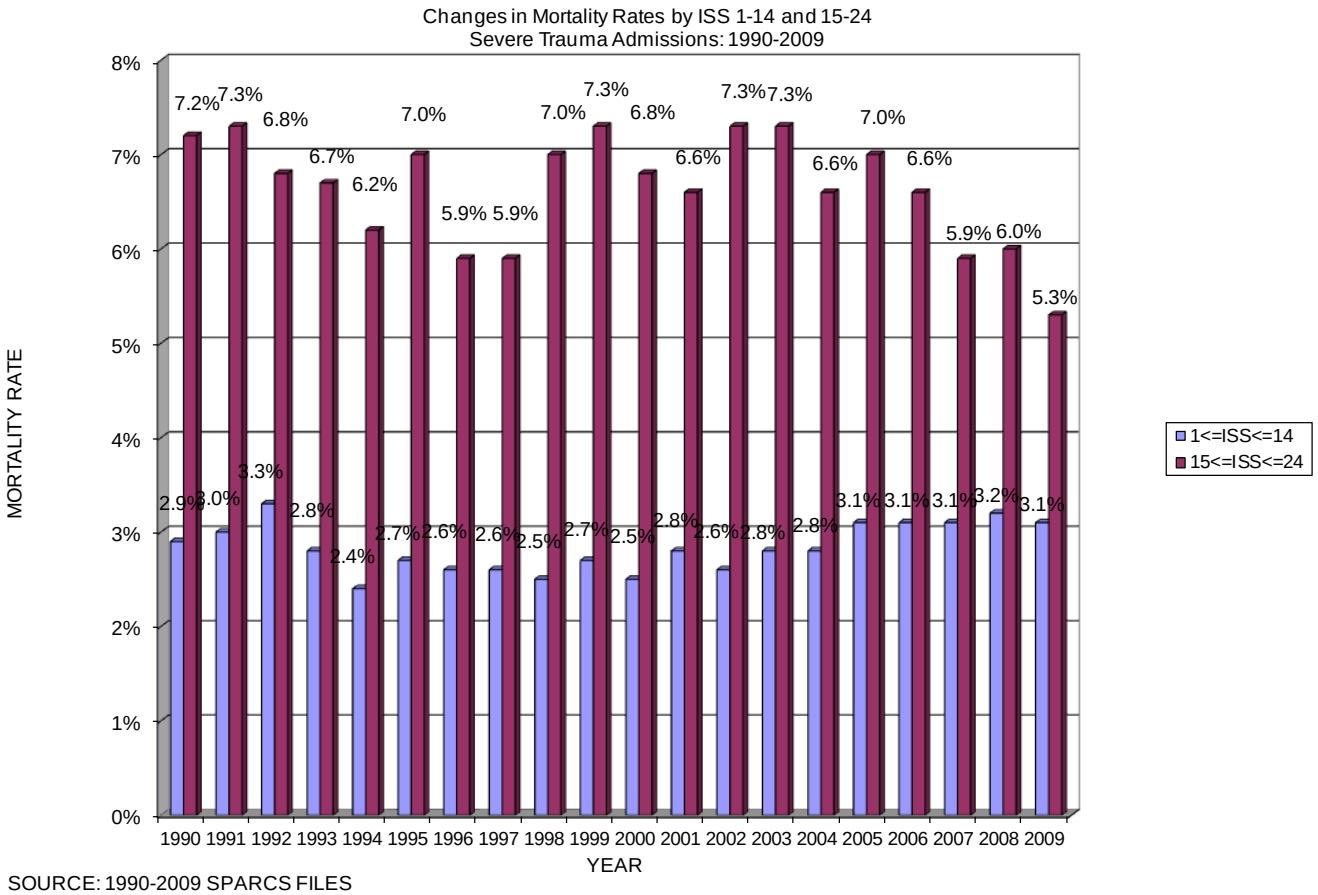
Chart 3 shows that the very high mortality associated with patients with an ISS between 25 and 75 decreased noticeably during the twenty-year period 1990-2009. The decrease in inpatient mortality also is evident for the range of 15-24. Since 1990, when most trauma centers were designated, the inpatient mortality rate for patients with an ISS between 15 and 24 decreased from 7.2 percent to 5.3 percent, a reduction of 26.4 percent. For patients with an ISS between 1 and 14, the inpatient mortality rate increased slightly from 2.9 percent to 3.1 percent. The chi-square test for trend shows there was a very highly statistically significant decrease ($p<0.0001$) in mortality rate for the time period of 1990-2009 for ISS groups 15-24 and 25-75.

Chart 3



SOURCE: 1990-2009 SPARCS FILES

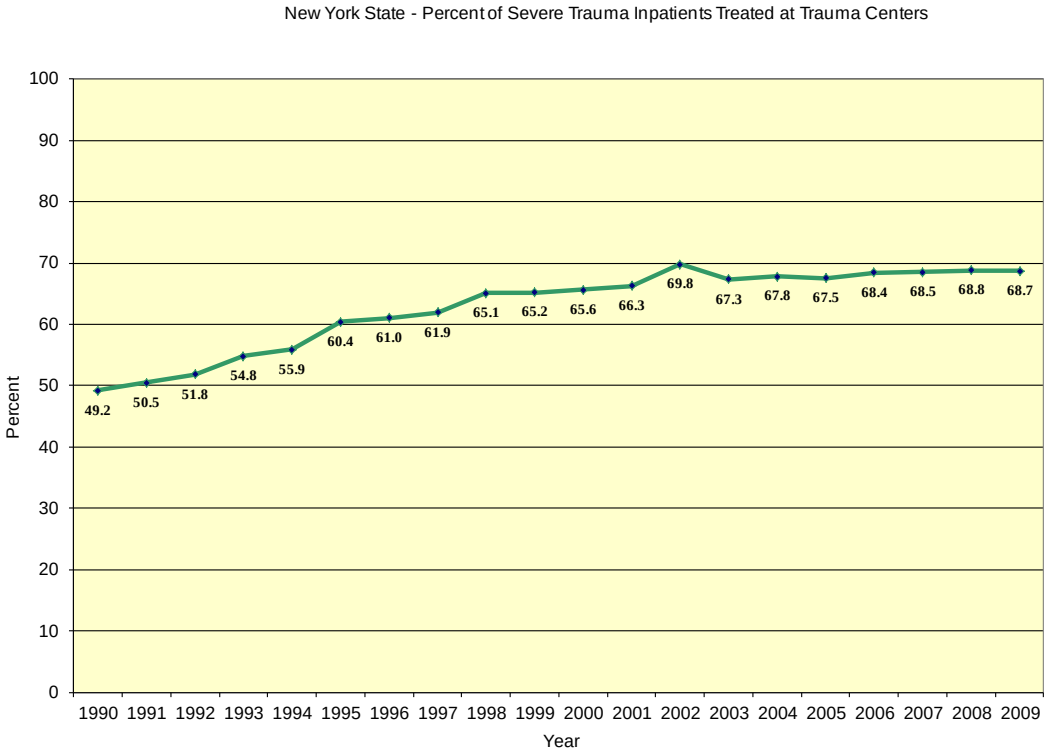
Chart 4



SOURCE: 1990-2009 SPARCS FILES

Chart 5 present the percentage of New York State trauma patients admitted to trauma centers between 1990 and 2009. For the years 1990-1992, this chart defines a hospital as a trauma center as it was designated in 1993. The percentage of patients triaged to trauma centers has risen from 49.2 percent in 1990 to 68.7 percent in 2009, an increase of 39.6 percent. The trend identified in the chart is consistent with the policy of transporting the more seriously injured patients beyond the nearest hospital to the nearest trauma center. The chi-square test for trend shows there was a very highly statistically significant increase ($p<0.0001$) in the percent of patients triaged to trauma centers over the time period 1990-2009.

Chart 5

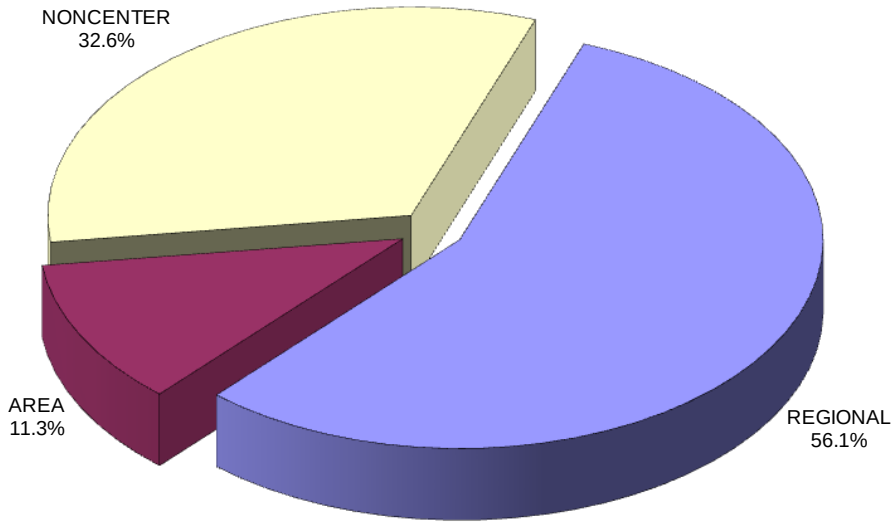


SOURCE: 1990-2009 SPARCS FILES

On page 6, Chart 1 entitled “1990-2009 Statewide Number of Trauma Inpatients and Number of Severe Trauma Inpatients” shows a total of 82,951 severe trauma inpatients for 2007-2009. As discussed earlier, some of these records were, after medical record review, deemed inappropriate for inclusion in the Registry. These exclusions reduced the total number of patients for 2007-2009 to 78,959. Among the inpatients qualifying for the 2007-2009 New York State Trauma Registry, 56.1 percent were admitted to regional trauma centers and 32.6 percent of these patients were admitted to non-centers (see Chart 6). Only 11.3 percent of these patients were hospitalized in area centers.

Chart 6

Distribution of Severe Trauma Inpatients by Hospital Level: 2007-2009

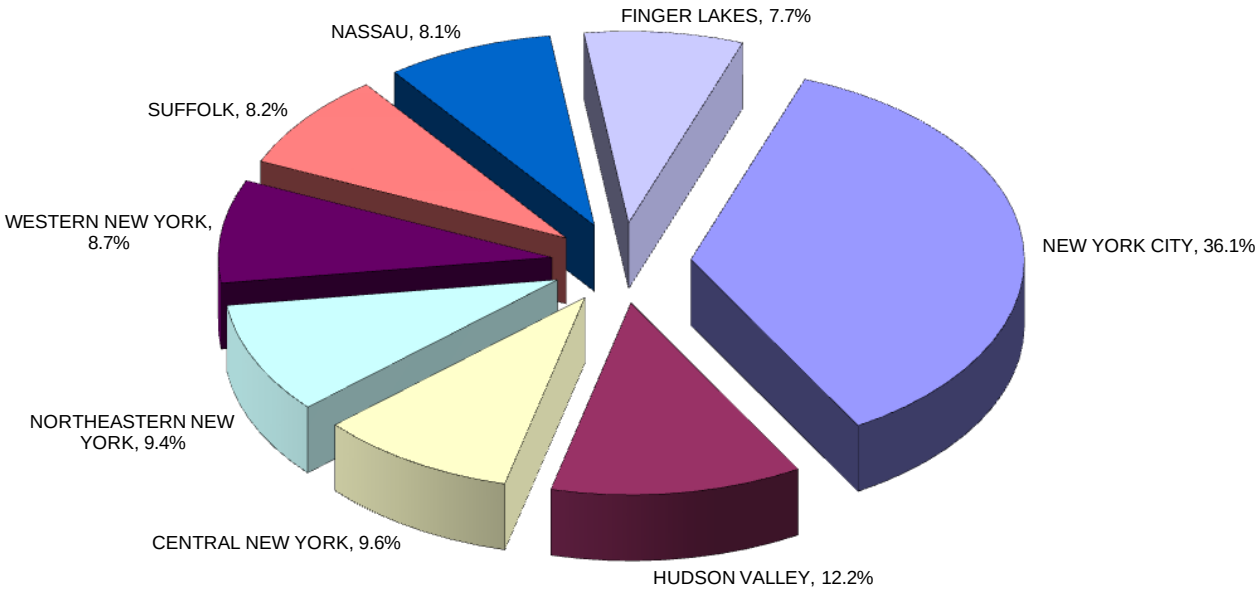


SOURCE: 2007-2009 SPARCS FILES

Chart 7 shows the distribution of inpatients qualifying for New York's 2007-2009 Registry by region of the state. About 36 percent of the patients were in New York City. No other region had more than 13 percent of the total. The regions outside of New York City with the most patients were Hudson Valley (12.2 percent) and Central New York (9.6 percent). The regions with the fewest patients were Nassau (8.1 percent) and Finger Lakes (7.7 percent).

Chart 7

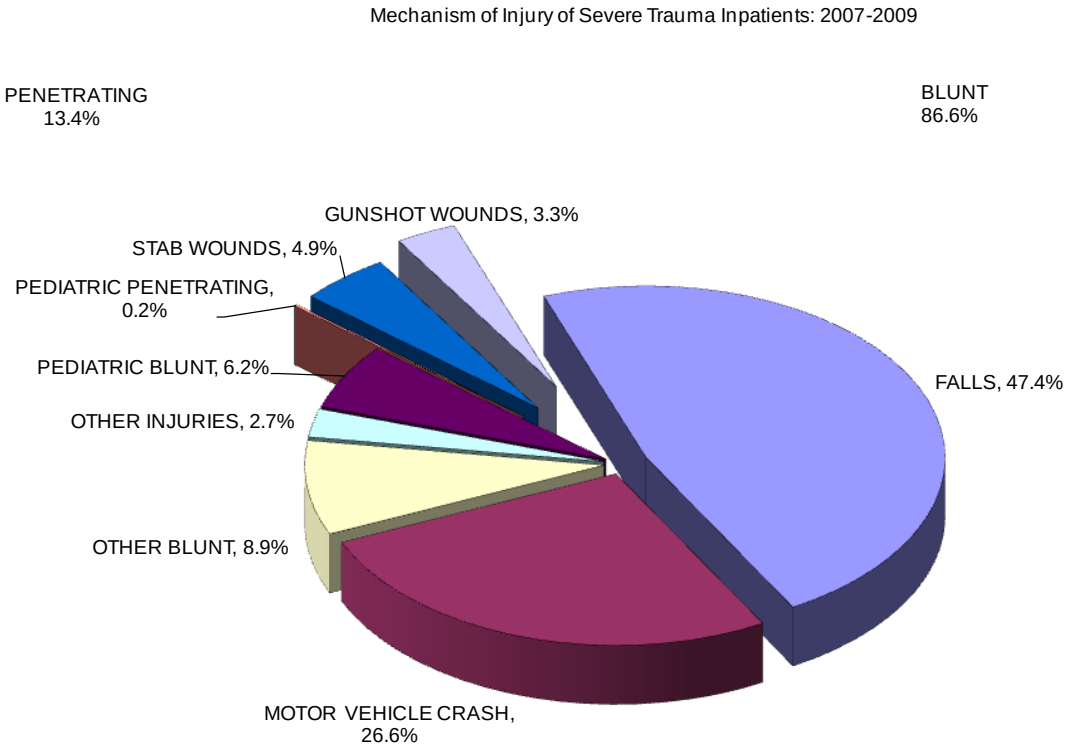
Regional Distribution of Severe Trauma Inpatients: 2007-2009



SOURCE: 2007-2009 SPARCS FILES

Of the inpatients qualifying for the 2007-2009 Registry, 86.6 percent were classified as having experienced blunt trauma (see Chart 8). The remaining 13.4 percent were classified as victims of penetrating trauma. The most common type of blunt trauma was falls (47.4 percent of all trauma patients), followed by motor vehicle crash (26.6 percent of all trauma patients). A total of 6.2 percent of the patients were pediatric patients (age less than 13 years) experiencing blunt injuries. A total of 4.9 percent of all inpatients qualifying for the Registry were adults who suffered stab wounds; 3.3 percent were treated for gunshot wounds. Only 0.2 percent of all 2007-2009 patients were pediatric patients with penetrating injuries (stab wounds or gunshot wounds).

Chart 8



SOURCE: 2007-2009 SPARCS FILES

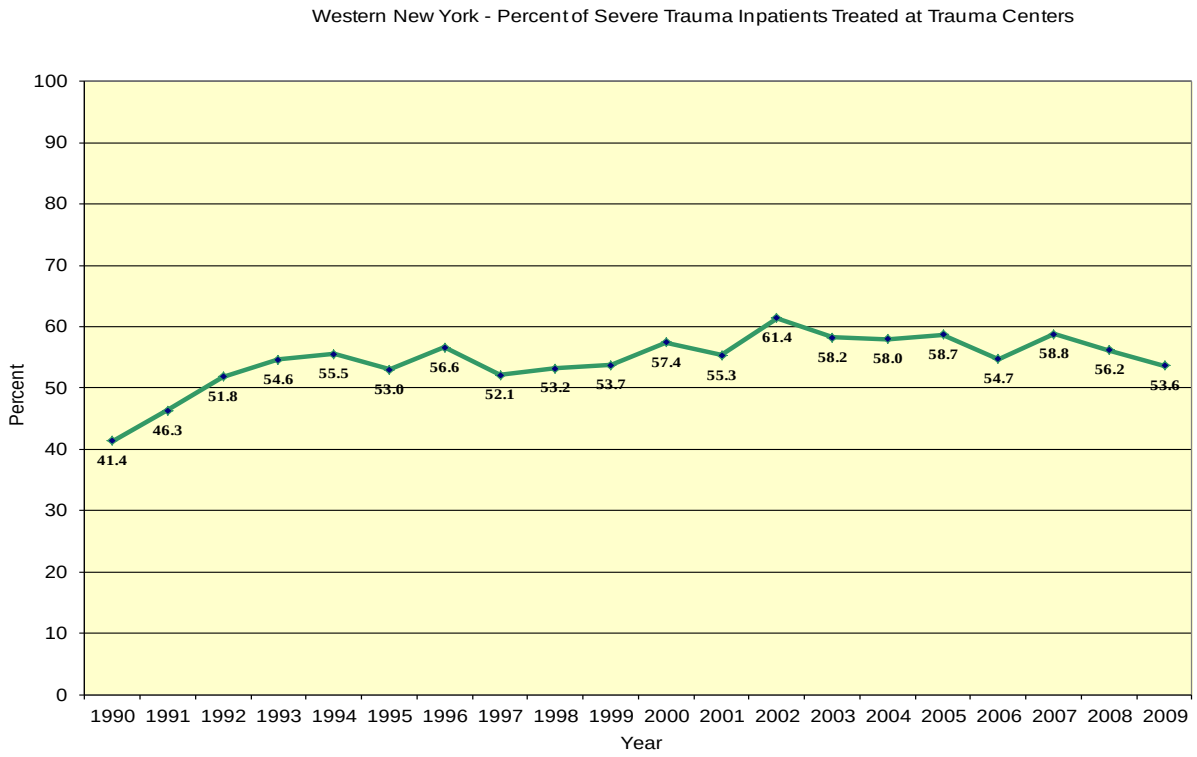
Percent of Inpatients Qualifying for the New York State Trauma Registry Admitted to Trauma Centers by Region: 1990-2009

Evident in the following eight charts are both the effect of the increase in the number of designated trauma centers and the influence of geography on the percent of patients in a particular region who were triaged to trauma centers. The geographically dispersed regions of Western New York (Chart 9), Finger Lakes (Chart 10), Central New York (Chart 11), and Northeastern New York (Chart 12) show moderate increases in the percent of patients triaged to centers. In these three regions, 50-65 percent of the patients are triaged to centers. In New York City (Chart 16), the

region with the highest density of hospitals per square mile, the triage rate to regional centers shows a moderate increase from about 60 percent to approximately 71 percent. Hudson Valley (Chart 13) and Suffolk (Chart 15) show sharp increases in the rate of triage at the time many additional centers were designated – Hudson Valley in 1998 and Suffolk in 1995. Nassau (Chart 14), the smallest region in

terms of square miles, has the highest density of trauma centers in any region outside of New York City. The percent of Nassau's severe trauma patients that are triaged to a center has grown from 72 percent to 84 percent.

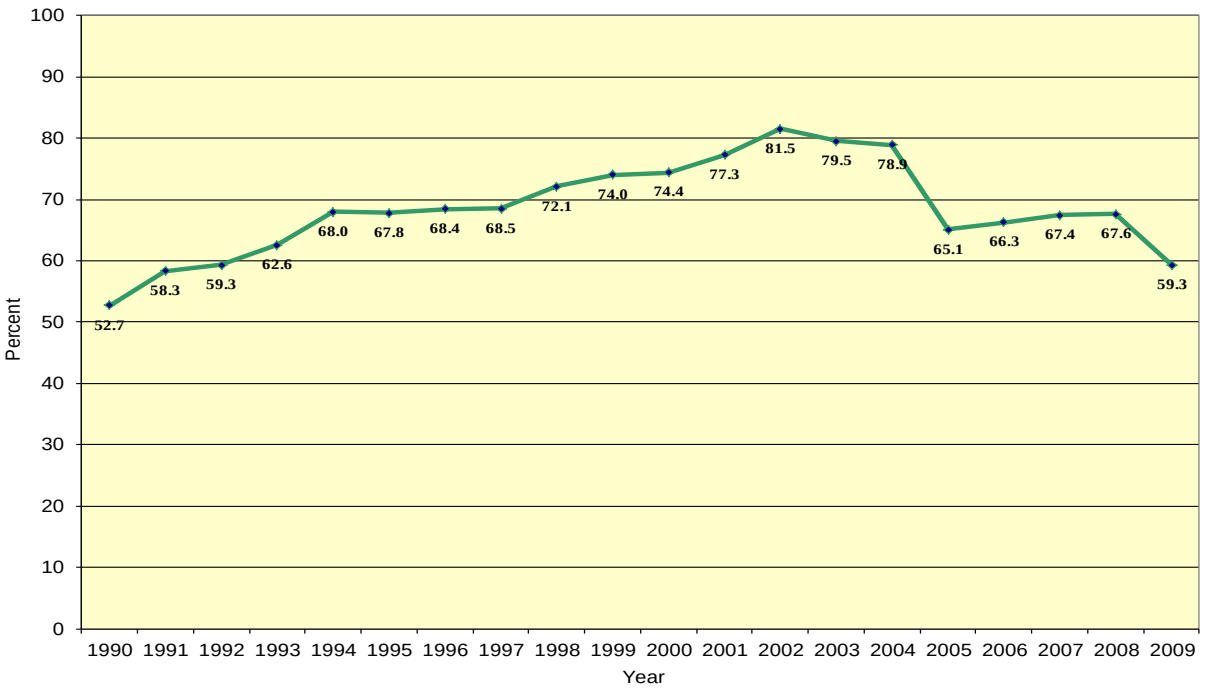
Chart 9



SOURCE: 1990-2009 SPARCS FILES

Chart 10

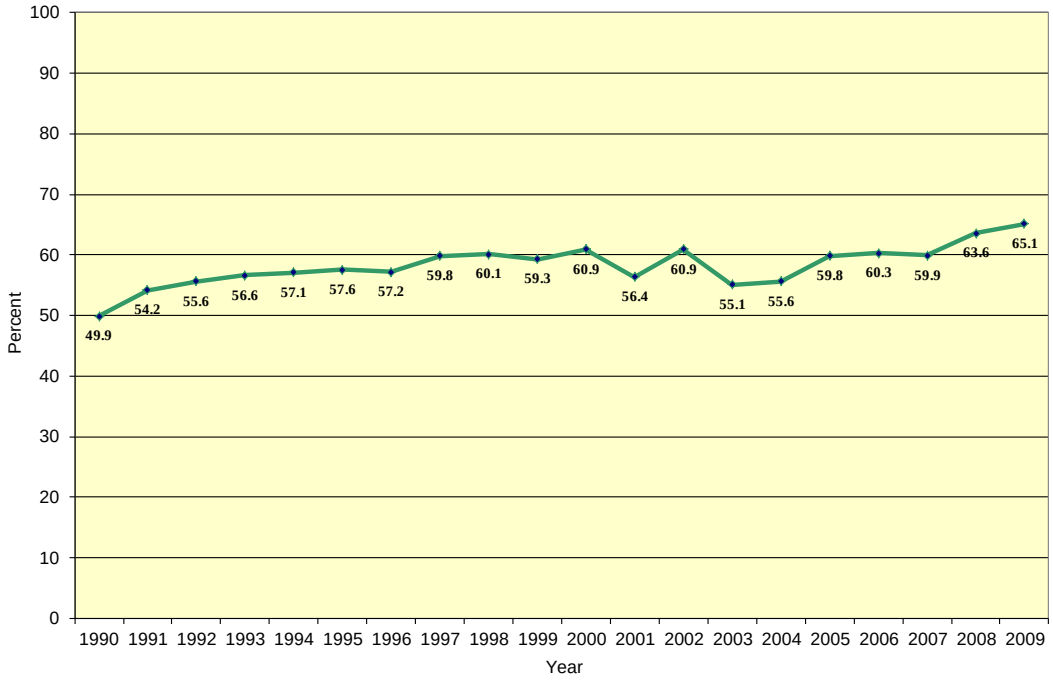
Finger Lakes - Percent of Severe Trauma Inpatients Treated at Trauma Centers



SOURCE: 1990-2007 SPARCS FILES

Chart 11

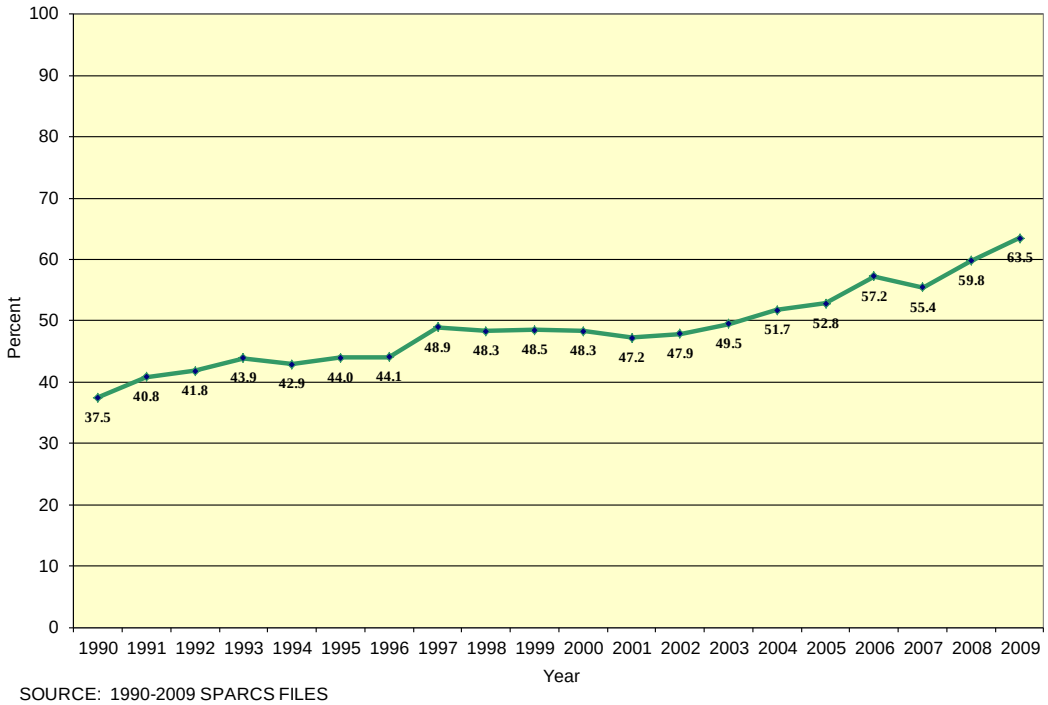
Central New York - Percent of Severe Trauma Inpatients Treated at Trauma Centers



SOURCE: 1990-2009 SPARCS FILES

Chart 12

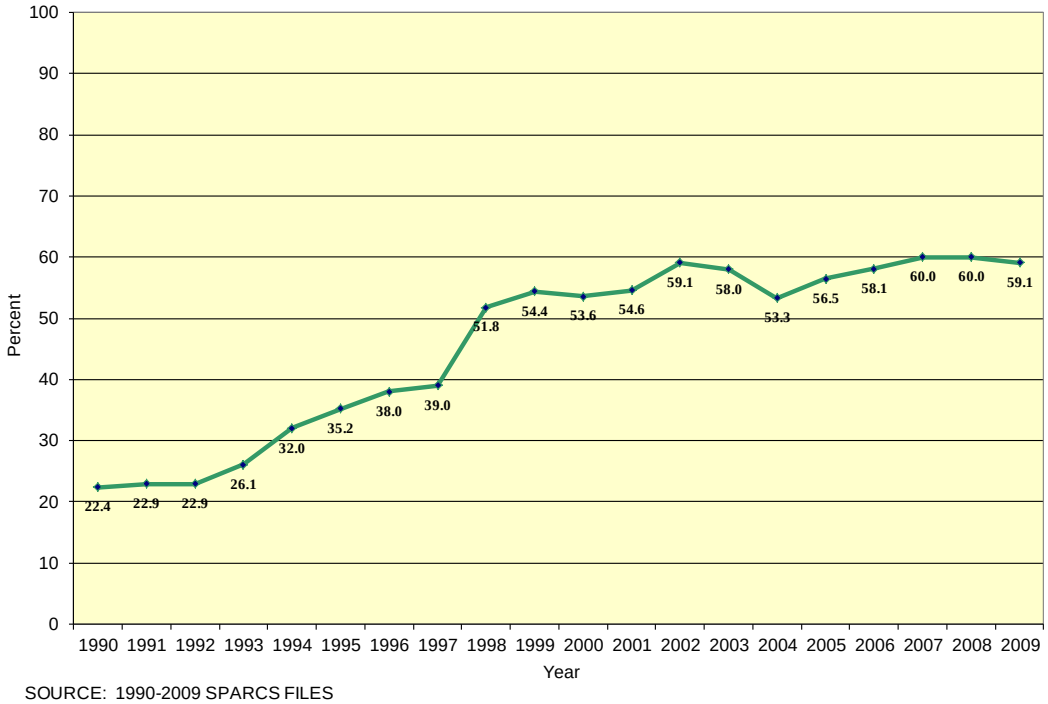
Northeastern New York - Percent of Severe Trauma Inpatients Treated at Trauma Centers



SOURCE: 1990-2009 SPARCS FILES

Chart 13

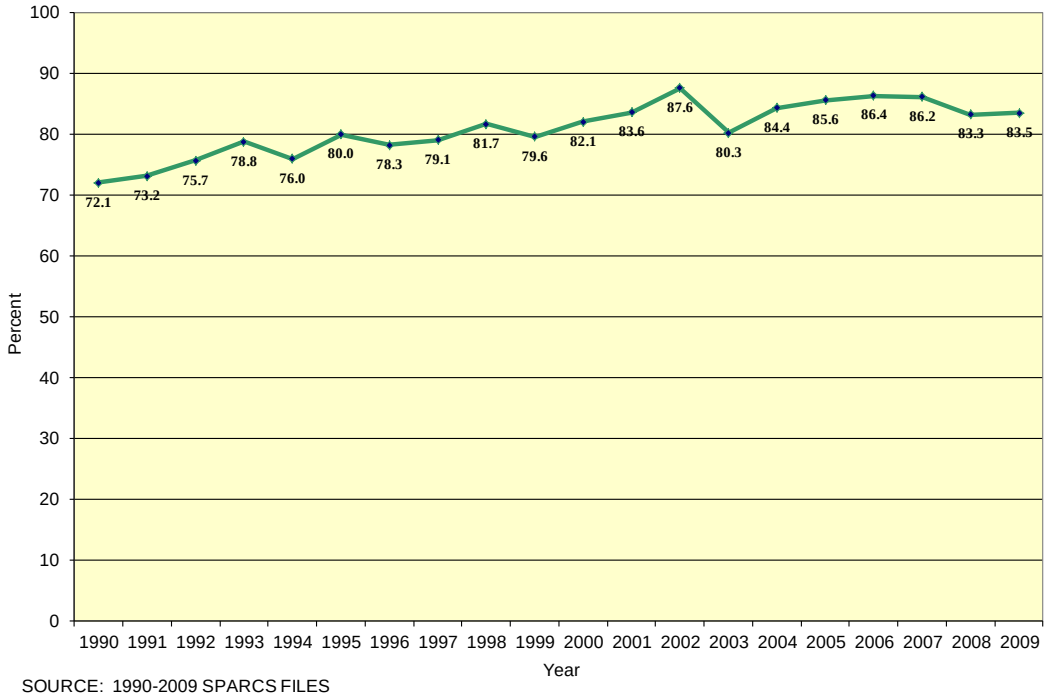
Hudson Valley - Percent of Severe Trauma Inpatients Treated at Trauma Centers



SOURCE: 1990-2009 SPARCS FILES

Chart 14

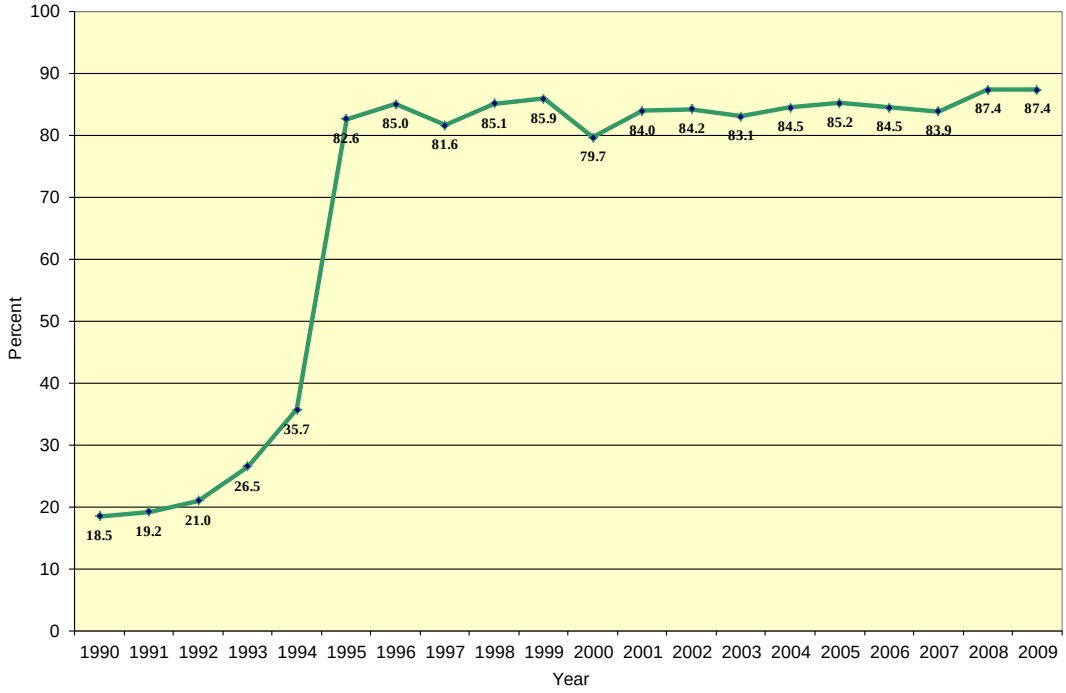
Nassau - Percent of Severe Trauma Inpatients Treated at Trauma Centers



SOURCE: 1990-2009 SPARCS FILES

Chart 15

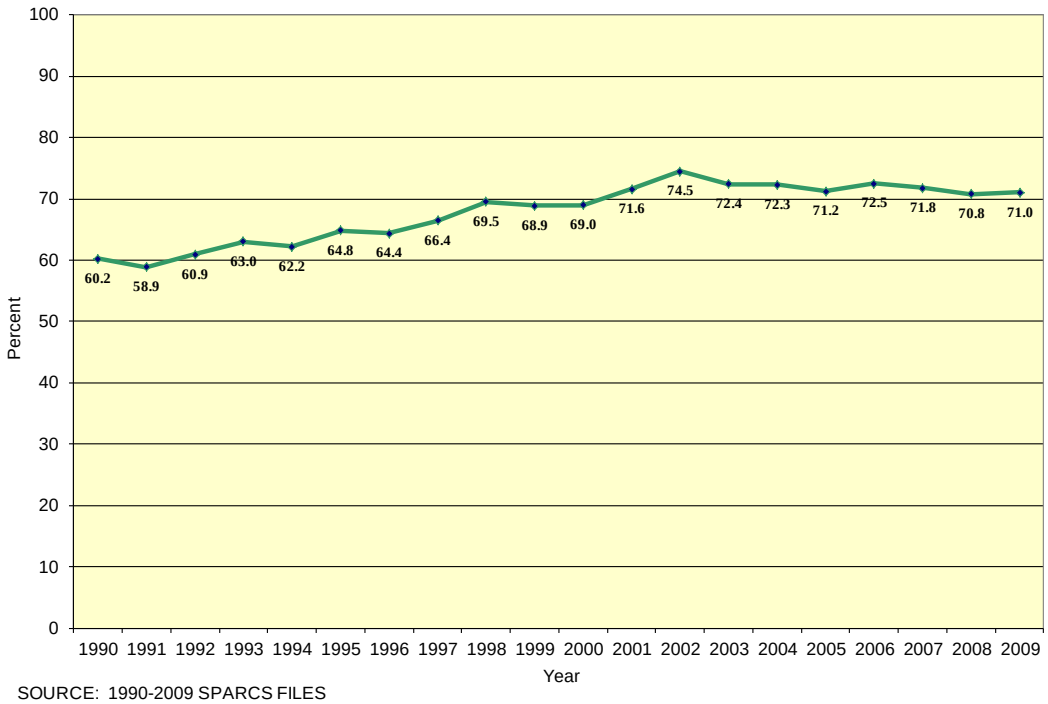
Suffolk - Percent of Severe Trauma Inpatients Treated at Trauma Centers



SOURCE: 1990-2009 SPARCS FILES

Chart 16

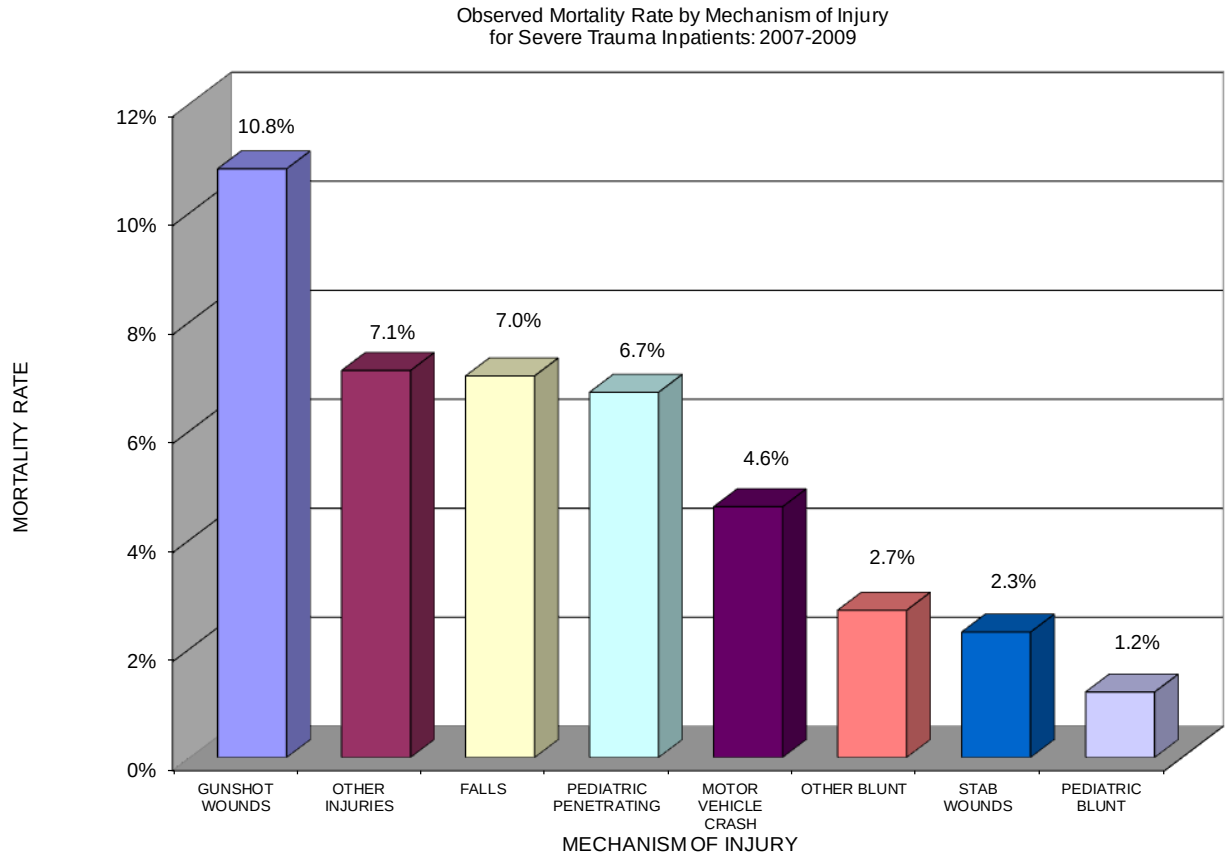
New York City - Percent of Severe Trauma Inpatients Treated at Trauma Centers



SOURCE: 1990-2009 SPARCS FILES

The overall statewide mortality rate for inpatients qualifying for inclusion in the 2007-2009 Registry was 5.5 percent (4,357 deaths among 78,959 patients). The mechanism of injury with the highest inpatient mortality rate among these patients was gunshot wounds, with a 10.8 percent mortality rate. The mechanisms of injury with the next highest mortality rates among adults were "other injuries" (7.1 percent), falls (7.0 percent), motor vehicle crashes (4.6 percent), and other blunt injuries (2.7 percent). The mechanism of injury with the lowest mortality rate among adult trauma inpatients qualifying for the Registry was stab wounds (2.3 percent). The mortality rates for pediatric patients were 6.7 percent for penetrating injuries and 1.2 percent for blunt injuries (see Chart 17).

Chart 17

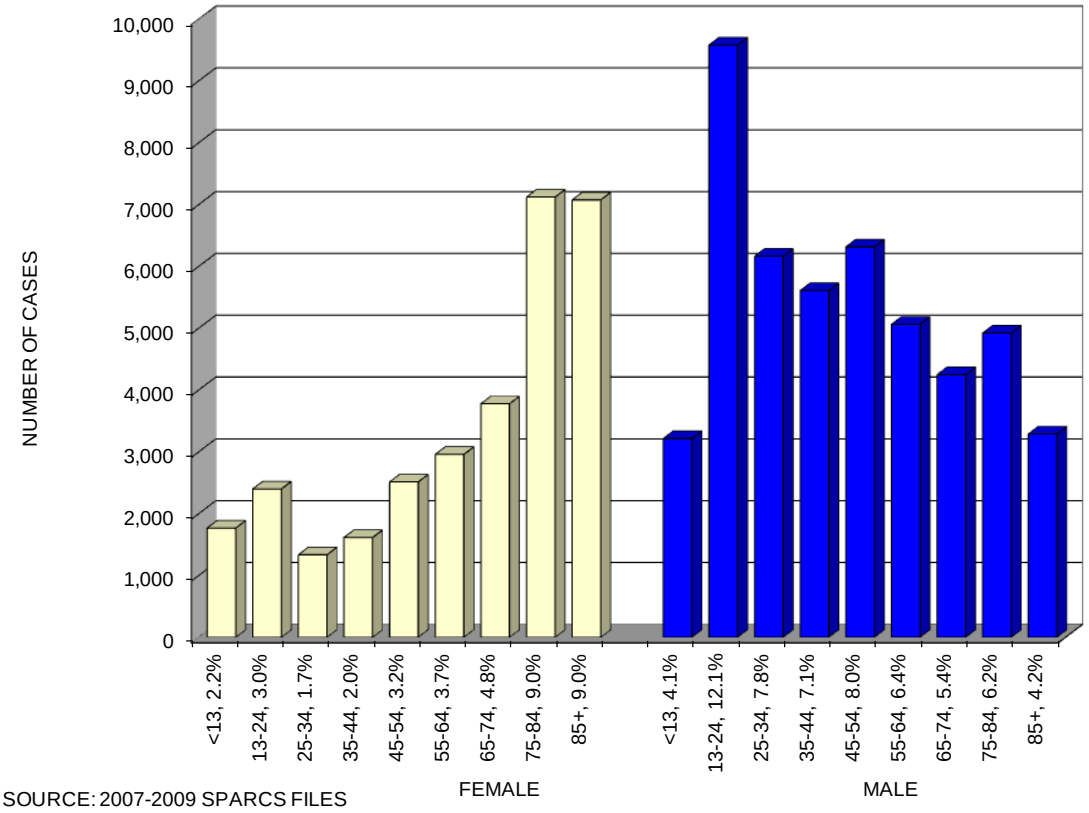


SOURCE: 2007-2009 SPARCS FILES

Among the inpatients qualifying for the 2007-2009 Registry, 61.3 percent were males. The age group among males with the highest percentage of trauma inpatients was 13-24 (12.1 percent), followed by males 45-54 (8.0 percent of all patients) and by males 25-34 (7.8 percent of all patients). Whereas the most common age ranges for men in the Trauma Registry were the younger groups, the most populous groups among females were the more elderly, with the two groups of ages 75-84 and ages 85 and higher each comprising 9.0 percent of all patients. Generally, men were less likely to be in the Registry with increasing age, whereas women after age 65 became more likely to be in the Registry (see Chart 18).

Chart 18

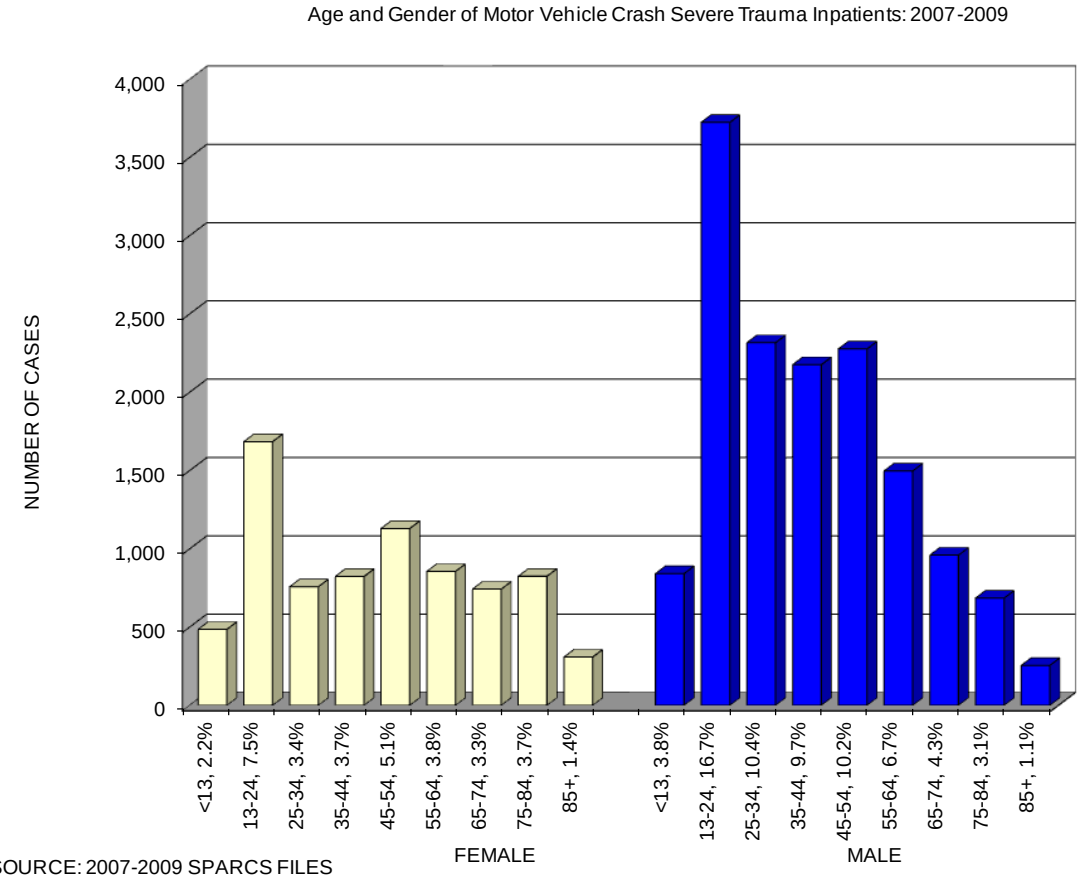
Age and Gender of Severe Trauma Inpatients: 2007-2009



SOURCE: 2007-2009 SPARCS FILES

Of the 22,334 inpatients qualifying for the 2007-2009 Registry who were victims of motor vehicle crashes, 65.9 percent were males. The percentage of males in the Registry declined by age group from a high of 16.7 percent of all inpatients for ages 13-24 to 1.1 percent for ages 85 and older. Males 25-34 comprised 10.4 percent of all patients and males 45-54 comprised 10.2 percent of all patients. The number of hospitalized female inpatients who were victims of motor vehicle crashes also declined with age for the most part, but not as precipitously. More females than males 75 and older were hospitalized victims of motor vehicle crashes, whereas for nearly every age group below 75, more men than women were hospitalized subsequent to motor vehicle crashes (see Chart 19).

Chart 19

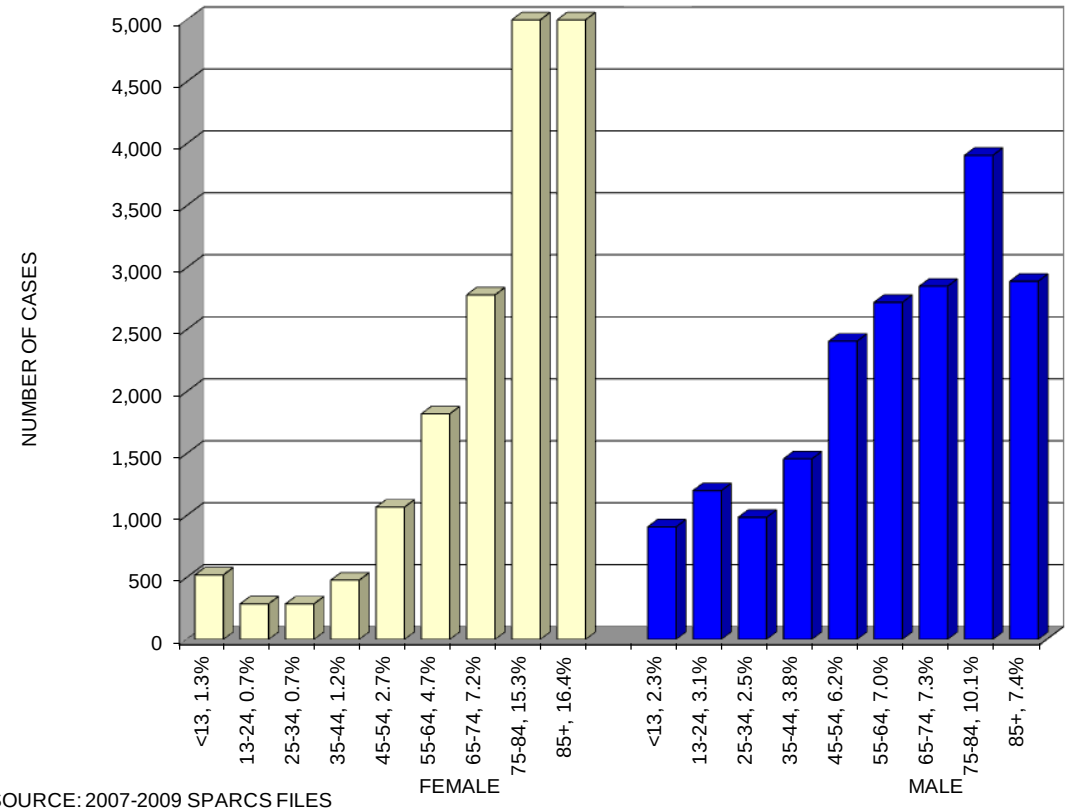


SOURCE: 2007-2009 SPARCS FILES

Of the 38,851 inpatients qualifying for the 2007-2009 Registry who were victims of falls, 50.3 percent were women. By far the most populous age/gender groups hospitalized with falls were women age 75-84 and 85 and above, which comprised 15.3 percent and 16.4 percent of all patients. These groups were followed by males between 75 and 84 (10.1 percent of all patients) and by males age 85 and above (7.4 percent of all patients). The number of females hospitalized with falls rose with age, with the largest increases occurring at ages 55, 65 and 75. The relationship with age was not as accentuated among men, with men of lower ages hospitalized more often with falls than women of the same age, and not nearly as many elderly men as women were hospitalized with falls (see Chart 19). This phenomenon is likely a result of greater longevity among women since more women are alive to experience falls.

Chart 19

Age and Gender of Falls Severe Trauma Inpatients: 2007-2009

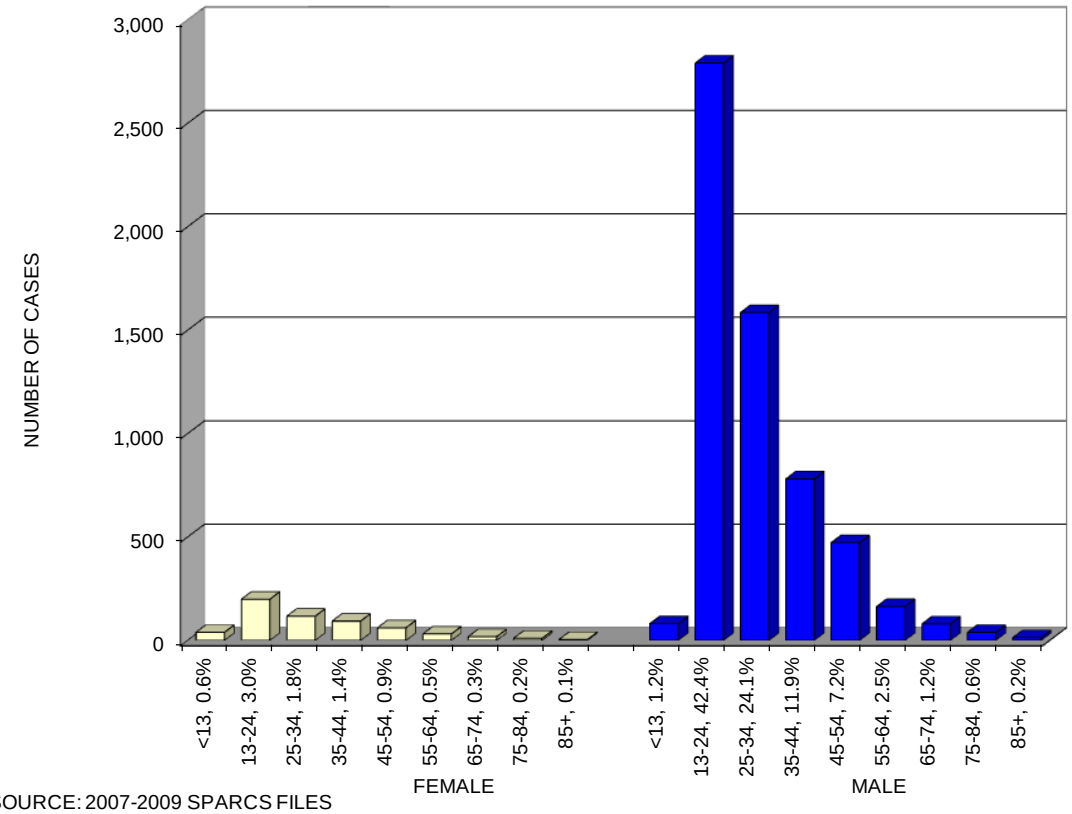


SOURCE: 2007-2009 SPARCS FILES

Of the 6,579 inpatients qualifying for the 2007-2009 Registry who were victims of penetrating injuries, 91.3 percent were males. The vast majority of these males were between ages 13 and 24 (42.4 percent of all patients), 25-34 (24.1 percent of all patients), and 35-44 (11.9 percent of all patients). The most common age group among women who were hospitalized victims of penetrating injuries was 13 to 24 (3.0 percent of all patients) (see Chart 21).

Chart 20

Age and Gender Penetrating Injuries Severe Trauma Inpatients: 2007-2009



SOURCE: 2007-2009 SPARCS FILES

DESCRIPTIVE STATISTICS DEVELOPED FROM THE NEW YORK STATE TRAUMA REGISTRY

Table 1 and Table 2 present the distribution of patients in the NYSTR by region according to level of trauma center designation (regional trauma center, area trauma center) and mechanism of injury (motor vehicle crash, fall, other blunt injury, gunshot wound, stab wound). Among the inpatients in the models used to assess hospital performance, 82.4 percent were treated at regional centers while 17.6 percent were treated at area trauma centers. In Western New York, Finger Lakes, and New York City, 100 percent of the patients were treated at regional centers since there are no area centers in those regions. The region with the next largest percent of patients treated at regional centers was Nassau with 88.8 percent. The region with the smallest percent of patients treated at regional centers was Suffolk with 40.7 percent.

Among the inpatients in the models used to assess hospital performance, 39.7 percent were victims of falls. This percentage ranged from a low of 29.5 percent in Western New York to a high of 53.5 percent in Nassau. Among the eight regions in New York State, penetrating injuries (stab wounds and gunshot wounds) ranged from 4.7% (Nassau) to 21.6% (New York City) of the total patients.

Table 1
Distribution of New York State Inpatients by Region and Level
Five Adult Mechanisms of Injury: 2007 – 2009

Region	Regional Trauma Centers n (%)	Area Trauma Centers n (%)	Total
Western	3,544 (100.0%)	0 (0.0%)	3,544 (7.2%)
Finger Lakes	3,222 (100.0%)	0 (0.0%)	3,222 (6.6%)
Central	2,903 (62.0%)	1,777 (38.0%)	4,680 (9.6%)
Northeastern	3,428 (84.1%)	648 (15.9%)	4,076 (8.3%)
Hudson Valley	2,955 (55.1%)	2,405 (44.9%)	5,360 (11.0%)
Nassau	4,924 (88.8%)	623 (11.2%)	5,547 (11.3%)
Suffolk	2,163 (40.7%)	3,158 (59.3%)	5,321 (10.9%)
New York City	17,190 (100.0%)	0 (0.0%)	17,190 (35.1%)
Total	40,329 (82.4%)	8,611 (17.6%)	48,940 (100.0%)

Table 2
Distribution of New York State Inpatients
by Region and Five Adult Mechanisms of Injury: 2007 – 2009

Region	Motor Vehicle Crashes n (%)	Other Blunt Injuries n (%)	Falls n (%)	Stab Wounds n (%)	Gunshot Wounds n (%)	Total
Western	1,617 (45.6%)	361 (10.2%)	1,044 (29.5%)	239 (6.7%)	283 (8.0%)	3,544 (7.2%)
Finger Lakes	1,555 (48.3%)	250 (7.8%)	1,061 (32.9%)	188 (5.8%)	168 (5.2%)	3,222 (6.6%)
Central	2,223 (47.5%)	412 (8.8%)	1,696 (36.2%)	209 (4.5%)	140 (3.0%)	4,680 (9.6%)
Northeastern	1,865 (45.8%)	360 (8.8%)	1,594 (39.1%)	155 (3.8%)	102 (2.5%)	4,076 (8.3%)
Hudson Valley	2,551 (47.6%)	453 (8.5%)	2,067 (38.6%)	214(4.0%)	75 (1.4%)	5,360 (11.0%)
Nassau	1,948 (35.1%)	367 (6.6%)	2,969 (53.5%)	152 (2.7%)	111 (2.0%)	5,547 (11.3%)
Suffolk	2,258 (42.4%)	428 (8.0%)	2,362 (44.4%)	179 (3.4%)	94 (1.8%)	5,321 (10.9%)
New York City	4,661 (27.1%)	2,165 (12.6%)	6,644 (38.7%)	2,155 (12.5%)	1,565 (9.1%)	17,190 (35.1%)
Total	18,678 (38.2%)	4,796 (9.8%)	19,437 (39.7%)	3,491 (7.1%)	2,538 (5.2%)	48,940 (100.0%)

DATA ANALYSES

METHODS FOR ANALYSES OF REGISTRY DATA

Assessing Risk-Adjusted Mortality Rates for Regions and for Levels of Care

As part of the effort to understand the determinants of adverse outcomes of care and to improve the overall quality of trauma care in the State, statistical models have been developed to predict trauma inpatient mortality and mortality that occurs among trauma inpatients in the New York State Trauma Registry. These models have been used to assess the quality of care for different regions of the State and for different levels of care (regional trauma center and area trauma center). The measure of quality used is risk-adjusted mortality rate. Following are the steps taken in the development of risk-adjusted mortality rates by region and level.

Obtaining and Cleaning the Data

Inpatients qualified for the Registry based on the nature of their injuries as represented by the diagnosis codes assigned to their records. To ensure that all appropriate inpatient records were being submitted, the School of Public Health at the University at Albany, State University of New York (SUNY), which serves as the data coordinator and evaluator for the project, compared the inpatient records with data from the Department of Health's SPARCS acute care database. Any missing records that met the Registry definition and were not contained in the data submitted by the centers were then brought to the attention of the centers that either subsequently submitted the data or justified why it was not submitted (e.g., the traumatic event occurred during a hospital admission, the event was not trauma-related, etc.). The School of Public Health edited the data and readied it for further analysis.

Predicting the Probability of Death for Each Inpatient

First, the inpatient data were subdivided into several mechanisms of injury (MOI) classifications for adult patients (age≥13 years): three groups for blunt injuries (motor vehicle crashes, falls and other blunt injuries), and two groups for penetrating injuries (stab wounds, gunshot wounds). Please note that pediatric patients are not included in the risk-adjusted mortality section of this report. Although previous reports used low falls as an MOI category and "other blunt" as the remaining falls and non-MVC blunt injury patients, this report used falls as one category and then defined "other blunt" as all blunt injuries not involving falls or MVCs because the ability to predict mortality was found to be superior with this approach.

For each of the three blunt injury groups and two penetrating injury groups, statistical models were developed to predict the individual patient's chance of dying in the hospital after admission. Mortality was measured as a function of various physiologic and anatomic risk factors. Most earlier studies had either attempted to predict mortality/survival with a single statistical model for all patients or by using only two models (one for blunt injuries and one for penetrating injuries); however, these approaches did not accurately predict mortality for each of the five mechanisms of injury. Consequently, separate models were developed for each mechanism of injury. Each model was used to assess performance across regions and between levels of care.

Various types of patients whose records included trauma diagnoses were excluded from the statistical analyses. Patients with E-codes[1] that represent late effects of injuries or surgical/medical misadventures[2] were excluded as were patients with a principal diagnosis of burn. Patients who, on arrival at the hospital, had a Glasgow Coma Scale (GCS) of three, no systolic blood pressure, no

[1] An E-code classifies environmental events, circumstances, and other conditions as the cause of injury and other adverse effects.

[2] A surgical/medical misadventure is an error or complication that arises from surgical or medical treatment.

respirations, no pulse, and who subsequently died, were excluded. Also excluded were patients who, upon the ambulance's arrival at the scene, had a GCS of three, no systolic blood pressure, no respirations, and no documented pulse.

Consistent with other trauma care studies, demographic and physiologic risk factors considered included the patient's age, GCS, gender, respiratory rate, systolic blood pressure, and a measure of injury severity. Quadratic terms for the two continuous variables, age and systolic blood pressure, were also tested. Also, for the age variable, a continuous, piecewise linear function was tested. Intubation status in the field, at the referring hospital, and upon arrival at the final hospital were also tested as predictors of mortality.

The GCS is comprised of three components: eye opening, verbal response, and motor response. Some statistical models, including those for this report, analyze these components separately rather than combining them into the GCS. Verbal response cannot be accurately measured in intubated patients and, for this reason, was excluded from the models for this report. Respiratory rate, which has been used in some other studies, was not used because it too, is not accurately measured in intubated patients. The eye opening, motor response, and systolic blood pressure measurements used were the first ones recorded in the ED report. If these measurements were not available in the ED report, the last recorded values in the Prehospital Care Report were used.

Also, the MVC model included a binary variable that denoted whether the injured patient was a pedestrian (instead of a driver or passenger of a motor vehicle), and the falls injury model included a binary variable to denote whether the injured patient had suffered a high fall (instead of another type of fall injury). The variable designating high fall was not a significant predictor of mortality. These last two strategies were attempts to delineate the uniqueness of more types of mechanisms of injury.

Another risk factor that was considered was the patient's transfer status. Being treated at the emergency department of one hospital and then transported to a second hospital was investigated as a predictor of mortality, and being admitted to one hospital and then being transferred to a second hospital was also tested as a possible predictor.

The next step consisted of identifying an anatomic measure (a measure of injury severity) to add to the demographic and physiologic variables being considered in each of the statistical models. Injury severity has been characterized in several ways in the trauma literature, all of which depend on ICD-9-CM diagnoses codes as the most basic components. The measure used was the International Classification of Diseases, Ninth Revisions-based Injury Severity Score (ICISS), developed by researchers in North Carolina[3]. The ICISS predicts that the injury severity component of a patient's mortality rate is the overall survival rate subtracted from one, where the overall survival rate is estimated as the product of the survival rates for each individual injury diagnosis in some comparable database, without regard to whatever other injury diagnoses each patient has. The survival rate for an individual injury is defined as the number of patients with that diagnosis who were discharged alive divided by the total number of patients with the diagnosis. The database used to derive the survival rate for each injury diagnosis was the federal Agency for Health Care Policy and Research Health Care Utilization Project's (HCUP) Nationwide Inpatient Sample (NIS) 2008.

Thus, the set of variables considered as potential predictors of mortality for each mechanism of injury were age, gender, systolic blood pressure, eye opening, motor response, ICISS, intubation in the field/referring hospital/upon arrival at the final hospital, patient being treated at the emergency department of one hospital and then transported to a second hospital, and patient being admitted to one hospital and then being transferred to a second hospital. Also, pedestrian status was used as a candidate variable in the MVC model and high fall status was used as a candidate variable in the falls model.

[3] Osler T, Rutledge R, Deis J, Bedrick E. ICISS: An international classification of disease-9 based injury severity score. *J Trauma.* 1996; 41:380-388.

Cases not containing all of the significant variables were relatively rare, with between 1.3 percent and 3.8 percent of the cases having missing values across mechanisms of injury. These cases were included in the analyses (because their mortality rates varied across hospitals, regions, and levels of care) by imputing the values of their missing data elements using multiple imputation methods.

Stepwise logistic regression was used to develop the models. This statistical methodology has been employed in most other studies that predict survival for trauma patients. It consists of determining which of the risk factors are significantly related to inpatient death for trauma patients and determining how to weight the predictors to obtain a predicted probability of death for each trauma inpatient. For each imputation of each MOI's data set, backwards stepwise regression was used to identify variables significantly related to mortality. A review of the resultant significant variables at each iteration determined the variables to be offered to each of the five imputed data sets for the next iteration. Categories for some variables were combined, as appropriate. When the final set of predictors was identified, the coefficients from the five imputed data sets were combined to produce the final model for the MOI.

Predicting Mortality Rates for Regions and Levels of Care for Each Mechanism of Injury

The mortality rate for each of the eight regions of the state and the two levels of care was then predicted using the statistical model. The resulting rate is an estimate of the relative chance of survival of that group's patients, or equivalently, an estimate of what that group's mortality rate would have been if its performance had been identical to the statewide performance. This rate is referred to as the **expected or predicted mortality rate.**

Computing the Risk-Adjusted Mortality Rate for Each Mechanism of Injury

The **risk-adjusted mortality rate** represents the best estimate, based on the associated statistical model, of what the group's mortality rate would have been if the group had a mix of patients identical to the statewide mix. Thus, the risk-adjusted mortality rate has, to the extent possible, mitigated differences among groups in patient severity of illness. It arrives at a mortality rate for each provider on an identical group of patients.

The risk-adjusted mortality rate is typically calculated by dividing a group's observed mortality rate by the expected mortality rate. The **observed mortality rate** is the number of inpatient deaths in the group divided by the number of patients in the group. If the resulting ratio of the observed mortality rate divided by the expected mortality rate is larger than one, the group has a higher mortality rate than expected on the basis of its patient mix; if it is smaller than one, the group has a lower mortality rate than expected from its patient mix. The ratio is then multiplied by the overall statewide mortality rate to obtain the group's risk-adjusted rate.

As stated above, imputation methods were used to estimate values for missing variables used in the logistic regression models. Each cycle of the imputation produced an estimate of the risk-adjusted mortality rate for a particular group. The overall estimate of a group's risk-adjusted mortality rate was calculated by averaging the risk-adjusted mortality rates derived from the iterations of the imputation method.

Confidence intervals for the risk-adjusted mortality rate indicate which groups had significantly more or fewer deaths than expected given the risk factors of their patients. Groups with significantly higher rates than expected after adjusting for risk are those with confidence intervals entirely above the statewide rate. Groups with significantly lower rates than expected given the injury severity of their patients have confidence intervals entirely below the statewide rate.

Interpreting the Risk-Adjusted Mortality Rate

If the risk-adjusted mortality rate is lower than the statewide mortality rate, the group has a better performance than the state as a whole; if the risk-adjusted mortality rate is higher than the statewide mortality rate, the group has a worse performance than the state as a whole. Also, groups are designated as statistically significantly higher (lower) than the statewide rate if the confidence interval for the group's risk-adjusted rate is entirely above (below) the statewide rate. The risk-adjusted mortality rate and its confidence interval are used in this report as measures of quality of care provided by regions and levels of care.

There are reasons that a group's risk-adjusted mortality rate may not be indicative of its true quality. For example, extreme outcome rates may occur due to chance alone. This is particularly true for low-volume hospitals, for whom very high or very low mortality rates are more likely to occur than for high-volume hospitals. An attempt to prevent misinterpretation of differences caused by chance variation is the use of expected ranges (confidence intervals) in the reported results.

Differences in hospital coding of risk factors could be an additional reason that a provider's risk-adjusted rate may not be reflective of quality of care. If some hospitals have a tendency not to code some patient injuries in SPARCS, those hospitals are at a disadvantage relative to other hospitals because their patients' injury severity will be underestimated.

Another reason that risk-adjusted rates may be misleading is that injury severity may not be accurately estimated because important risk factors/predictors of in-hospital mortality are not contained in the statistical model for predicting mortality. This is a particular concern for regional trauma centers because non-centers, and sometimes area trauma centers, tend to triage the most seriously injured patients to regional trauma centers. These are the patients for whom injury severity is most likely to be underestimated. Although no important risk factors identified in other studies have been omitted in the risk-adjustment methodology used in this report, there remains the possibility that other, unidentified risk factors could yield a better predictive formula if they had been included in the statistical model.

Although the risk-adjusted mortality rates presented here should not be considered as definitive reflections of the quality of care, this information can be a valuable aid in identifying key issues for overall systems development and important opportunities for additional study to improve the delivery of trauma care throughout New York State.

ANALYSIS BY MECHANISM OF INJURY

Motor Vehicle Crashes

Regional Comparisons

In the 2007-2009 Registry, there were a total of 18,678 motor vehicle crash (MVC) inpatients in the logistic regression model. A total of 966 of these patients (5.17 percent) died in the hospital during the same admission. Appendix 3 presents the significant risk factors for mortality of trauma inpatients who were victims of MVCs, the coefficients for these risk factors, levels of statistical significance, and a measure of fit of the statistical model.

Table 3 presents the number of MVC inpatients, the percentage of all MVC inpatients, the number of deaths, the observed mortality rate, the expected mortality rate, and the risk-adjusted mortality rate with its 95 percent confidence interval for each region. Figure 4 presents the risk adjusted mortality rate for each region along with its 95 percent confidence interval.

New York City had the largest number of MVC inpatients in the model (4,661 or 24.95 percent of all patients). The region with the fewest MVC inpatients was Finger Lakes with 1,555 patients (8.33 percent).

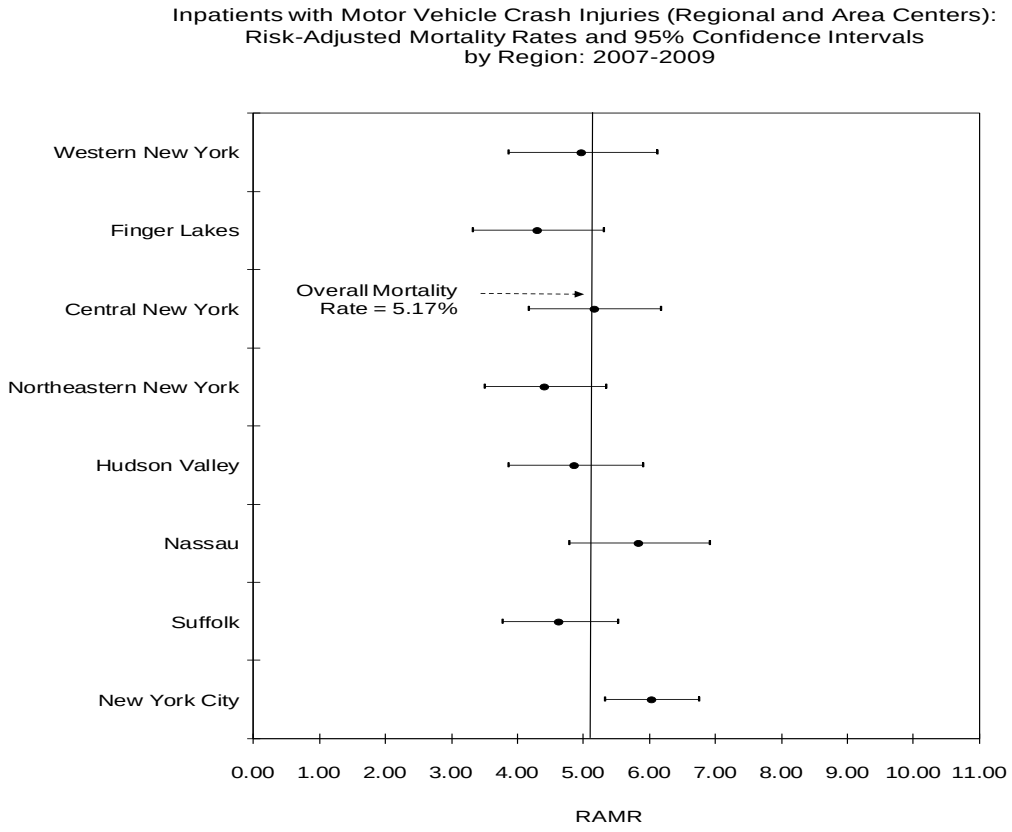
Observed mortality rates ranged from 3.65 percent to 6.31 percent, and expected mortality rates (a measure of relative injury severity) ranged from 3.87 percent to 6.01 percent. The risk-adjusted mortality rate, a measure of relative performance, ranged from 4.31 percent in the Finger Lakes to 6.03 percent in New York City. A comparison of the 95 percent confidence intervals for each region's risk-adjusted mortality rate with the overall statewide in-hospital mortality rate for MVC patients demonstrates that New York City had a significantly higher mortality rate than expected (because the statewide rate of 5.17 percent is not contained in the confidence interval for New York City's risk-adjusted mortality rate).

Table 3
Statistical Significance of Risk-Adjusted Mortality Rates
Motor Vehicle Crash Injuries
Inpatients (Regional and Area Centers)

Region	Number Of Patients	Percent Of Patients	Number Of Deaths	Observed Mortality Rate	Expected Mortality Rate	Risk-Adjusted Mortality Rate	Confidence Interval For RAMR
Western	1,617	8.66	79	4.89	5.07	4.98	(3.85, 6.12)
Finger Lakes	1,555	8.33	78	5.02	6.01	4.31	(3.32, 5.30)
Central	2,223	11.90	108	4.86	4.86	5.17	(4.17, 6.17)
Northeastern	1,865	9.99	93	4.99	5.84	4.42	(3.49, 5.34)
Hudson Valley	2,551	13.66	93	3.65	3.87	4.87	(3.85, 5.89)
Nassau	1,948	10.43	123	6.31	5.59	5.84	(4.78, 6.90)
Suffolk	2,258	12.09	116	5.14	5.73	4.64	(3.77, 5.51)
New York City	4,661	24.95	276	5.92	5.08	6.03	**(5.31, 6.75)**
Total	18,678	100.00	966	5.17	-----	-----	----------

As shown in Figure 4, the lower bound of the confidence interval on NYC's risk-adjusted mortality rate is above the statewide rate.

Figure 4



Comparisons for Different Levels of Care

Table 4Table 4 presents the number of inpatients, the percentage of all inpatients, the number of deaths, the observed mortality rate, the expected mortality rate, and the risk-adjusted mortality rate with its 95 percent confidence interval for the two levels, regional and area, of trauma center care for MVC patients in 2007-2009. Figure 5 presents the risk-adjusted mortality rate and its 95 percent confidence interval for each level of trauma center designation.

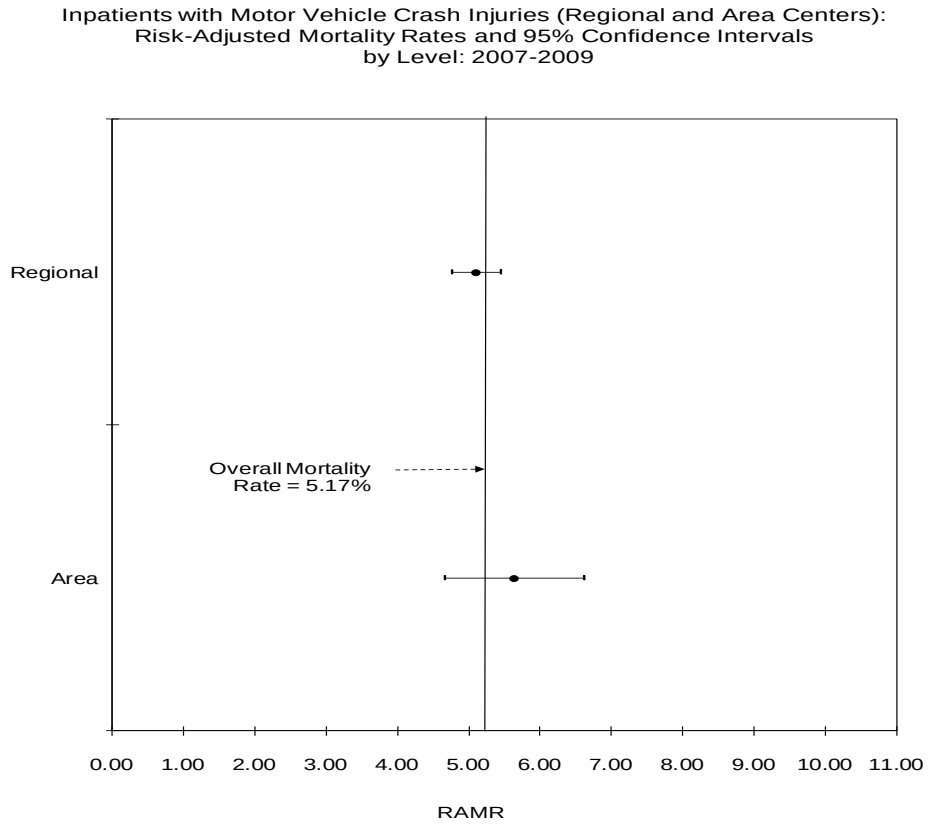
Regional centers accommodated 82.51 percent of all MVC inpatients in the 2007-2009 data. The 2007-2009 observed morality rate for regional centers (5.40 percent) was considerably higher than the rate for area centers (4.10 percent); however, regional centers cared for the most severely injured patients as indicated by their expected mortality rate (5.47 percent), which was much higher than the expected rate for area centers (3.76 percent). These rates show there is a strong tendency to triage the more seriously injured MVC patients to regional trauma centers.

After adjusting for severity of injury, regional centers had the lower risk-adjusted mortality rate (5.10 percent) compared to that of the area centers (5.64 percent). Neither of these risk-adjusted mortality rates was significantly different from the statewide mortality rate.

Table 4
Statistical Significance of Risk-Adjusted Mortality Rates
Motor Vehicle Crash Injuries
Inpatients (Regional and Area Centers)

Level	Number Of Patients	Percent Of Patients	Number Of Deaths	Observed Mortality Rate	Expected Mortality Rate	Risk- Adjusted Mortality Rate	Confidence Interval For RAMR
Regional	15,411	82.51	832	5.40	5.47	5.10	(4.75, 5.45)
Area	3,267	17.49	134	4.10	3.76	5.64	(4.66, 6.62)
Total	18,678	100.00	966	5.17	------	------	----------

Figure 5



Other Blunt Injuries

Regional Comparisons

"Other blunt injuries" are blunt injuries that are neither motor vehicle crash-related nor falls. Some examples of these injuries are being struck by an object or person, accidents caused by machinery or explosions, and intentionally self-inflicted injuries. There were a total of 4,796 hospital inpatients in the Registry in New York State in 2007-2009. A total of 133 of these patients (2.77 percent) died in the hospital during the same admission. Appendix 4 presents the significant risk factors for mortality of trauma inpatients who suffered other blunt injuries, along with coefficients for these risk factors, levels of statistical significance, and a measure of fit of the statistical model.

For inpatients with other blunt injuries by region, Table 5 presents the number of patients, the percentage of patients, the observed mortality rate, the expected mortality rate, the risk-adjusted mortality rate and its 95 percent confidence interval. Figure 6 presents the risk-adjusted mortality rate and 95 percent confidence interval for each region.

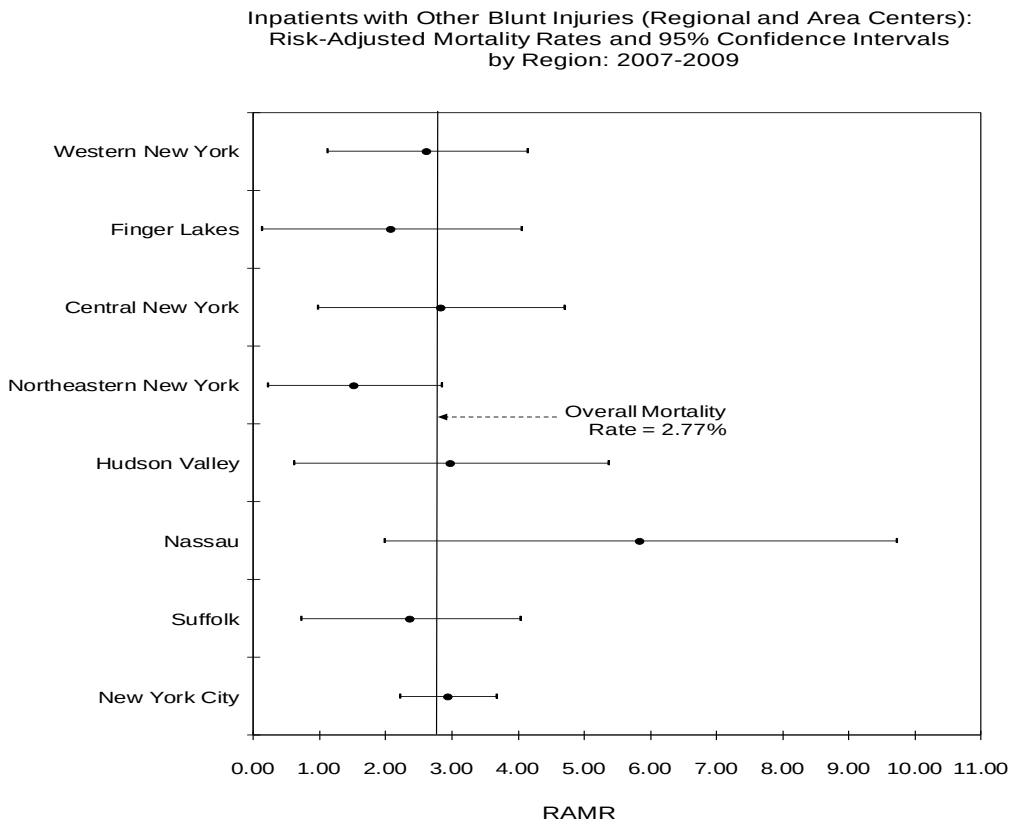
The region with the most patients with other blunt injuries was New York City, with 2,165 patients (45.14 percent). Finger Lakes had the fewest patients with other blunt injuries (250 or 5.21 percent of the total), followed by Northeastern New York with 360, or 7.51%, of the total.

Observed mortality rates for patients with other blunt injuries varied by region from 1.77 percent to 3.88 percent, and expected mortality rates ranged from 1.42 percent to 4.10 percent. Risk-adjusted mortality rates ranged from 1.52 percent in Northeastern New York to 5.84 percent in Nassau. No region had a risk-adjusted mortality rate that was significantly different from the statewide rate.

Table 5
Statistical Significance of Risk-Adjusted Mortality Rates
Other Blunt Injuries
Inpatients (Regional and Area Centers)

Region	Number Of Patients	Percent Of Patients	Number Of Deaths	Observed Mortality Rate	Expected Mortality Rate	Risk-Adjusted Mortality Rate	Confidence Interval For RAMR
Western	361	7.53	14	3.88	4.10	2.62	(1.11, 4.14)
Finger Lakes	250	5.21	6	2.40	3.20	2.08	(0.11, 4.04)
Central	412	8.59	11	2.67	2.62	2.83	(0.96, 4.70)
Northeastern	360	7.51	7	1.94	3.54	1.52	(0.21, 2.83)
Hudson Valley	453	9.45	8	1.77	1.64	2.99	(0.61, 5.36)
Nassau	367	7.65	11	3.00	1.42	5.84	(1.97, 9.71)
Suffolk	428	8.92	10	2.34	2.74	2.37	(0.71, 4.02)
New York City	2,165	45.14	66	3.05	2.88	2.94	(2.20, 3.67)
Total	4,796	100.00	133	2.77	-----	-----	----------

Figure 6



Comparison for Different Levels of Care

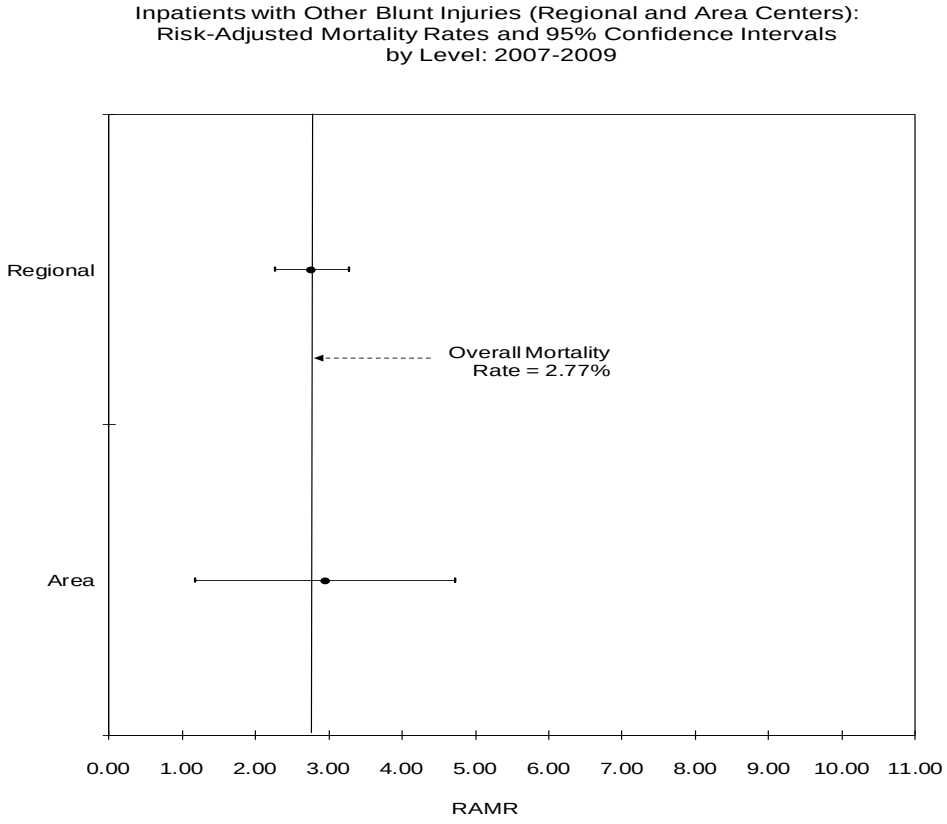
Table 6 contains the number of patients, percent of patients, number of deaths, observed mortality rate, expected mortality rate and risk-adjusted mortality rate along with its 95 percent confidence interval for the two levels of care (regional trauma centers and area trauma centers) for patients with other blunt injuries. Figure 7 presents the risk-adjusted mortality rate and its 95 percent confidence interval for each level of trauma center designation. Regional centers treated 4,086 inpatients with other blunt injuries or 85.20 percent of the total.

Regional centers had the higher observed mortality rate for patients with other blunt injuries (2.94 percent). The observed mortality rate at area centers was 1.83 percent. Regional centers also treated the most severely injured patients, with an expected mortality rate of 2.96 percent compared to 1.72 percent at area centers. After accounting for what was observed and what was expected to obtain risk-adjusted mortality rates, regional centers were found to have a slightly lower rate of 2.76 percent compared to that of the area centers (2.95 percent). Neither rate was statistically different from the statewide rate.

Table 6
Statistical Significance of Risk-Adjusted Mortality Rates
Other Blunt Injuries
Inpatients (Regional and Area Centers)

Level	Number Of Patients	Percent Of Patients	Number Of Deaths	Observed Mortality Rate	Expected Mortality Rate	Risk- Adjusted Mortality Rate	Confidence Interval For RAMR
Regional	4,086	85.20	120	2.94	2.96	2.76	(2.25, 3.26)
Area	710	14.80	13	1.83	1.72	2.95	(1.17, 4.72)
Total	4,796	100.00	133	2.77	------	------	----------

Figure 7



Falls

Regional Comparisons

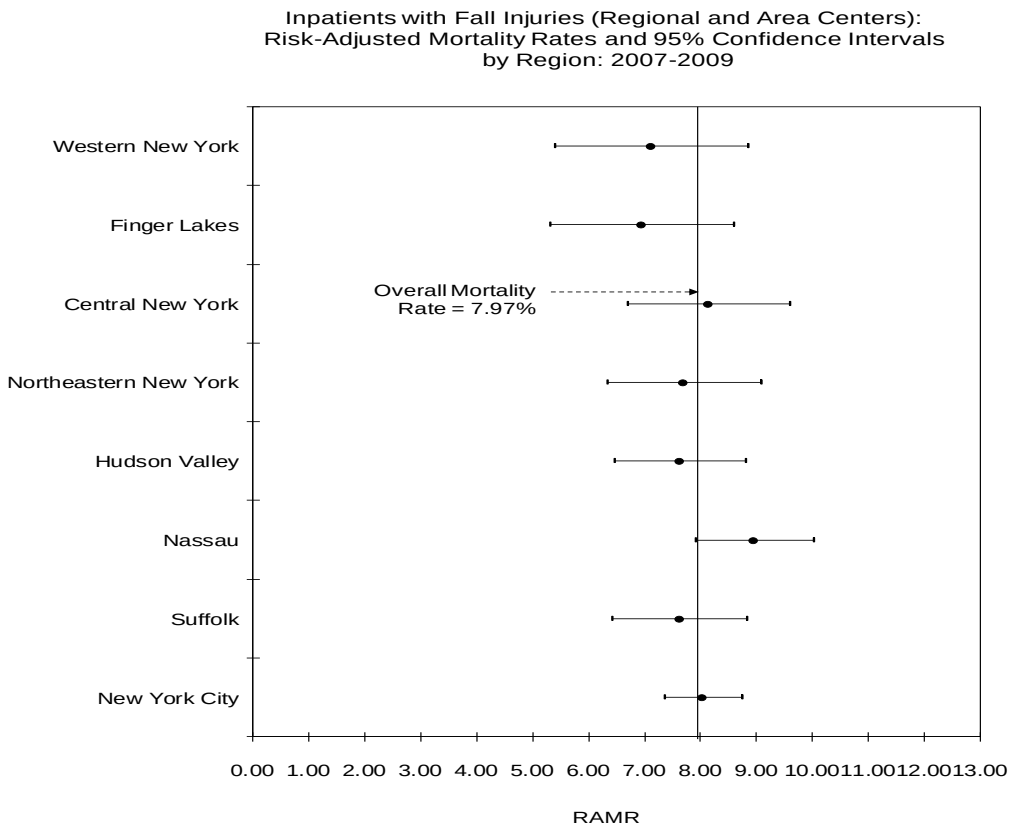
Falls are defined in terms of ICD-9-CM E-codes as a fall from the same or higher level. In New York State during the years 2007-2009, there were a total of 19,437 hospital inpatients with falls injury in the New York State Trauma Registry (see Table 7). A total of 1,549 of these patients (7.97 percent) died in the hospital during the same admission. Appendix 5 presents the significant risk factors for mortality of trauma inpatients in the database who suffered falls along with coefficients for these risk factors, levels of statistical significance, and measures of fit of the statistical model.

The observed inpatient mortality rates for patients suffering falls ranged from 6.70 percent in Western New York to 9.70 percent in Nassau. Expected mortality rates ranged from 7.22 percent in Suffolk to 8.63 percent in Nassau. Risk-adjusted mortality rates ranged from 6.94 percent in Finger Lakes to 8.95 percent in Nassau. No regions had risk-adjusted mortality rates that were either significantly lower or significantly higher than expected given the average severity of injury of their patients.

Table 7
Statistical Significance of Risk-Adjusted Mortality Rates
Falls Injuries
Inpatients (Regional and Area Centers)

Region	Number Of Patients	Percent Of Patients	Number Of Deaths	Observed Mortality Rate	Expected Mortality Rate	Risk-Adjusted Mortality Rate	Confidence Interval For RAMR
Western	1,044	5.37	70	6.70	7.51	7.11	(5.38, 8.84)
Finger Lakes	1,061	5.46	74	6.97	8.01	6.94	(5.30, 8.58)
Central	1,696	8.73	127	7.49	7.33	8.14	(6.69, 9.60)
Northeastern	1,594	8.20	127	7.97	8.25	7.69	(6.32, 9.07)
Hudson Valley	2,067	10.63	170	8.22	8.59	7.63	(6.46, 8.80)
Nassau	2,969	15.27	288	9.70	8.63	8.95	(7.90, 10.01)
Suffolk	2,362	12.15	163	6.90	7.22	7.62	(6.42, 8.82)
New York City	6,644	34.18	530	7.98	7.91	8.04	(7.35, 8.73)
Total	19,437	100.00	1,549	7.97	-----	-----	----------

Figure 8



Comparison for Different Levels of Care

Table 8 contains the number of patients, percent of patients, number of deaths, observed mortality rate, expected mortality rate and risk-adjusted mortality rate along with its 95 percent confidence interval for the two levels of care (regional trauma centers and area trauma centers) for falls patients. Figure 9 presents the risk-adjusted mortality rate and its 95 percent confidence interval for each level of care. Regional centers accommodated 15,251 falls patients (78.46 percent).

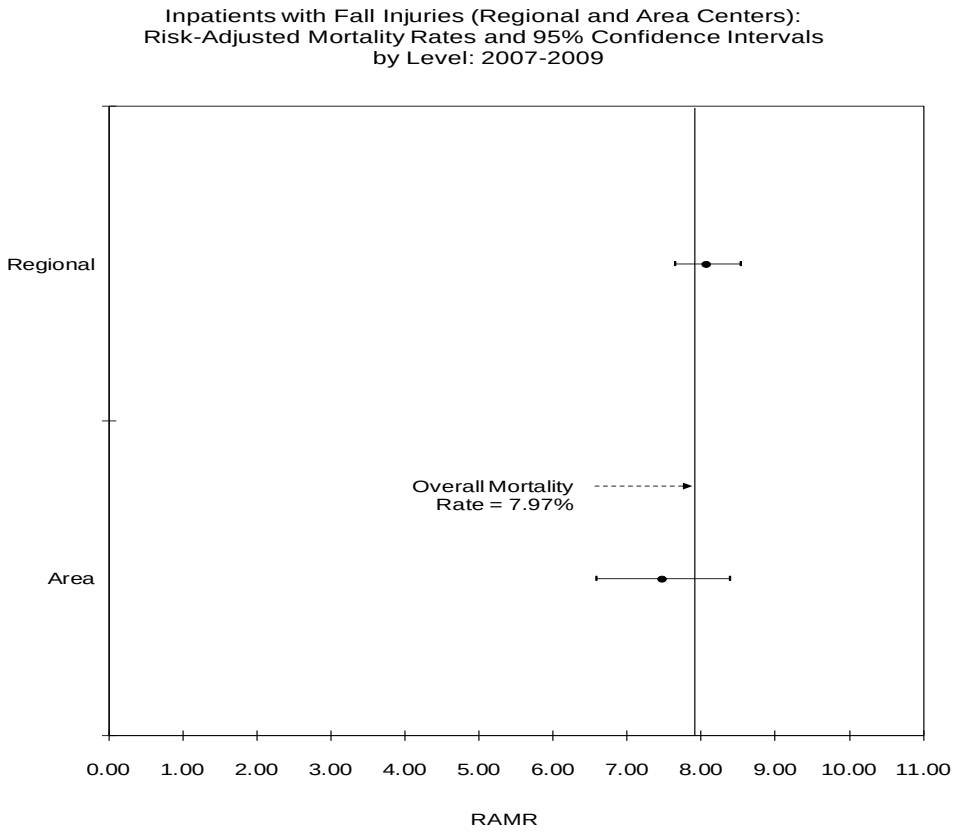
Regional centers had the higher observed mortality rate for falls patients (8.36 percent, vs. 6.55 percent for area centers); however, the expected mortality rate for regional centers (8.24 percent) was also high. The expected rate for area centers was 6.98 percent. After factoring in the observed and the expected rates for each level, regional centers had the higher risk-adjusted mortality rate (8.08 percent) relative to that of the area centers (7.47 percent). Neither rate was statistically different from the statewide rate.

Table 8

Statistical Significance of Risk-Adjusted Mortality Rates
Falls Injuries
Inpatients (Regional and Area Centers)

Level	Number Of Patients	Percent Of Patients	Number Of Deaths	Observed Mortality Rate	Expected Mortality Rate	Risk- Adjusted Mortality Rate	Confidence Interval For RAMR
Regional	15,251	78.46	1,275	8.36	8.24	8.08	(7.64, 8.53)
Area	4,186	21.54	274	6.55	6.98	7.47	(6.57, 8.38)
Total	19,437	100.00	1,549	7.97	------	------	----------

Figure 9



Stab Wounds

Regional Comparisons

There were a total of 3,491 stab wound inpatients in the 2007-2009 Registry. Eighty-one of these patients (2.32 percent) died in the hospital during the same admission. Appendix 6 presents the significant risk factors for mortality of trauma inpatients who suffered stab wounds along with coefficients for these risk factors, levels of statistical significance, and a measure of fit of the statistical model.

For inpatients with stab wounds by region, Table 9 presents the number of patients, the percentage of patients, the observed mortality rate, the expected mortality rate and the risk-adjusted mortality rate and its 95 percent confidence interval. Figure 10 presents the risk-adjusted mortality rate and its 95 percent confidence interval for each region.

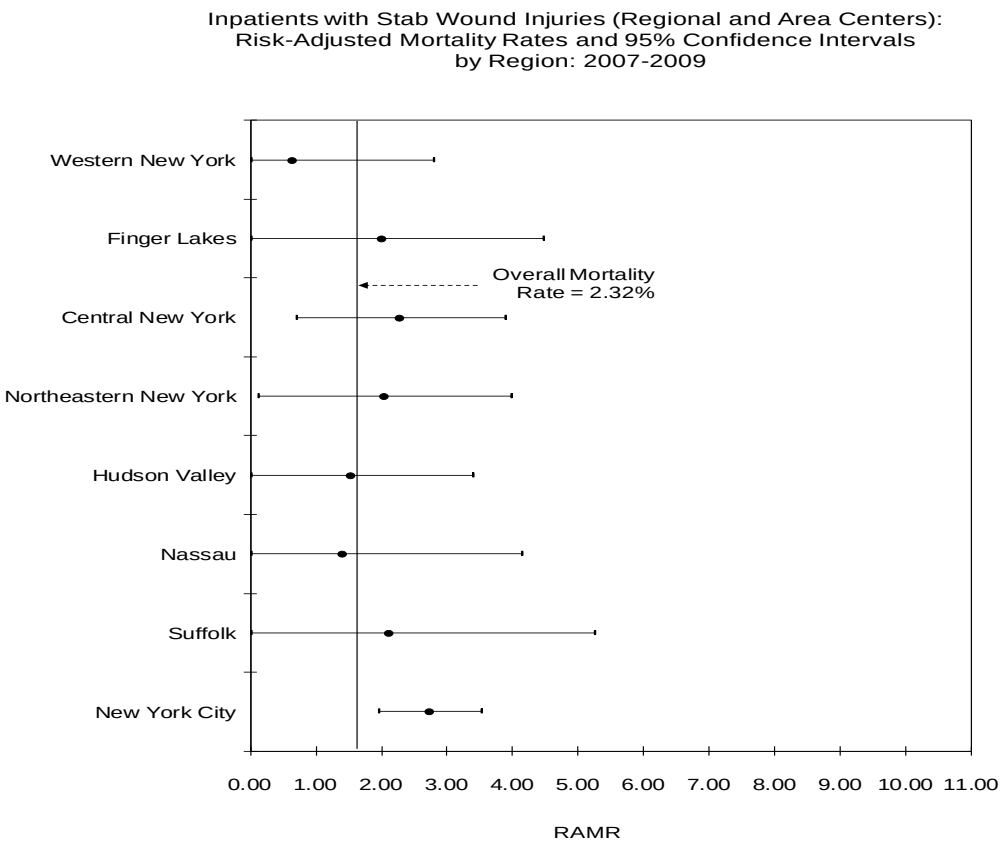
The region with the most patients with stab wounds was New York City with 2,155 patients (61.73 percent). Western New York had the second highest percentage with 6.85 percent, and Nassau had the lowest percentage of stab wound patients in the Registry (4.35 percent).

Observed mortality rates ranged from 0.42 percent in Western New York to 4.78 percent in Central New York. Expected mortality rates ranged from 1.50 percent to 4.85 percent. Risk-adjusted mortality rates ranged from 0.65 percent in Western New York to 2.74 percent in New York City. No regions had a risk-adjusted mortality rate that was statistically significantly lower or higher than expected.

Table 9
Statistical Significance of Risk-Adjusted Mortality Rates
Stab Wound Injuries
Inpatients (Regional and Area Centers)

Region	Number Of Patients	Percent Of Patients	Number Of Deaths	Observed Mortality Rate	Expected Mortality Rate	Risk-Adjusted Mortality Rate	Confidence Interval For RAMR
Western	239	6.85	1	0.42	1.50	0.65	(0.00, 2.79)
Finger Lakes	188	5.39	4	2.13	2.46	2.01	(0.00, 4.46)
Central	209	5.99	10	4.78	4.85	2.29	(0.69, 3.89)
Northeastern	155	4.44	6	3.87	4.39	2.05	(0.11, 3.98)
Hudson Valley	214	6.13	4	1.87	2.83	1.53	(0.00, 3.40)
Nassau	152	4.35	2	1.32	2.18	1.40	(0.00, 4.13)
Suffolk	179	5.13	3	1.68	1.83	2.12	(0.00, 5.25)
New York City	2,155	61.73	51	2.37	2.01	2.74	(1.95, 3.52)
Total	3,491	100.00	81	2.32	-----	-----	----------

Figure 10



Comparison for Different Levels of Trauma Center Designation

Table 10 contains the number of patients, the percent of patients, number of deaths, observed mortality rate, expected mortality rate, and risk-adjusted mortality rate along with its 95 percent confidence interval for the two levels of trauma center designation (regional and area) for patients with stab wounds. Figure 11 presents the risk-adjusted mortality rate and its 95 percent confidence interval for each level of designation. Regional centers treated 3,191 inpatients with stab wounds (91.41 percent of the total), while area centers treated the other 300 inpatients (8.59 percent).

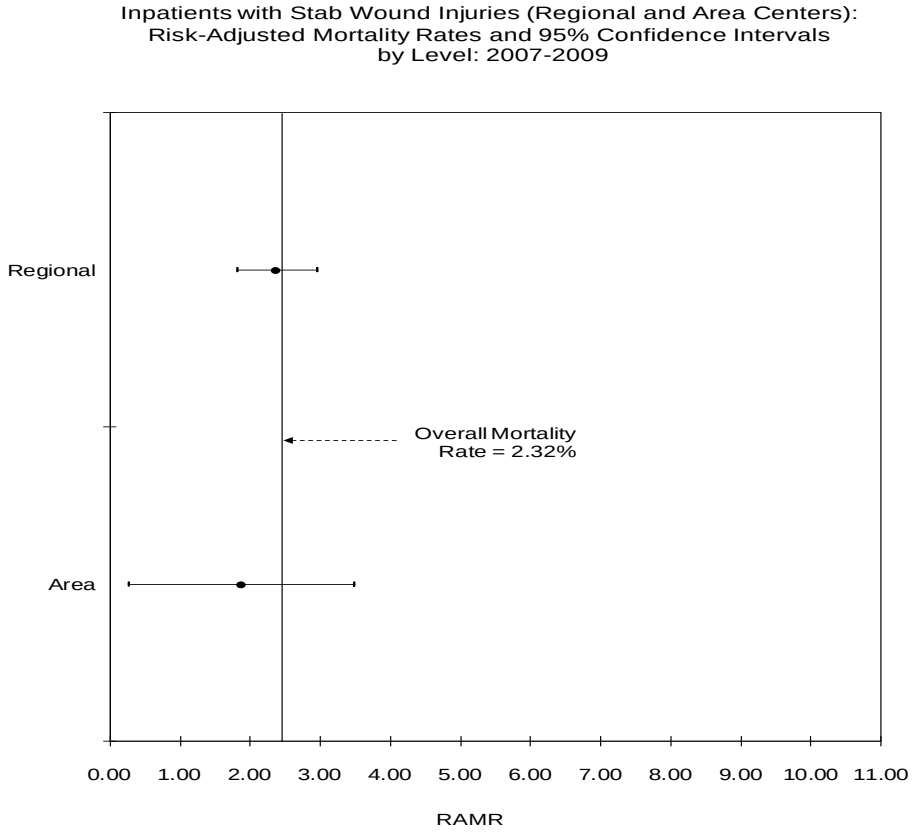
The observed mortality rate was about the same for regional centers (2.32 percent) and for area centers (2.33 percent). Area centers had the higher expected mortality rate of 2.90 percent while the regional expected rate was 2.27 percent.

A lower risk-adjusted mortality rate occurred among area centers (1.87 percent). The risk-adjusted rate for the regional centers was 2.37 percent. Neither of these rates was significantly different from the overall statewide rate of 2.32 percent.

Table 10
Statistical Significance of Risk-Adjusted Mortality Rates
Stab Wounds Injuries
Inpatients (Regional and Area Centers)

Level	Number Of Patients	Percent Of Patients	Number Of Deaths	Observed Mortality Rate	Expected Mortality Rate	Risk- Adjusted Mortality Rate	Confidence Interval For RAMR
Regional	3,191	91.41	74	2.32	2.27	2.37	(1.81, 2.94)
Area	300	8.59	7	2.33	2.90	1.87	(0.26, 3.47)
Total	3,491	100.00	81	2.32	------	------	----------

Figure 11



Gunshot Wounds

Regional Comparisons

There was a total of 2,538 gunshot wound inpatients in the logistic regression model. A total of 300 of these patients (11.82 percent) died in the hospital during the same admission. Appendix 7 presents the significant risk factors for mortality of trauma inpatients who suffered gunshot wounds along with coefficients for these risk factors, levels of statistical significance, and a measure of fit of the statistical model.

For inpatients with gunshot wounds in each region, Table 11 presents the number of patients, the percentage of patients, the observed mortality rate, the expected mortality rate and the risk-adjusted mortality rate and its 95 percent confidence interval. Figure 12 presents the risk-adjusted mortality rate and its 95 percent confidence interval for each region.

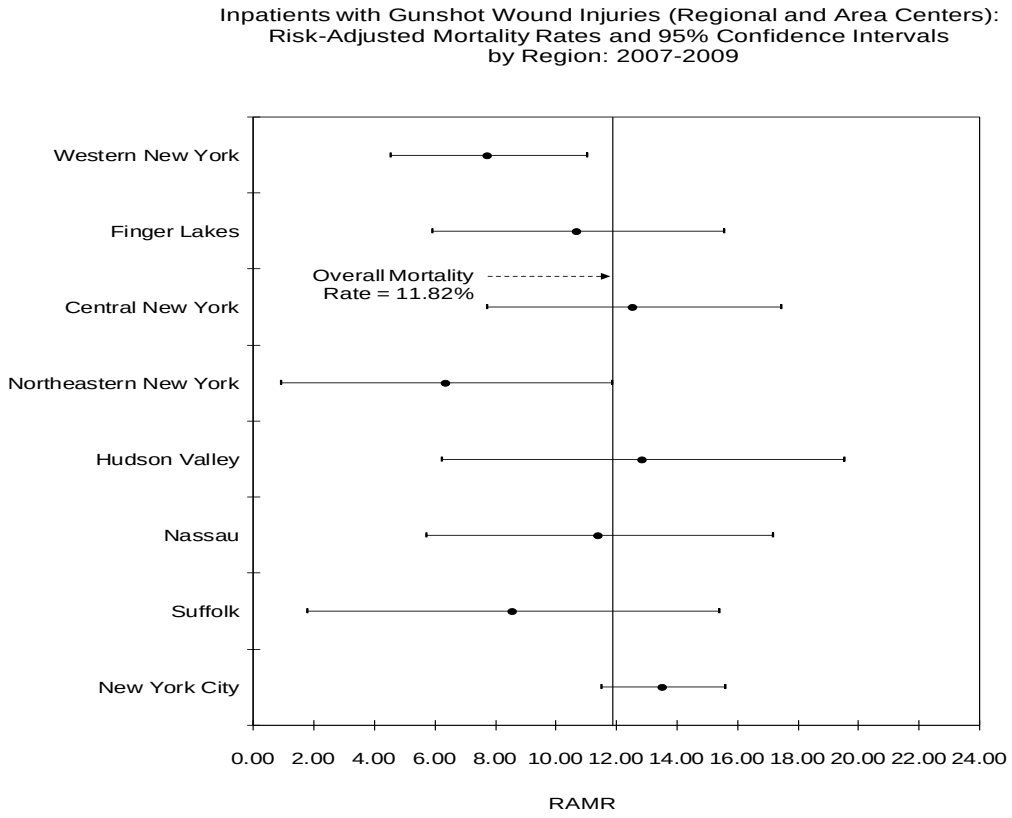
New York City accounted for an overwhelming majority of the patients (1,565 or 61.66 percent) of this mechanism of injury. Western New York had the second highest percentage with 11.15 percent, and Hudson Valley accounted for only 2.96 percent of inpatients suffering from gunshot wounds.

Observed mortality rates varied across regions from 6.86 percent to 22.67 percent, and expected mortality rates ranged from 9.71 percent to 20.82 percent. The region with the lowest risk-adjusted mortality rate was Northeastern New York with 6.35 percent. New York City had the highest risk-adjusted mortality rate (13.53 percent). A comparison of the 95 percent confidence intervals for each region's risk-adjusted mortality rate with the overall statewide in-hospital mortality rate for gunshot wound patients demonstrates that Western New York had a significantly lower mortality rate than expected (because the statewide rate of 11.82 percent is not contained in the confidence interval for Western New York's risk-adjusted mortality rates).

Table 11
Statistical Significance of Risk-Adjusted Mortality Rates
Gunshot Wound Injuries
Inpatients (Regional and Area Centers)

Region	Number Of Patients	Percent Of Patients	Number Of Deaths	Observed Mortality Rate	Expected Mortality Rate	Risk-Adjusted Mortality Rate	Confidence Interval For RAMR
Western	283	11.15	25	8.83	13.46	7.76	**(4.50, 11.01)**
Finger Lakes	168	6.62	22	13.10	14.45	10.71	(5.90, 15.53)
Central	140	5.52	29	20.71	19.51	12.55	(7.69, 17.41)
Northeastern	102	4.02	7	6.86	12.77	6.35	(0.88, 11.82)
Hudson Valley	75	2.96	17	22.67	20.82	12.87	(6.21, 19.53)
Nassau	111	4.37	18	16.22	16.79	11.42	(5.69, 17.15)
Suffolk	94	3.70	8	8.51	11.73	8.58	(1.75, 15.40)
New York City	1,565	61.66	174	11.12	9.71	13.53	(11.47, 15.58)
Total	2,538	100.00	300	11.82	------	------	----------

Figure 12



Comparison of Different Levels of Care

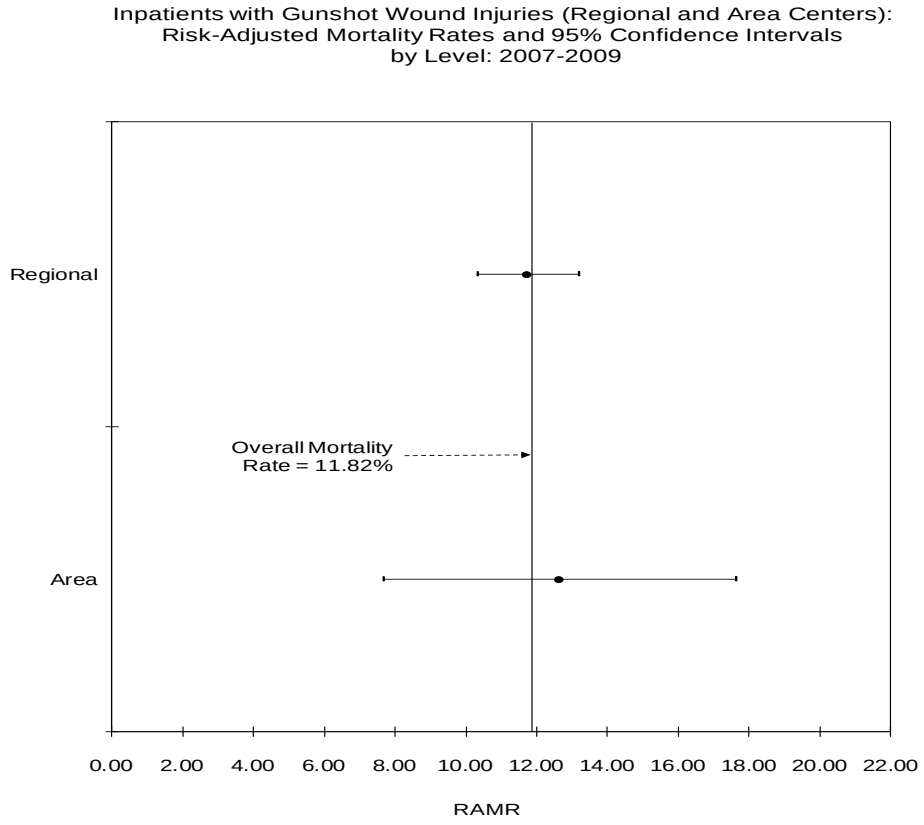
Table 12 contains the number of patients, percent of patients, number of deaths, observed mortality rate, expected mortality rate and risk-adjusted mortality rate along with its 95 percent confidence interval for the different levels of care for gunshot wound patients. Figure 13 presents the risk-adjusted mortality rate and its 95 percent confidence interval for each level of care. Regional centers treated 2,390 inpatients with gunshot wounds (94.17 percent of the total). Area centers treated 148 inpatients (5.83 percent).

The observed mortality rate was higher for area centers (18.92 percent) than for regional centers (11.38 percent). The risk-adjusted mortality rates were 12.64 percent for area centers and 11.74 percent for regional trauma centers. Neither rate was significantly different from the overall statewide rate.

Table 12
Statistical Significance of Risk-Adjusted Mortality Rates
Gunshot Wounds Injuries
Inpatients (Regional and Area Centers)

Level	Number Of Patients	Percent Of Patients	Number Of Deaths	Observed Mortality Rate	Expected Mortality Rate	Risk- Adjusted Mortality Rate	Confidence Interval For RAMR
Regional	2,390	94.17	272	11.38	11.46	11.74	(10.32, 13.16)
Area	148	5.83	28	18.92	17.69	12.64	(7.65, 17.63)
Total	2,538	100.00	300	11.82	------	------	----------

Figure 13



All Patients

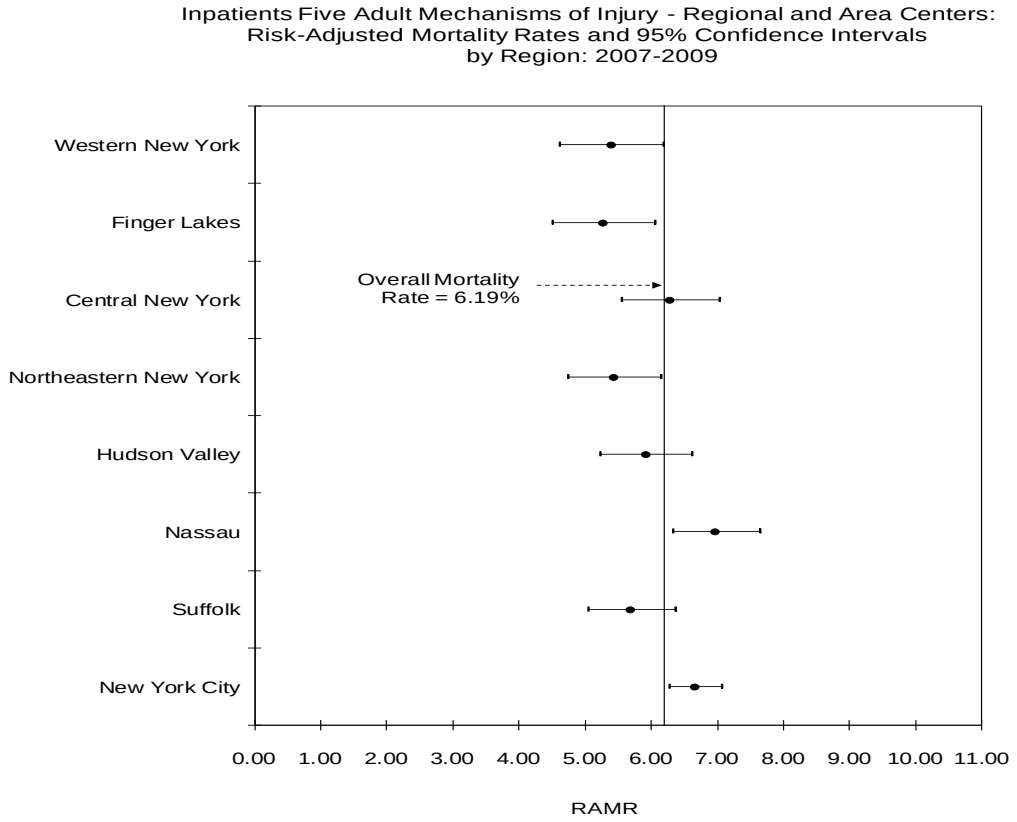
Regional Comparisons

Table 13 and Figure 14 compare regions across all mechanisms of injury by summing expected and observed deaths across MOIs and then testing for statistical differences between each region and the entire state. As indicated, Western New York (RAMR= 5.40 percent), Finger Lakes (RAMR= 5.28 percent) and Northeastern New York (RAMR = 5.44 percent) had significantly lower mortality than the statewide value of 6.19 percent. Nassau (RAMR = 6.98 percent) and New York City (RAMR = 6.66 percent) both had significantly higher mortality than the statewide mortality rate.

Table 13
Statistical Significance of Risk-Adjusted Mortality Rates
Five Adult Mechanisms of Injury Combined
Inpatients (Regional and Area Centers)

Region	Number Of Patients	Percent Of Patients	Number Of Deaths	Observed Mortality Rate	Expected Mortality Rate	Risk-Adjusted Mortality Rate	Confidence Interval For RAMR
Western	3,544	7.24	189	5.33	6.11	5.40	**(4.61, 6.18)**
Finger Lakes	3,222	6.58	184	5.71	6.69	5.28	**(4.50, 6.06)**
Central	4,680	9.56	285	6.09	6.00	6.28	(5.54, 7.02)
Northeastern	4,076	8.33	240	5.89	6.70	5.44	**(4.74, 6.14)**
Hudson Valley	5,360	10.95	292	5.45	5.70	5.92	(5.23, 6.61)
Nassau	5,547	11.33	442	7.97	7.07	6.98	**(6.32, 7.64)**
Suffolk	5,321	10.87	300	5.64	6.12	5.70	(5.04, 6.36)
New York City	17,190	35.12	1,097	6.38	5.93	6.66	**(6.26, 7.06)**
Total	48,940	100.00	3,029	6.19	-----	-----	----------

Figure 14



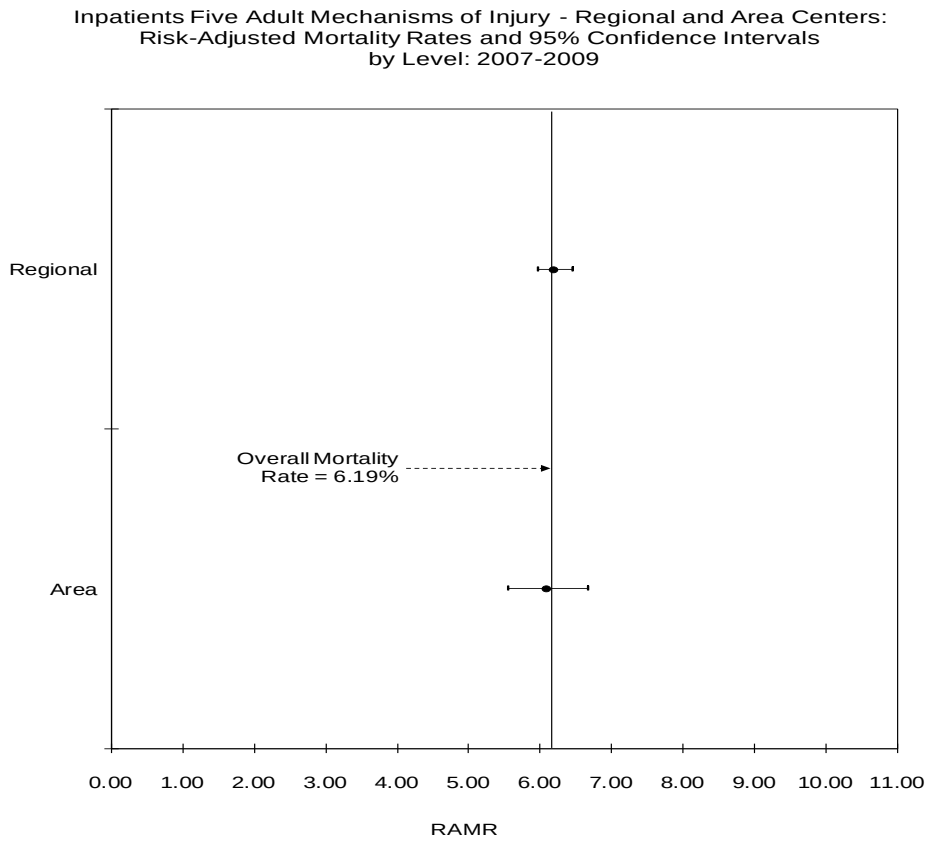
Comparison of Levels of Care for All Patients

The following table compares the performance of regional trauma centers and area trauma centers against the statewide performance. Neither level of care was shown to be statistically significantly different from the statewide average.

Table 14
Statistical Significance of Risk-Adjusted Mortality Rates
Five Adult Mechanisms of Injury Combined
Inpatients (Regional and Area Centers)

Level	Number Of Patients	Percent Of Patients	Number Of Deaths	Observed Mortality Rate	Expected Mortality Rate	Risk- Adjusted Mortality Rate	Confidence Interval For RAMR
Regional	40,329	82.40	2,573	6.38	6.36	6.20	(5.96, 6.45)
Area	8,611	17.60	456	5.30	5.37	6.10	(5.54, 6.67)
Total	48,940	100.00	3,029	6.19	------	------	----------

Figure 15


Inpatients Five Adult Mechanisms of Injury - Regional and Area Centers:
Risk-Adjusted Mortality Rates and 95% Confidence Intervals
by Level: 2007-2009
Regional
Overall Mortality
Rate = 6.19%
Area
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
RAMR

TRENDS IN VOLUME OF CASES AND MORTALITY RATES FOR 1999-2009

Trends in Risk-Adjusted Mortality Rates for Mechanisms of Injury in SPARCS

The following charts look at the trends in the number of trauma cases and the associated mortality during the time period 1999-2009. This information is derived from the SPARCS files for all levels of hospitals (regional, area, and non-center) for these years. The source data are limited to severe injuries among the five adult mechanisms of injury – motor vehicle crashes, other blunt injuries, falls, stab wounds, and gunshot wounds.

Chart 21 shows that the number of these cases increased from 16,770 in 1999 to 24,921 in 2009, an increase of 48.6 percent in ten years.

Chart 21

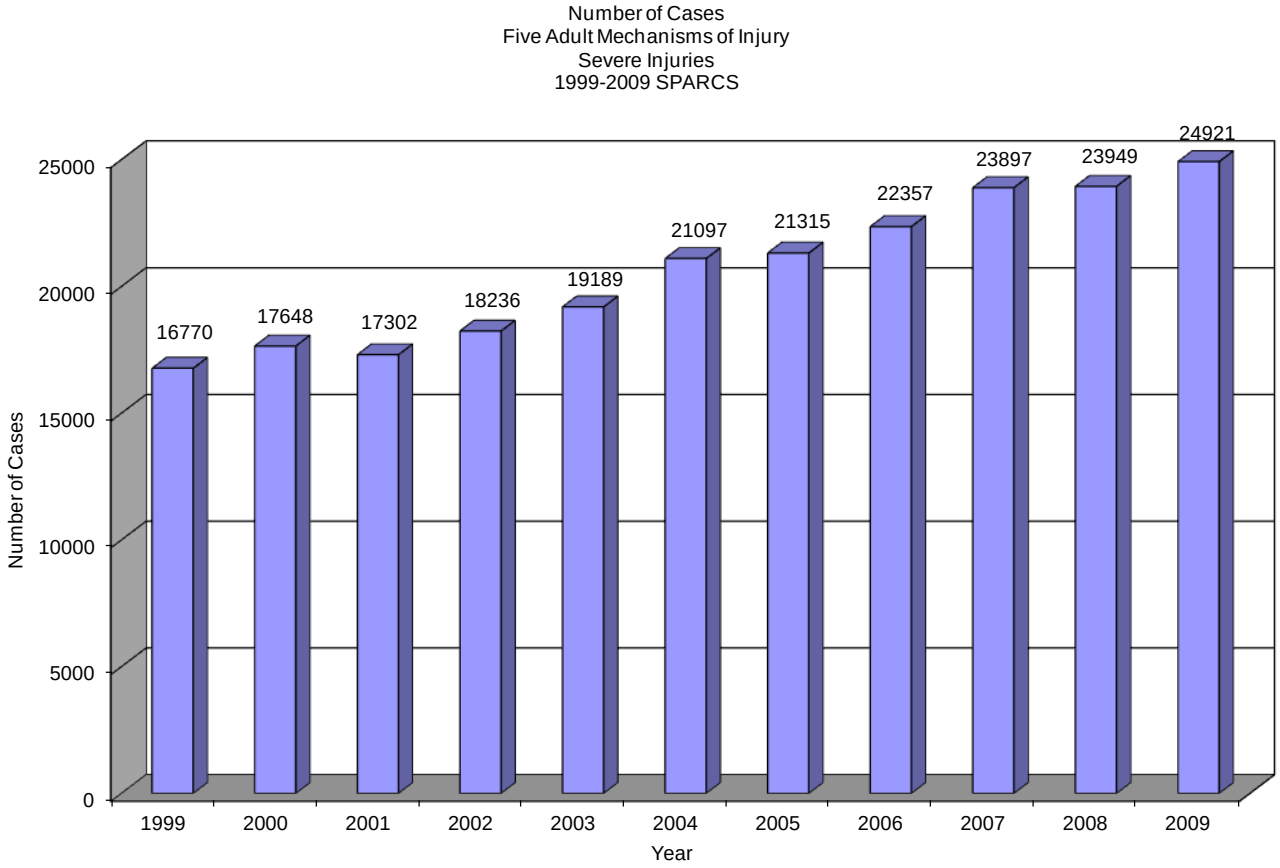


Chart 22 shows that the number of these cases that were treated at regional or area centers increased from 10,920 in 1999 to 16,714 in 2009, an increase of 53.1 percent.

Chart 22

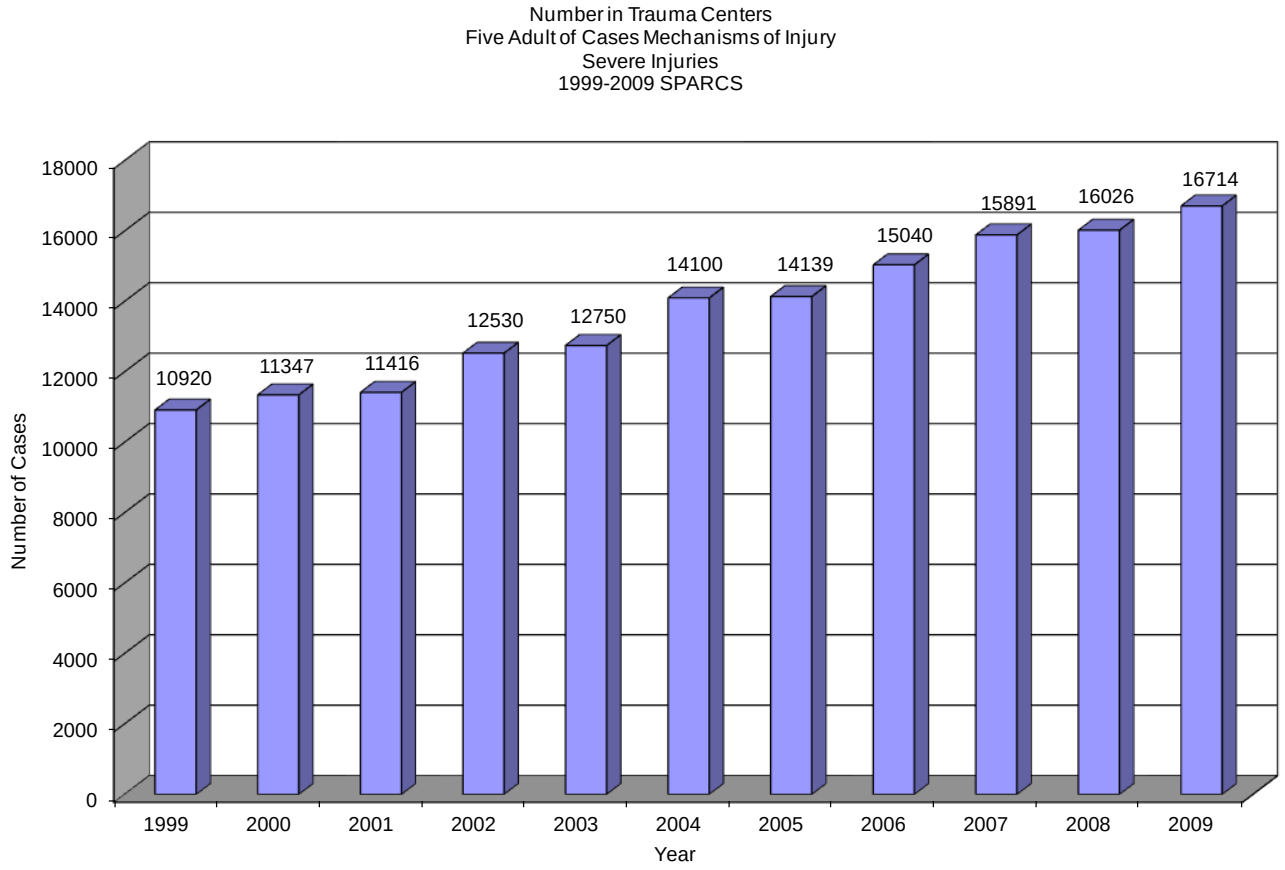


Chart 23 shows that the percent of serious injuries that were treated at trauma centers has remained fairly constant over this time period, ranging from a low of 64.3 percent in 2000 to 68.7 percent in 2002.

Chart 23

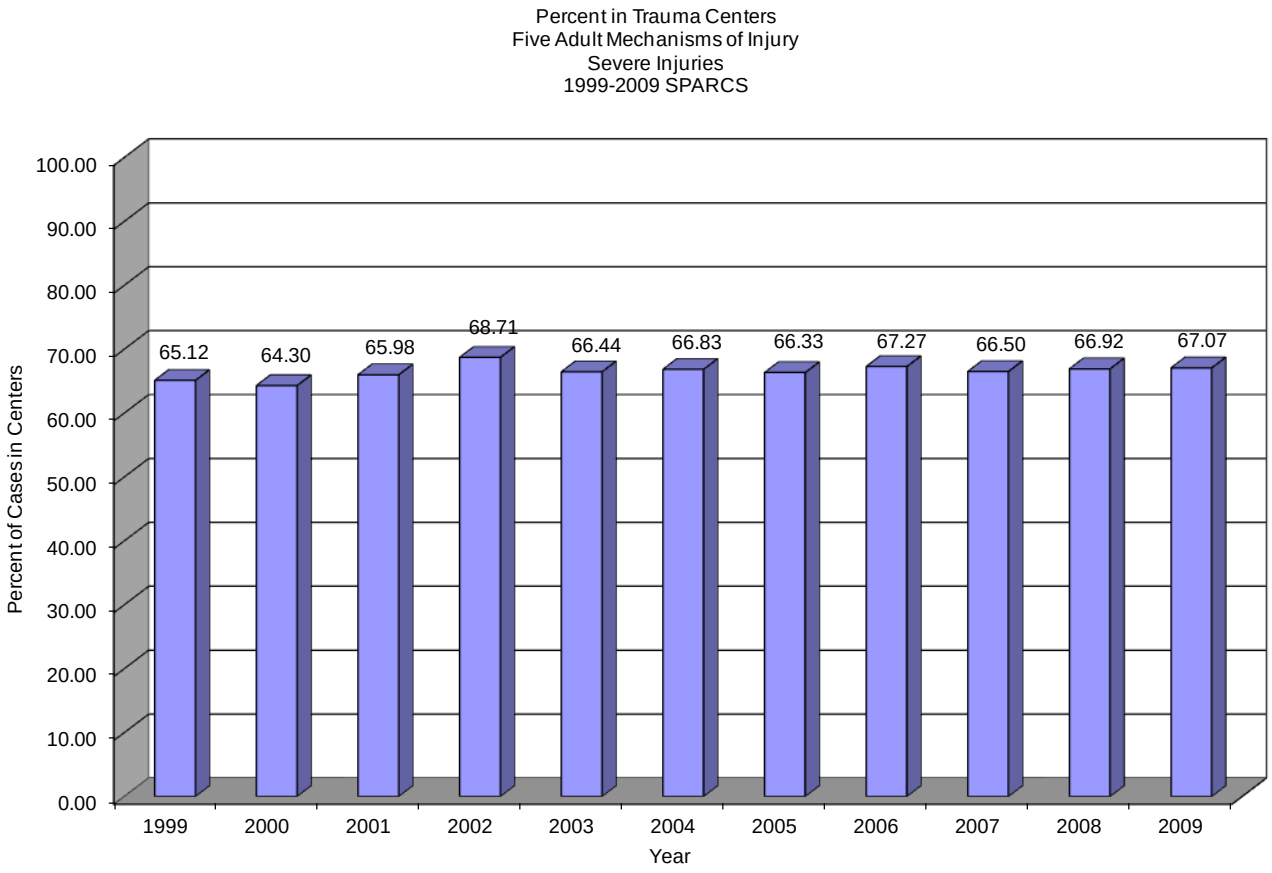


Chart 24 shows the reduction in crude mortality for severe injuries among these five adult mechanisms of injury. The crude mortality decreased from 8.30 percent in 1999 to 5.84 percent in 2009.

Chart 24

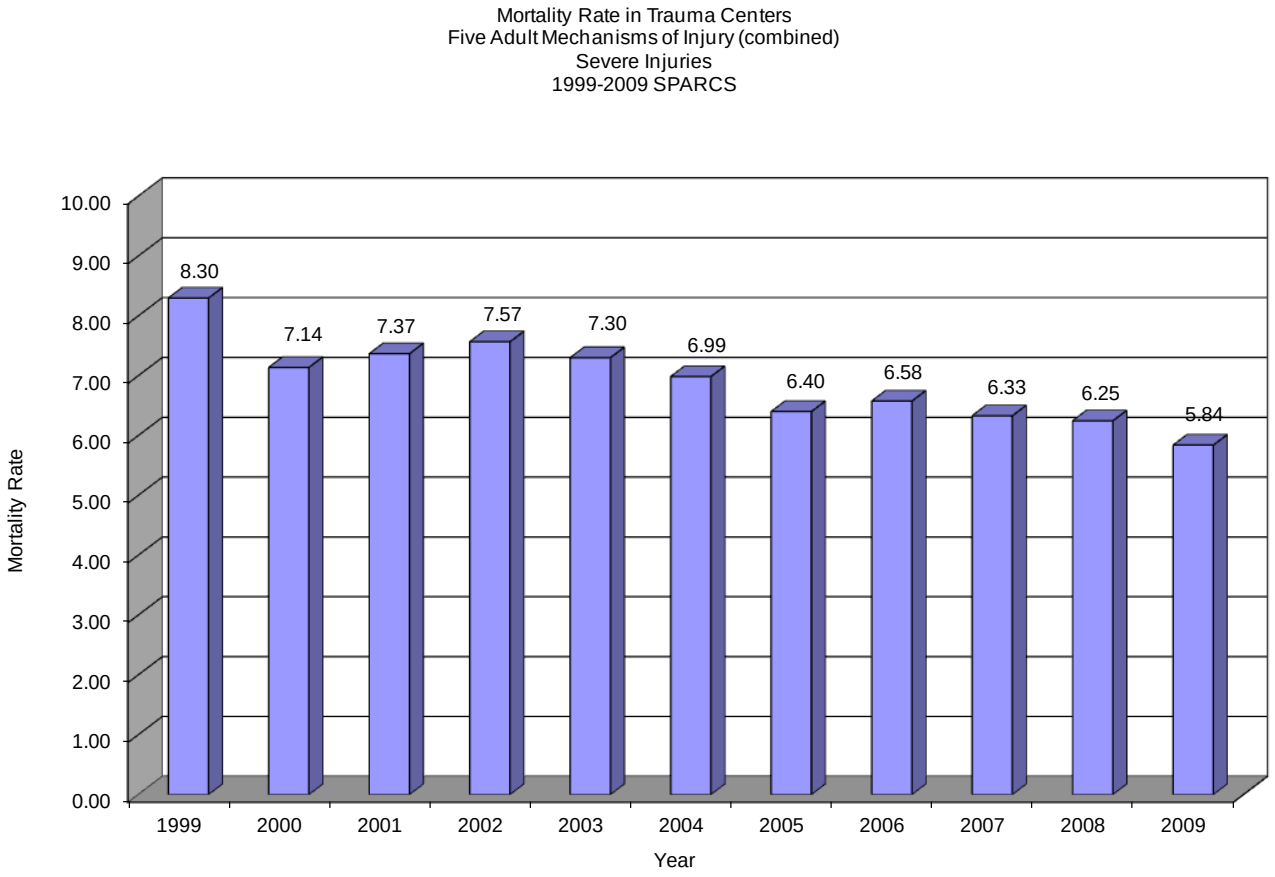
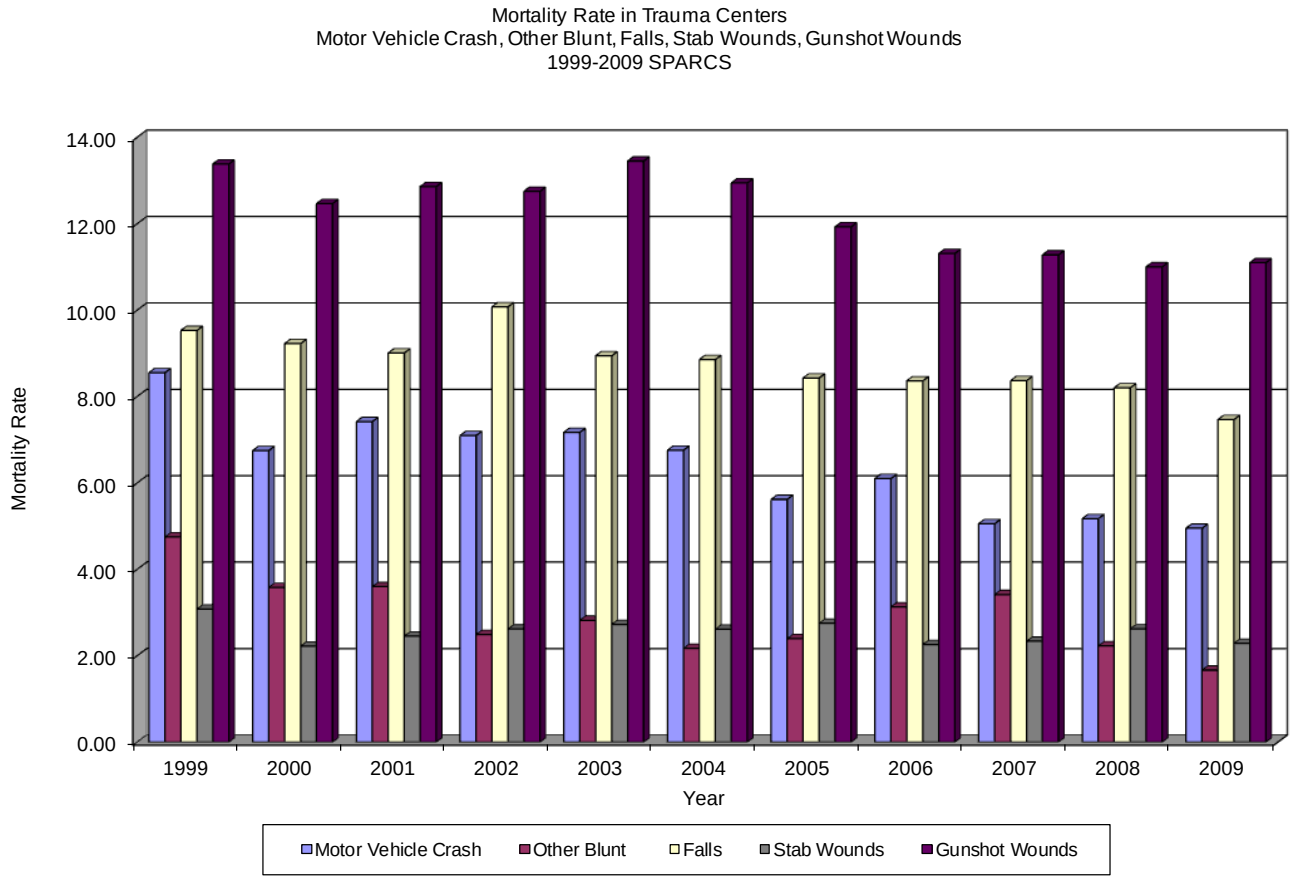


Chart 25 indicates that there were substantial decreases in mortality between 1999 and 2009 for patients with gunshot wounds (from 13.38 percent to 11.10 percent), falls (from 9.53 percent to 7.47 percent), stab wounds (from 3.08 percent to 2.29 percent), motor vehicle crashes (from 8.55 percent to 4.95 percent) and other blunt injuries (from 4.75 percent to 1.67 percent).

Chart 25



As is clear in Chart 27, this reduction in crude mortality occurred for all age groups over this time period.

Chart 26

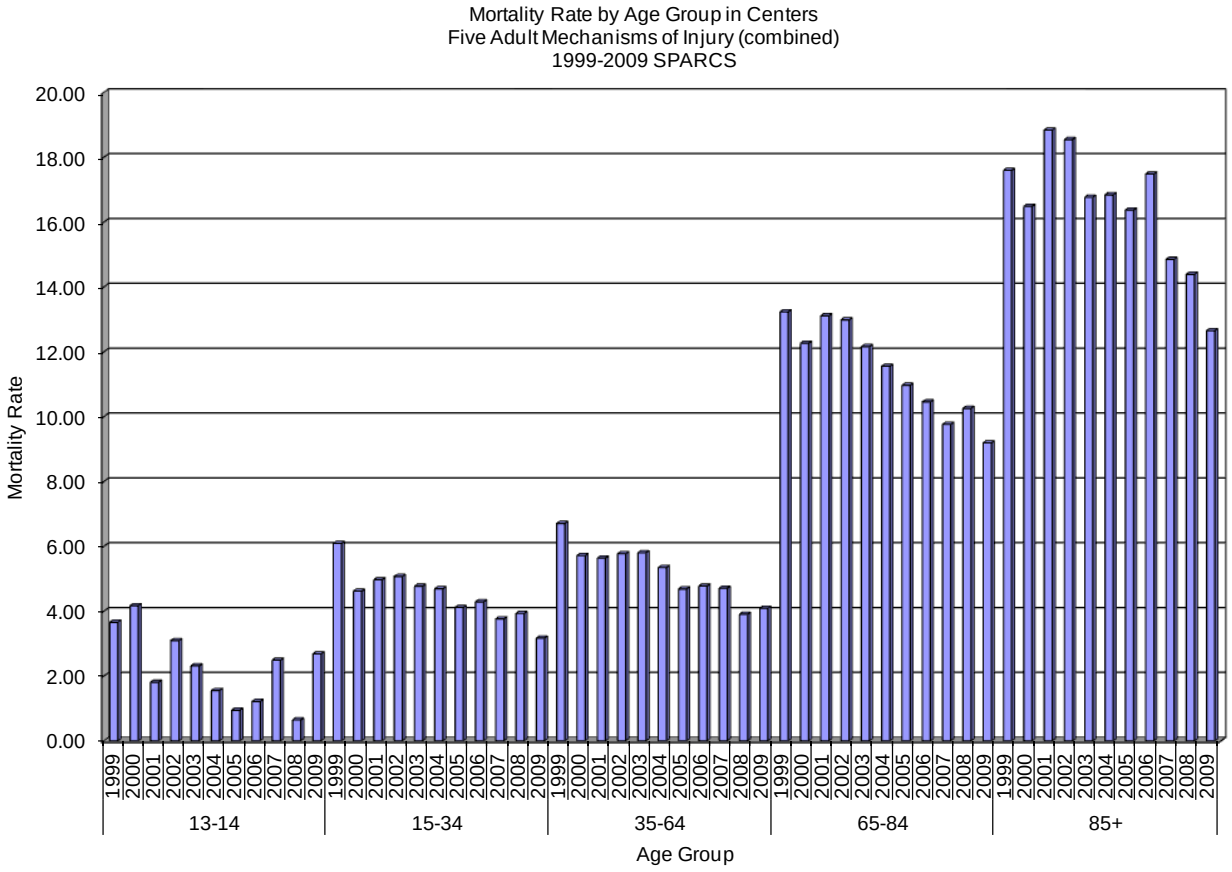


Chart 28 shows changes in the number of patients per mechanism. The three blunt injury mechanisms, motor vehicle crashes, other blunt injuries, and falls, all show a growth in the number of patients over these ten years. Of particular note is the increase in the number of falls patients. The number of patients in the two penetrating injury mechanisms has remained fairly stable during this time period.

Chart 27

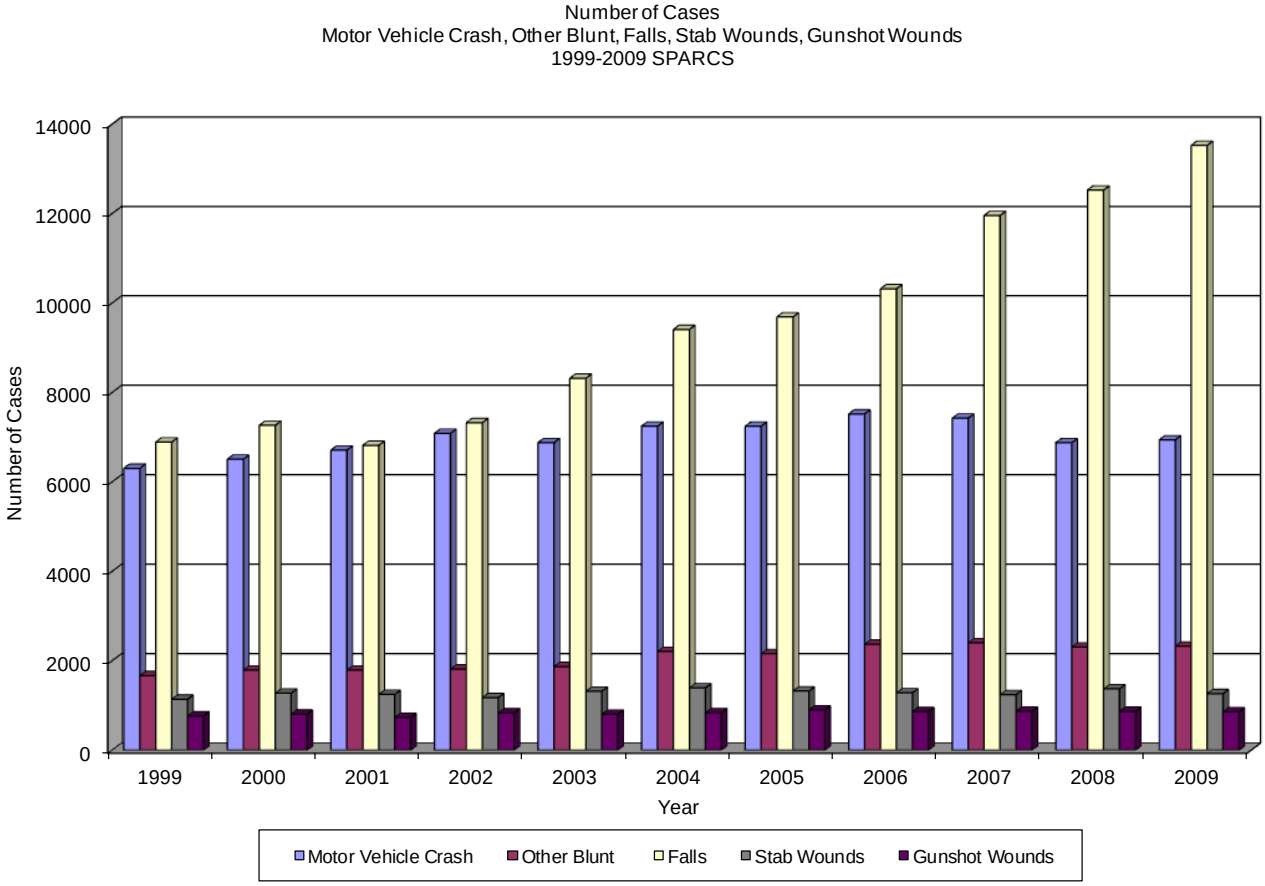
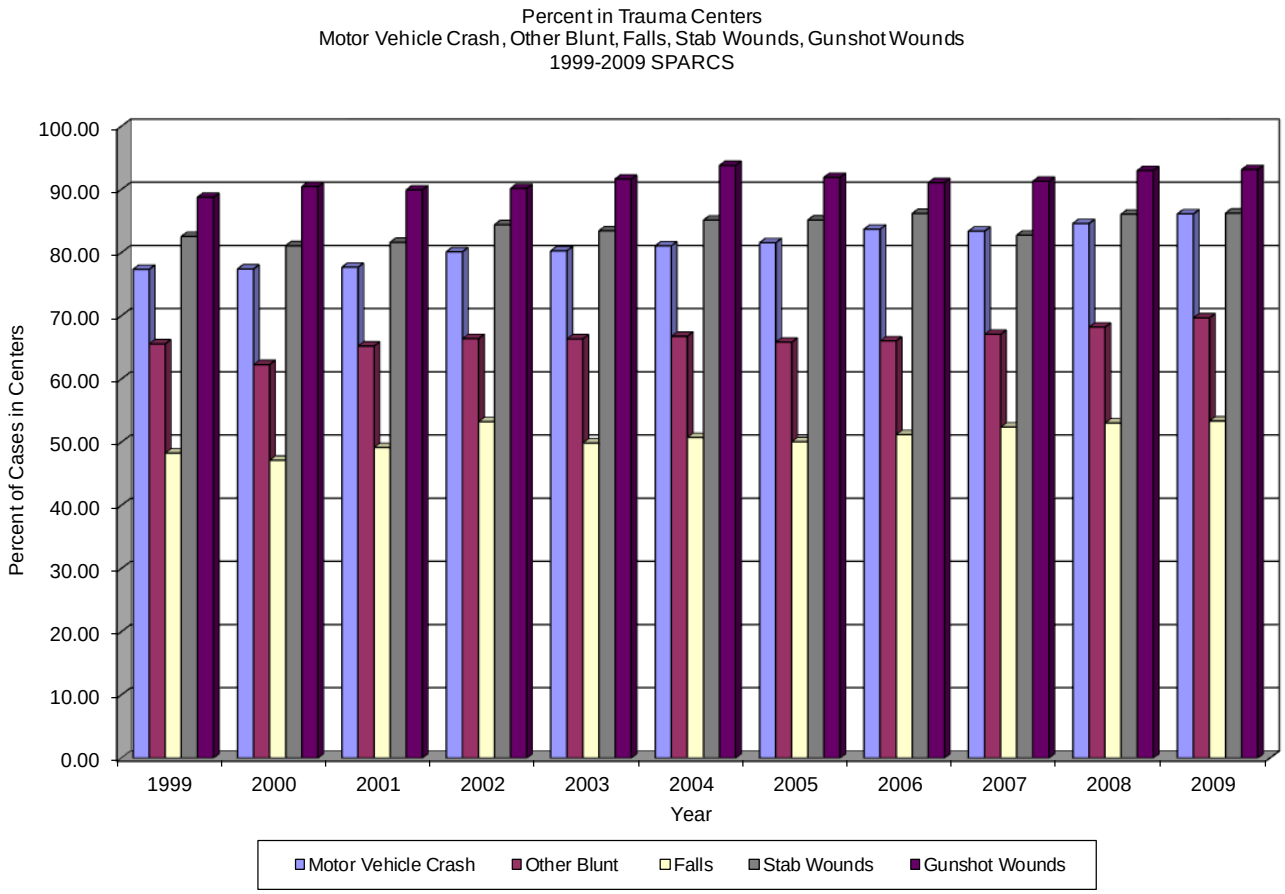


Chart 29 indicates that, for each mechanism of injury, there was an increase in the percentage of patients referred to trauma centers. This increase was noticeably higher for motor vehicle crashes relative to the other four mechanisms.

MVCs increased nearly 9 percent from 77.36 percent in 1999 to 86.14 percent in 2009. Falls increased from 48.29 percent in 1999 to 53.37 percent in 2009, other blunt increased from 65.57 percent to 69.69 percent, stab wounds from 82.56 percent to 86.27 percent and gunshot wounds from 88.77 percent to 93.15 percent.

Chart 28



Trends in Risk-Adjusted Mortality Rates for Mechanisms of Injury in the NYSTR

In order to assess the change in mortality over the years 2007-2009, a variable representing year was added to each MOI's logistic regression model. Among the inpatient-only models, the coefficient for this additional variable was negative (indicative of decreasing mortality over the three years) for four of the five models. The p-value of the variable was significant ($p<0.05$) for two of these four mechanisms, falls and other blunt. The odds ratio for the falls model was 0.913, indicative of an average drop in odds of mortality of 8.7% per year. The odds ratio for the other blunt model was 0.639, indicative of an average drop in mortality of 36.1%. There were no significant changes in either direction for the other three MOIs.

2007-2009 HOSPITAL OUTCOMES FOR PATIENTS IN THE NEW YORK STATE TRAUMA REGISTRY

Table 15 presents the 2007-2009 results for hospitals treating trauma inpatients who qualified for the New York State Trauma Registry. For each hospital, the table contains the number of discharges, the number of inpatient deaths, the observed mortality rate, the expected mortality rate, the risk-adjusted mortality rate, and a 95 percent confidence interval for the risk-adjusted mortality rate.

As noted earlier in this report, a statistical model was developed for each of the five mechanisms of injury. The statistics for each of these models are shown in Appendices 3-7 for inpatient deaths. The predicted or expected probability of death from the model appropriate for each individual patient was used to assess hospital-level performance for all adult trauma patients. For each hospital, these predicted values were then combined and used with the hospital's overall observed mortality rate to calculate the hospital's risk-adjusted mortality rate.

Definitions of key terms are as follows:

The **observed mortality rate (OMR)** is the number of observed deaths divided by the number of patients.

The **expected mortality rate (EMR)** is the sum of the predicted probabilities of death for all patients divided by the total number of patients.

The **risk-adjusted mortality rate (RAMR)** is the best estimate, based on the statistical model, of what the provider's mortality rate would have been if the provider had a mix of patients identical to the statewide mix.

Confidence intervals for the risk-adjusted mortality rate indicate which hospitals had significantly more or fewer deaths than expected, given the risk factors of their patients. Hospitals with significantly higher rates than expected after adjusting for risk are those with confidence intervals entirely above the statewide rate. Hospitals with significantly lower rates than expected given the severity of illness of their patients before treatment have confidence intervals entirely below the statewide rate.

The overall mortality rate for the 48,940 adults treated at the 40 trauma centers in the statistical models used to assess performance for inpatients was 6.19 percent. Observed mortality rates ranged from 0.00 percent to 8.86 percent. The risk-adjusted mortality rate used to measure performance for all hospitals ranged from 0.00 percent to 8.88 percent.

Four hospitals (Albany Medical Center Hospital, Stony Brook University Medical Center, Strong Memorial Hospital, and New York-Presbyterian/Weill Cornell Medical Center) had inpatient mortality rates that were significantly lower than the statewide mean. Two hospitals (Lutheran Medical Center and Jamaica Hospital Medical Center) had inpatient mortality rates that were significantly higher than the statewide mean.

It should be noted that previous reports on New York State's trauma system included risk-adjustment models that predicted in-hospital mortality in addition to models that predicted inpatient mortality. In-hospital mortality includes deaths in the emergency department as well as inpatient deaths. The in-hospital mortality models were not developed for the time period 2007-2009 since it could not be confirmed that all deaths in the emergency department (DIEs) were reported to the NYSTR from the New York City region. Confirmation was impossible due to lack of access to the NYC vital statistics file.

A region in which patients move more quickly from the emergency department to the inpatient setting or from the scene to the inpatient setting (e.g., because of shorter travel times) is likely to have a higher risk-adjusted inpatient mortality rate since more deaths are counted as inpatient deaths. Thus, the quicker transition of patients to the inpatient setting can result in a bias against the hospital/region.

Consequently, a caveat regarding the identification of regions and hospitals that were identified as outliers in either direction is that it would have been desirable to determine if they had remained an outlier if in-hospital mortality had been used as a second outcome measure.

Table 15
Statistical Significance of Risk-Adjusted Mortality Rates
Inpatients (Five Adult Mechanisms of Injury Combined)
Statewide Mortality Rate = 6.19%

Hospital (PFI: name)	Cases	Deaths	OMR	EMR	RAMR	95% CI for RAMR
Western New York						
Regional Centers						
0208:Women and Children's Hospital of Buffalo	224	1	0.45	0.77	3.59	(0.00, 15.44)
0210:Erie County Medical Center	3,320	188	5.66	6.48	5.41	(4.62, 6.20)
Finger Lakes						
Regional Center						
0413:Strong Memorial Hospital	3,222	184	5.71	6.69	5.28	**(4.50, 6.06)**
Central New York						
Regional Center						
0635:University Hospital SUNY Health Science Center	2,903	194	6.68	6.11	6.77	(5.80, 7.74)
Area centers						
0058:United Health Services Hospitals Inc.-Wilson Hospital	1,188	61	5.13	5.91	5.38	(3.97, 6.78)
0598:St. Elizabeth Medical Center	589	30	5.09	5.65	5.58	(3.46, 7.71)
Northeastern New York						
Regional Center						
0001:Albany Medical Center Hospital	3,428	211	6.16	7.15	5.33	**(4.60, 6.06)**
Area centers						
0135:Champlain Valley Physicians' Hospital Medical Center	203	9	4.43	3.51	7.82	(2.01, 13.62)
0746:Mary Imogene Bassett Hospital	445	20	4.49	4.69	5.93	(3.12, 8.74)
Hudson Valley						
Regional Center						
1139:Westchester Medical Center	2,955	190	6.43	6.43	6.19	(5.29, 7.09)
Area Centers						
0180:St. Francis Hospital	1,265	52	4.11	4.11	6.19	(4.43, 7.95)
0776:Nyack Hospital	553	17	3.07	4.64	4.10	(1.98, 6.23)
0779:Good Samaritan Hospital of Suffern	372	21	5.65	6.84	5.11	(2.75, 7.46)
1072:Sound Shore Medical Center of Westchester	215	12	5.58	5.77	5.98	(2.21, 9.76)

Hospital (PFI: name)	Cases	Deaths	OMR	EMR	RAMR	95% CI for RAMR
Nassau						
Regional Centers						
0511:Winthrop University Hospital	1,130	84	7.43	6.04	7.62	(5.93, 9.30)
0528:Nassau University Medical Center	1,716	152	8.86	8.88	6.17	(5.17, 7.18)
0541:North Shore University Hospital	2,078	157	7.56	6.51	7.18	(6.03, 8.33)
Area center						
0527:South Nassau Communities Hospital	623	49	7.87	5.81	8.37	(5.92, 10.82)
Suffolk						
Regional Center						
0245:Stony Brook University Medical Center	2,163	115	5.32	6.78	4.85	**(3.94, 5.76)**
Area Centers						
0885:Brookhaven Memorial Hospital Medical Center Inc.	748	42	5.61	5.14	6.76	(4.61, 8.91)
0913:Huntington Hospital	754	37	4.91	5.55	5.47	(3.61, 7.33)
0924:Southside Hospital	658	44	6.69	5.92	7.00	(4.83, 9.16)
0925:Good Samaritan Hospital Medical Center, W. Islip	998	62	6.21	6.00	6.41	(4.75, 8.07)
New York City						
Regional Centers						
1165:Jacobi Medical Center	1,485	75	5.05	5.11	6.11	(4.68, 7.55)
1172:Lincoln Medical & Mental Health Center	1,065	55	5.16	5.71	5.60	(4.05, 7.14)
1176:St. Barnabas Medical Center	1,204	79	6.56	5.07	8.01	(6.19, 9.84)
1286:Brookdale University Hospital Medical Center	998	82	8.22	7.60	6.69	(5.19, 8.19)
1301:Kings County Hospital Center	1,821	126	6.92	5.88	7.29	(5.98, 8.59)
1304:Lutheran Medical Center	1,483	108	7.28	5.44	8.28	**(6.67, 9.89)**
1438:Bellevue Hospital Center	1,421	75	5.28	5.41	6.04	(4.62, 7.45)
1445:Harlem Hospital Center	683	44	6.44	5.53	7.21	(4.97, 9.45)
1458:New York Presbyterian/Weill Cornell Medical Center	1,292	75	5.80	7.27	4.94	**(3.78, 6.10)**
1464:New York Presbyterian Morgan Stanley Children's Hospital/Columbia University Medical Center	51	0	0.00	0.53	0.00	(0.00, 60.29)
1469:St. Luke's and Roosevelt Hospital Center	540	41	7.59	6.87	6.84	(4.64, 9.04)
1626:Elmhurst Hospital Center	1,472	83	5.64	5.59	6.24	(4.85, 7.63)
1629:Jamaica Hospital Medical Center	1,243	86	6.92	5.24	8.16	**(6.38, 9.95)**
1630:Steven and Alexandra Cohen Children's Medical Center of NY	99	2	2.02	2.92	4.28	(0.00, 12.63)
1637:New York Hospital Medical Center of Queens	1,103	78	7.07	7.77	5.63	(4.34, 6.93)
1738:Richmond University Medical Center	460	35	7.61	5.61	8.39	(5.45, 11.33)
1740:Staten Island University Hospital-North	770	53	6.88	6.51	6.54	(4.70, 8.38)

COMPARISON OF RECENT TRAUMA MORTALITY RATES IN NEW YORK AND THE UNITED STATES

A good gauge of the performance of New York's trauma system in the past several years is a comparison with national trauma outcomes. The following data are taken from the CDC.[4]

Death data come from a national mortality database compiled by CDC's National Center for Health Statistics. This database contains information from death certificates filed in state vital statistics offices and includes causes of death reported by attending physicians, medical examiners and coroners. It also includes demographic information about decedents reported by funeral directors, who obtain that information from family members and other informants. Population data come from the Bureau of the Census. These data are based on information gathered in censuses and on estimation procedures conducted in non-census years.

The following is a comparison of outcomes in New York and the United States of three groups of trauma patients (motor vehicle crash, falls, and gunshot wounds) in 2007 that comprise approximately three-quarters of all traumatic injuries contained in New York's Registry.

Motor Vehicle Crashes

Table 16 presents, for motor vehicle crashes in New York State and the United States in 2007, the mortality rate per 100,000 population, the age-adjusted mortality rate per 100,000 population (based on 2000 data), and the level of significance (p-value) of the difference in age-adjusted rates between New York and the United States. It should be noted that, although it would have been preferable to report risk-adjusted mortality rates for New York and the United States that adjusted for patients' physiologic and anatomic risk factors as well as for age, this was impossible because these data were not available for the United States as a whole.

As indicated, the rate of MVC deaths per 100,000 population in the United States in 2007 was considerably higher than the rate in New York State, as was the age-adjusted rate per 100,000 population. For example, the age–adjusted mortality rate per 100,000 population for MVCs in the United States was 14.39 percent, whereas it was only 7.41 percent in New York State. The difference between these two rates was significant ($p<0.0001$).

Table 16
Mortality Rate per 100,000 Population for MVCs
United States vs. New York State: 2007

	Population	Deaths	Mortality Rate/100,000 Population	Age-Adjusted* Mortality Rate/ 100,000 Population	p-value for Difference in Age-Adjusted* Mortality Rates
United States	301,579,895	43,945	14.57	14.39	<0.0001
New York State	19,422,777	1,478	7.61	7.41	

* Adjusted using population of the United States in 2000

Previous studies in other states have demonstrated that the mortality rate per capita for MVCs in a region is inversely related to the population density of the region. This may, in part, explain why New York's mortality rate per 100,000 population is so much lower than that of the United States,

[4] Center for Disease Control and Prevention (CDC), National Center for Injury Prevention and Control, Web-Based Injury Statistics Query and Reporting System (WISQARS) at www.cdc.gov/ncipc/wisqars.

however, the relative population density of New York and the United States were not substantially different in 2003 and 2007. Consequently, a valid measure of the recent impact of New York's trauma system on MVC mortality is to compare the percent change in age-adjusted mortality per 100,000 population in New York with the percent change in the United States. The appropriate time period to ascertain the recent impact of the trauma system is 2003 to 2007, the latest available year of data. This is done in Table 17.

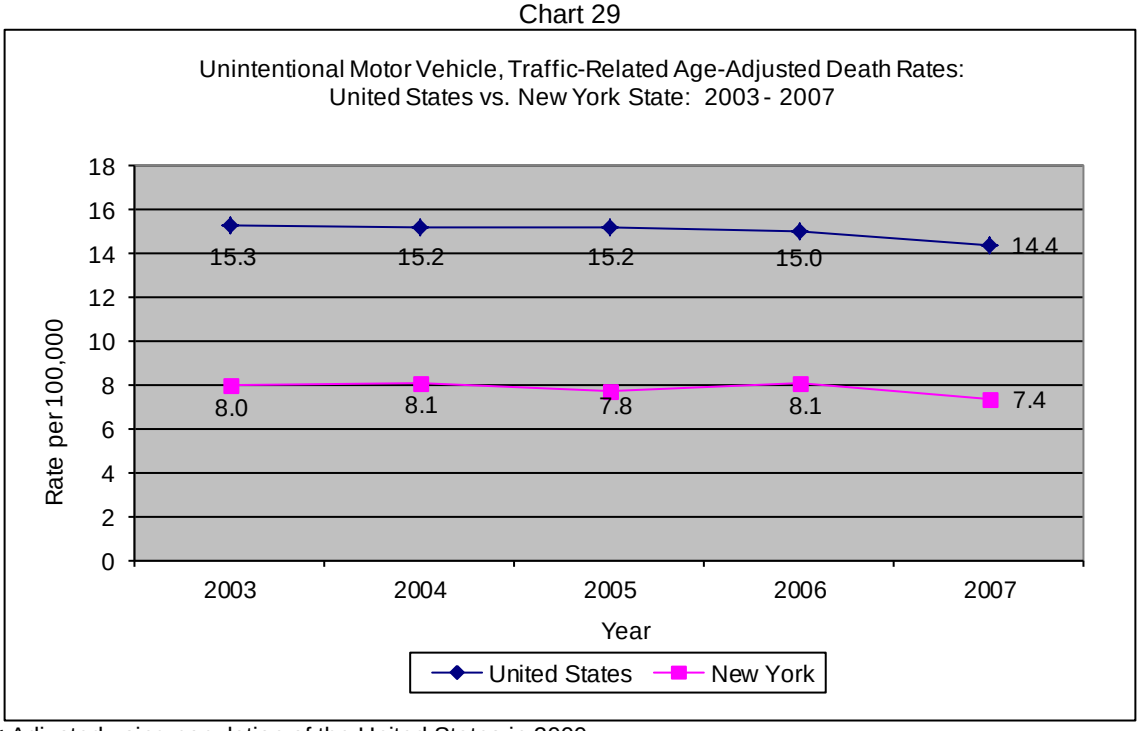
Table 17
Change in Deaths per 100,000 Population for MVCs
United States vs. New York State: 2003 to 2007

	Age- Adjusted* Mortality Rate: 2003	Age-Adjusted* Mortality Rate: 2007	Percent Change	p-value for Difference in Percent Change
United States	15.32	14.39	-6.0	<0.0001
New York State	8.05	7.41	-8.0	

* Adjusted using population of the United States in 2000

Chart 29 presents the mortality rates per 100,000 population for New York and the United States from 2003 through 2007. As demonstrated in Table 17, the mortality rate in the United States changed from 15.32 per 100,000 in 2003 to 14.39 per 100,000 in 2007, a decrease of 6.0 percent. During the same time period in New York, the mortality rate per 100,000 changed from 8.05 to 7.41, a decrease of 8.0 percent. The change in mortality rate per 100,000 in New York was found to be significantly different from the change in the United States ($p<0.0001$).

Chart 29



* Adjusted using population of the United States in 2000

Falls

Table 18 presents, for falls in New York State and the United States in 2007, the mortality rate per 100,000 population, the age-adjusted mortality rate per 100,000 population (based on 2000 data), and the level of significance (p-value) of the difference in age-adjusted rates between New York and the United States.

As indicated in Table 18 the mortality rate for falls per 100,000 population in the United States in 2007 was higher than the rate in New York (7.08 vs. 5.37, respectively). This difference was statistically significant ($p < 0.0001$).

Table 18
Mortality Rate per 100,000 Population for Falls
United States vs. New York State: 2007

	Population	Deaths	Mortality Rate/100,000 Population	Age-Adjusted* Mortality Rate/ 100,000 Population	p-value for Difference in Age-Adjusted* Mortality Rates
United States	301,579,895	22,631	7.50	7.08	<0.0001
New York State	19,422,777	1,158	5.96	5.37	

* Adjusted using population of the United States in 2000

Table 19 presents the age-adjusted mortality rates per 100,000 population for falls in New York and for the United States in 2003 and 2007, as well as the percent change over this time period, and the level of significance of the difference in rates of change between the United States and New York. This table also demonstrates that the mortality rate per 100,000 population in the United States rose from 5.87 in 2003 to 7.08 in 2007, an increase of 20.5 percent. During the same time period, the rate in New York rose from 5.02 to 5.37, an increase of 7.0 percent. The difference in the rates of change was statistically significant ($p < 0.0001$).

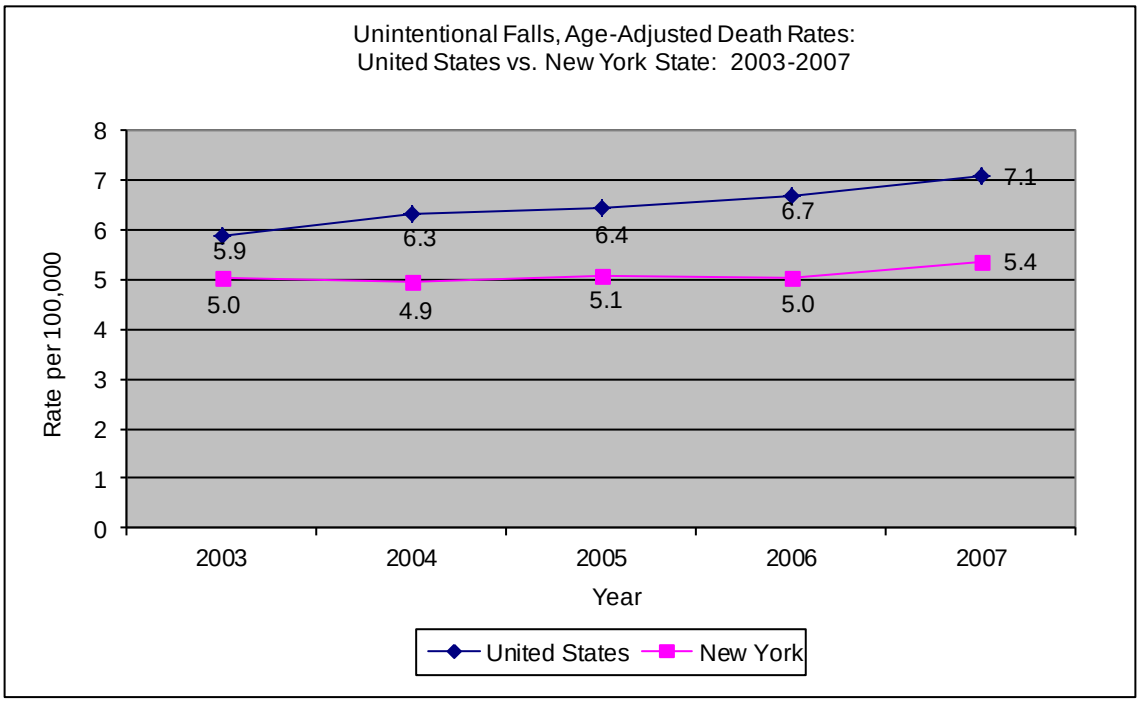
Table 19
Change in Deaths per 100,000 Population for Falls
United States vs. New York State: 2003 to 2007

	Age- Adjusted* Mortality Rate: 2003	Age-Adjusted* Mortality Rate: 2007	Percent Change	p-value for Difference in Percent Change
United States	5.87	7.08	20.5	<0.0001
New York State	5.02	5.37	7.0	

* Adjusted using population of the United States in 2000

Chart 30 presents the falls mortality rates per 100,000 population for New York and the United States for all years between 2003 and 2007.

Chart 30



*Adjusted using population of the United States in 2000

Firearms

Table 20 presents, for firearms[5] in New York State and the United States in 2007, the mortality rate per 100,000 population, the age-adjusted mortality rate per 100,000 population (based on 2000 data), and the level of significance (p-value) of the difference in age-adjusted rates between New York and the United States.

As indicated in Table 20, the age-adjusted mortality rate of firearms per 100,000 population in the United States in 2007 was 10.23, substantially higher than the comparable rate in New York (5.00), and this difference was statistically significant ($p < 0.0001$).

Table 20
Mortality Rate per 100,000 Population for Firearms
United States vs. New York State: 2007

	Population	Deaths	Mortality Rate/100,000 Population	Age-Adjusted* Mortality Rate/ 100,000 Population	p-value for Difference in Age-Adjusted* Mortality Rates
United States	301,579,895	31,224	10.35	10.23	<0.0001
New York State	19,422,777	985	5.07	5.00	

* Adjusted using population of the United States in 2000

[5] The CDC database uses the grouping “firearms” which is comparable to the NYSTR’s “gunshot wounds”.

Table 21 presents the age-adjusted mortality rates per 100,000 population for firearms in New York and for the United States in 2003 and 2007, as well as the percent change over this time period, and the level of significance of the difference in rates of change between the United States and New York. Also, Chart 31 presents the mortality rates per 100,000 population for New York and the United States for all years between 2003 and 2007.

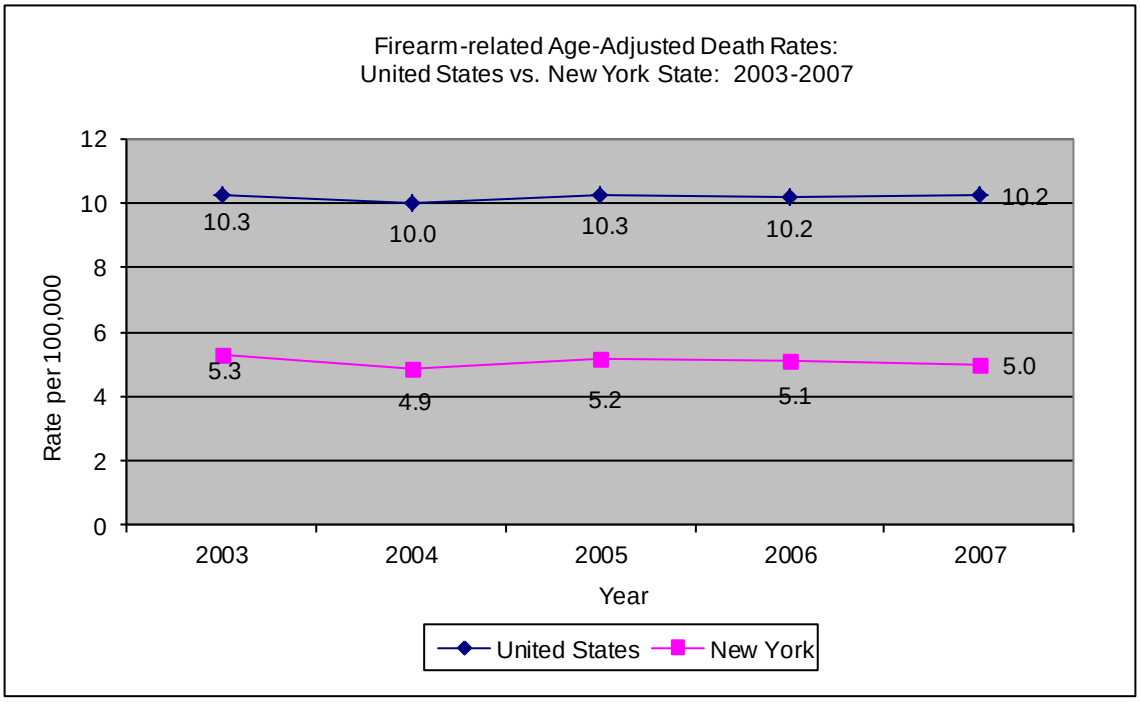
Table 21 demonstrates that the mortality rate for firearms per 100,000 population in the United States decreased from 10.28 in 2003 to 10.23 in 2007, a decrease of 0.5 percent. During the same time period, the rate decreased in New York from 5.32 to 5.00, a decrease of 6.1 percent. The difference in New York's rate and the U.S. rate was statistically significant ($p < 0.0001$). It appears that the quality assurance and improvement efforts associated with New York's trauma system and Registry may have resulted in a substantially higher decrease in population mortality than was experienced nationwide.

Table 21
Change in Deaths per 100,000 Population for Firearms
United States vs. New York State: 2003 to 2007

	Age- Adjusted* Mortality Rate: 2003	Age-Adjusted* Mortality Rate: 2007	Percent Change	p-value for Difference in Percent Change
United States	10.28	10.23	-0.5	<0.0001
New York State	5.32	5.00	-6.1	

* Adjusted using population of the United States in 2000

Chart 31



* Adjusted using population of the United States in 2000

DISCUSSION

This report describes and assesses the quality of the New York State trauma system in the years 2007-2009. It is intended for use by trauma clinicians and administrators to identify important areas and issues for additional study to enhance system development and clinical quality improvement. This report also can be used by the public to learn more about the trauma system in New York.

The following descriptive statistics present information (1) on all trauma patients with serious enough injuries to qualify for the Registry, even those in non-centers, that are derived from SPARCS, and (2) on patients treated in trauma centers, based on data from the NYSTR.

Descriptive Statistics for All Seriously Injured Trauma Inpatients in SPARCS

The following statements apply to all patients with high-risk injuries who qualify for the NYSTR in the time period 2007-2009, including patients from non-centers (who are not contained in the Registry).

- 36 percent of the patients were in New York City;
  no other region had more than 13 percent of the total

- 86.6 percent were classified as having experienced blunt trauma
  - the most common type of blunt trauma was falls (47.4 percent) followed by motor vehicle crashes (26.6 percent)

- 6.2 percent were pediatric patients (age<13 years) with blunt injuries

- 4.9 percent of all inpatients qualifying for the Registry were adults who suffered stab wounds; 3.3 percent were treated for gunshot wounds

- 0.2 percent were pediatric patients with penetrating injuries

- 61.3 percent were males
  - males 13-24 were the highest percentage of trauma inpatients (12.1 percent), followed by males 45-54 (8.0 percent) and by males 25-34 (7.8 percent)

- the most populous groups among females were the more elderly
  - ages 75-84 (9.0 percent); ages 85+ (9.0 percent)

- 22,334 were victims of motor vehicle crashes
  - 65.9 percent were males
  - more females than males 75 and older were hospitalized for motor vehicle crashes; whereas for every age group below 75, more men than women were hospitalized

- 38,851 inpatients were victims of falls
  - 50.3 percent were women
  - the most populous age/gender groups hospitalized with falls were women age 75-84 (15.3 percent) and 85+ (16.4 percent)
  - these groups were followed by males between 75 and 84 (10.1 percent) and male age 85+ (7.4 percent)

- 6,579 inpatients were victims of penetrating injuries
    - 91.3 percent were males
    - the vast majority of these males were ages 13-24 (42.4 percent), 25-34 (24.1 percent) and 35-44 (11.9 percent)

- the overall statewide mortality rate was 5.52 percent
    - 4,357 deaths among 78,959 patients
    - gunshot wounds had the highest inpatient mortality rate (10.8 percent)
    - next highest mortality rates were “other injuries” (7.1 percent), falls (7.0 percent), pediatric penetrating (6.7 percent) and motor vehicle crashes (4.6 percent)

Descriptive Statistics for All Seriously Injured Trauma Inpatients in the NYSTR (Patients Treated in Trauma Centers)

The following statements apply to patients in the NYSTR:

- the levels of designation are regional trauma center and area trauma center
    - 82.4 percent treated at regional centers
    - in Western New York, Finger Lakes, and New York City, 100 percent of the patients were treated at regional centers, since there are no area centers in those regions
    - region with the next largest percent of patients treated at regional centers was Nassau (88.8 percent)
    - region with the smallest percent treated at regional centers was Suffolk (40.7 percent)

- 39.7 percent were victims of falls
    - this percentage ranged from a low of 29.5 percent in Western New York to a high of 53.5 percent in Nassau

- among the eight regions of the state, penetrating injuries (stab wounds and gunshot wounds) represent from 4.7 percent to 21.6 percent of the total patients
    - in New York City, these two mechanisms of injury represent 12.5 percent and 9.1 percent of patients

Significant Mortality Results by Region and Level

Mortality rates for trauma patients were evaluated and compared according to region of the state and to level of care. The mortality data were risk-adjusted to account for differences in patient injury severity.

- there were no significant differences among levels of care for any mechanism of injury or for all mechanisms combined for inpatient mortality

- among motor vehicle crash inpatients
    - New York City had a risk-adjusted rate of 6.03 percent that was significantly higher than the statewide rate (5.17 percent)

- among gunshot wound inpatients

    - Western New York (7.76 percent) had significantly lower mortality rate than the statewide rate (11.82 percent)

- for all inpatients combined
    - Western New York inpatients (5.40 percent), Finger Lakes inpatients (5.28 percent) and Northeastern New York inpatients (5.44 percent) had risk-adjusted rates that were significantly lower than the statewide rate of 6.19 percent
    - Nassau inpatients (6.98 percent) and New York City inpatients (6.66 percent) had risk-adjusted rates that were significantly higher than the statewide rate

Individual Hospital Outcomes

- The mortality rate for 48,940 adult inpatients treated at 40 trauma centers was 6.19 percent
    - observed mortality rates ranged from 0.00 percent to 8.86 percent
    - risk-adjusted mortality rates used to measure performance for all hospitals ranged from 0.00 percent to 8.88 percent
        - Four hospitals (Albany Medical Center Hospital, StonyBrook University Medical Center, Strong Memorial Hospital, and NY Presbyterian/Weill Cornell Medical Center) had risk-adjusted inpatient mortality rates significantly lower than the statewide rate of 6.19 percent
        - Two hospitals (Lutheran Medical Center and Jamaica Hospital Medical Center) had risk-adjusted inpatient mortality rates significantly higher than the statewide rate of 6.19 percent

Trends in Risk-Adjusted Mortality Rates for Mechanisms of Injury in the NYSTR

Over the time period of 2007-2009, there was a significant 8.7% decrease in risk-adjusted inpatient mortality for falls inpatients. There was a significant 36.1% decrease in risk-adjusted inpatient mortality for other blunt inpatients. There were no significant changes in the risk-adjusted mortality in either direction for the other inpatient MOIs.

Comparison of Recent Trauma Mortality Rates in New York and the United States

Probably the best gauge of the performance of New York's trauma system in the past several years is a comparison with national trauma outcomes data from the CDC.[6] The following is a comparison of outcomes in New York and the United States of three groups of trauma patients (motor vehicle crash, falls, and firearm[7] injuries) that comprise approximately three-quarters of all traumatic injuries contained in New York's Registry.

- Motor Vehicle Crashes
    - The age–adjusted mortality rate per 100,000 population for MVCs in the United States was 14.39 percent, whereas it was only 7.41 percent in New York State. The difference between these two rates was statistically significant ($p<0.0001$).
- Falls
    - The mortality rate for falls per 100,000 population in the United States in 2007 was higher than the rate in New York (7.08 vs. 5.37, respectively). This difference was statistically significant ($p<0.0001$).
- Firearms
    - The age-adjusted mortality rate of firearms per 100,000 population in the United States in 2007 was 10.23, significantly higher than the comparable rate in New York (5.00) ($p <0.0001$).

[6] Center for Disease Control and Prevention (CDC), National Center for Injury Prevention and Control (NCIPC), Web-Based Injury Statistics Query and Reporting System (WISQARS) www.cdc.gov/ncipc/wisqars.

[7] The CDC database uses the grouping "firearms" which is comparable to the NYSTR's "gunshot wounds".

Caveats/Limitations of the Report

There are several caveats/limitations of the report that could have an impact on the reported findings. The following is a short discussion of these caveats.

(1) There may be other missing variables in the risk-adjustment process.

The risk-adjusted outcomes are dependent on the variables that are used in the risk-adjustment process, and ideally this set of variables is comprehensive in that it contains all patient characteristics that have a bearing on the outcome (inpatient mortality). To the extent that an unidentified variable would have been a significant independent predictor of mortality and there were differences across hospitals in the rates of occurrence of that variable, hospitals with higher rates would be at a disadvantage in the risk-adjustment process since hospitals with sicker patients have risk-adjusted mortality rates that are lower than their observed rates. We do not think this is a major threat to the validity of the results because the set of patient risk factors used in the study is quite comprehensive in relation to what has been used in other studies.

(2) There is not a formal auditing process.

Ideally, the data reported to the DOH would be audited for accuracy by reviewing medical records, but this is a very expensive and time-consuming process, and there are no funds available for such an audit. It should be noted that the American College of Surgeons database is not audited. An advantage of the New York database is that completeness of data (all trauma patients in participating hospitals are included) is assured by matching registry data to SPARCS, New York's hospital discharge database.

(3) Process outcome links have not yet been established.

In a quality improvement initiative of this nature, there is ideally a link that is established between outcomes and processes of care, whereby effective processes of care can be demonstrated to be more prevalent in hospitals with better outcomes and less prevalent in hospitals with worse outcomes. This has not yet been done, and it is frequently difficult to establish process-outcome links, in part because it is difficult to identify effective processes.

(4) Distance of transport may be a confounding factor.

When transport times are longer, the most seriously injured patients are more likely to die in transport rather than in a hospital emergency room or as an inpatient. With shorter transport times, unsalvageable patients may die either in the ED, or shortly after being admitted. Thus, hospitals with shorter transport times may be more likely to have deaths that are reflected in the risk-adjusted inpatient mortality rates in this report.

Appendix 1

ICD-9-CM Codes for Inclusion in the New York State Trauma Registry (effective January 1, 2007)

800	.00-.06	.09-.16	.19-.26	.29-.36	.39-.46	.49-.56	.59-.66	.69-.76	.79-.86	.89-.96	.99	
801	.00-.06	.09-.16	.19-.26	.29-.36	.39-.46	.49-.56	.59-.66	.69-.76	.79-.86	.89-.96	.99	
802	.7											
803	.00-.01	.03-.05	.12-.15	.20-.25	.33-.35	.43-.45	.52-.55	.62-.65	.72-.75	.82-.85	.92-.95	
804	.03-.05	.10-.16	.19-.26	.29-.36	.39-.46	.49-.56	.59-.66	.69-.76	.79-.86	.89-.96	.99	
805	.01-.08	.10-.18	.3	.5	.6	.7	.8					
806	.00-.39	.4	.5	.60-.62	.69-.72	.79	.8	.9				
807	.04-.19	.4	.5	.6								
808	.1	.3	.43	.51-.53	.59	.9						
819	.0	.1										
821	.00-.01	.10-.11	.20-.23	.29-.33	.39							
823	.10	.12	.30	.32	.90	.92						
824	.1	.3	.5	.7	.9							
828	.0	.1										
836	.51-.52	.61-.64	.69									
839	.01-.08	.11-.18	.20-.21	.30-.31	.40-.42	.51-.52	.59	.8				
850	.2	.3	.4									
851	.00-.06	.09-.16	.19-.26	.29-.36	.39-.46	.49-.56	.59-.66	.69-.76	.79-.86	.89-.96	.99	
852	.00-.06	.09-.16	.19-.26	.29-.36	.39-.46	.49-.56	.59					
853	.00-.06	.09-.16	.19									
854	.03-.05	.10-.16	.19									
860	.0	.1	.2	.3	.4	.5						
861	.00-.03	.10-.13	.20-.22	.30-.32								
862	.0	.1	.21-.22	.29	.31-.32	.39	.8	.9				
863	.0	.1	.20-.21	.29-.31	.39-.46	.49-.56	.59	.80-.85	.89-.95	.99		
864	.02-.05	.10-.15	.19									
865	.01-.04	.09	.11-.14	.19								
866	.02-.03	.11-.13										
867	.1	.2	.3	.4	.5							
868	.01-.04	.09-.14	.19									
874	.00-.02	.10-.12	.4	.5								
887	.0	.1	.2	.3	.4	.5	.6	.7				
896	.0	.1	.2	.3								
897	.0	.1	.2	.3	.4	.5	.6	.7				
900	.00-.03	.1	.81-.82	.89	.9							
901	.0	.1	.2	.3	.40-.42	.81-.83	.89	.9				
902	.0	.10-.11	.19-.27	.29	.31-.34	.39-.42	.49-.56	.59	.81-.82	.87	.89	.9
903	.01-.02											
904	.0	.1										
925	.1	.2										
927	.00-.03	.09-.11	.21	.8	.9							
928	.00-.01	.10-.11	.20-.21	.8	.9							
950	.0	.1	.2	.3	.9							
952	.00-.19	.2	.3	.4	.8	.9						
953	.0	.1	.2	.4								
954	.8	.9										
955	.8											
956	.0	.8										
958	.4	.90-.93	.99									

Appendix 2

Hospitals Participating in the New York State Trauma Registry in 2007-2009

Region:	Western New York	
Level	PFI:	Hospital Name
Regional	0208:	Women's and Children's Hospital of Buffalo
	0210:	Erie County Medical Center

Region:	Finger Lakes	
Level	PFI:	Hospital Name
Regional	0413:	Strong Memorial Hospital

Region:	Central New York	
Level	PFI:	Hospital Name
Regional	0635:	Upstate University Hospital, SUNY
Area	0598:	St. Elizabeth's Medical Center
	0058:	United Health Services Hospitals, Inc.-Wilson

Region:	Northeastern New York	
Level	PFI:	Hospital Name
Regional	0001:	Albany Medical Center Hospital
Area	0135:	Champlain Valley Physicians' Hospital Medical Center
	0746:	Bassett Medical Center

Region:	Hudson Valley	
Level	PFI:	Hospital Name
Regional	1139:	Westchester Medical Center
Area	0779:	Good Samaritan Hospital, Suffern
	0776:	Nyack Hospital
	1072:	Sound Shore Medical Center of Westchester
	0180:	St. Francis Hospital

Hospitals Participating in the New York State Trauma Registry in 2007-2009

Region:	Nassau	
Level	PFI:	Hospital Name
Regional	0528:	Nassau University Medical Center
	0541:	North Shore University Hospital
	0511:	Winthrop University Hospital
Area	0527:	South Nassau Communities Hospital

Region:	Suffolk	
Level	PFI:	Hospital Name
Regional	0245:	Stony Brook University Medical Center
Area	0885:	Brookhaven Memorial Hospital Medical Center, Inc.
	0925:	Good Samaritan Hospital Medical Center, West Islip
	0913:	Huntington Hospital
	0924:	Southside Hospital

Region:	New York City	
Level	PFI:	Hospital Name
Regional	1438:	Bellevue Hospital Center
	1286:	Brookdale University Hospital Medical Center
	1626:	Elmhurst Hospital Center
	1445:	Harlem Hospital Center
	1165:	Jacobi Medical Center
	1629:	Jamaica Hospital Medical Center
	1301:	Kings County Hospital Center
	1172:	Lincoln Medical & Mental Health Center
	1630:	Steven & Alexandra Cohen Children's Medical Center
	1304:	Lutheran Medical Center
	1637:	New York Hospital Medical Center of Queens
	1464:	New York Presbyterian Morgan Stanley Children's Hospital/Columbia University Medical Center
	1458:	New York Presbyterian/Weill Cornell Medical Center
	1738:	Richmond University Medical Center
	1176:	St. Barnabas Medical Center
	1469:	St. Luke's and Roosevelt Hospital Center
	1740:	Staten Island University Hospital-North

Appendix 3

Independent Risk Factors for Inpatient Mortality for Motor Vehicle Crash Inpatients in New York State: 2007 - 2009

Risk Factor	Parameter Estimate	p-value	Odds Ratio
Pedestrian *	0.441973	<.0001	1.556
Intubated in the field or at the referring hospital	0.391438	0.0339	1.479
Intubated in the ED of the final hospital	1.290928	<.0001	3.636
Motor response on arrival at final hospital = 1	1.410197	<.0001	4.097
Motor response on arrival at final hospital = 2,3,4,5	0.711285	<.0001	2.037
Age	0.028319	<.0001	1.029
Age greater than 60	0.052238	<.0001	1.054
Systolic blood pressure on arrival at the final hospital	-0.032751	<.0001	0.968
Systolic blood pressure squared	0.000085906	<.0001	1.000
ICISS[8]	-5.328021	<.0001	0.005

Intercept = 0.877894
***C* = 0.950**
***Odds relative to non-pedestrians**

[8] For an explanation of ICISS, see Footnote #3.

Appendix 4

Independent Risk Factors for Inpatient Mortality for Other Blunt Inpatients in New York State: 2007 - 2009

Risk Factor	Parameter Estimate	p-value	Odds Ratio
Transfer from emergency department of referring hospital *	0.658533	0.0433	1.932
Intubated in the ED of the final hospital	1.557913	<.0001	4.749
Motor response on arrival at final hospital = 1,2,3	1.692964	<.0001	5.436
Motor response on arrival at final hospital = 4	1.514043	0.0002	4.545
Age	0.049445	<.0001	1.051
Systolic blood pressure on arrival at the final hospital	-0.013701	0.0003	0.986
ICISS[9]	-5.512453	<.0001	0.004

Intercept = -0.815531
***C* = 0.957**
***Odds relative to patients not transported from the emergency department of another hospital**

[9] For an explanation of ICISS, see Footnote #3.

Appendix 5

Independent Risk Factors for Inpatient Mortality for Fall Inpatients in New York State: 2007 – 2009

Risk Factor	Parameter Estimate	p-value	Odds Ratio
Male gender	0.468056	<.0001	1.597
Intubated in the field or at the referring hospital	0.793707	<.0001	2.212
Intubated in the ED of the final hospital	1.453576	<.0001	4.278
Eye response on arrival at final hospital = 1,2,3	0.388179	0.0238	1.474
Motor response on arrival at final hospital = 1,2,3	0.816557	<.0001	2.263
Motor response on arrival at final hospital = 4,5	0.660131	<.0001	1.935
Age	0.028146	0.0267	1.029
Age squared	0.000218	0.0211	1.000
Systolic blood pressure on arrival at the final hospital	-0.017343	0.0002	0.983
Systolic blood pressure squared	0.000051396	0.0013	1.000
ICISS[10]	-5.061440	<.0001	0.006

Intercept = - 0.936202
***C* = 0.889**

[10] For an explanation of ICISS, see Footnote #3.

Appendix 6

Independent Risk Factors for Inpatient Mortality for Stab Wound Inpatients in New York State: 2007 – 2009

Risk Factor	Parameter Estimate	p-value	Odds Ratio
Motor response on arrival at final hospital = 1,2	3.387458	<.0001	29.591
Motor response on arrival at final hospital = 3	2.953952	<.0001	19.182
Motor response on arrival at final hospital = 4	1.760567	0.0027	5.816
Motor response on arrival at final hospital = 5	1.091787	0.0464	2.980
Age	0.020537	0.0373	1.021
Systolic blood pressure on arrival at the final hospital	-0.013624	0.0001	0.986
ICISS[11]	-6.840308	<.0001	0.001

Intercept = 1.252206
***C* = 0.953**

[11] For an explanation of ICISS, see Footnote #3.

Appendix 7

Independent Risk Factors for Inpatient Mortality for Gunshot Wound Inpatients in New York State: 2007 – 2009

Risk Factor	Parameter Estimate	p-value	Odds Ratio
Intubated in the field or at the referring hospital	0.866896	0.0297	2.380
Intubated in the ED of the final hospital	1.237191	<.0001	3.446
Motor response on arrival at final hospital = 1	2.190982	<.0001	8.944
Motor response on arrival at final hospital = 2,3,4,5	1.010807	0.0002	2.748
Age greater than 50	0.083541	0.0002	1.087
Systolic blood pressure on arrival at the final hospital	-0.046273	<.0001	0.955
Systolic blood pressure squared	0.000142	0.0006	1.000
ICISS[12]	-5.156203	<.0001	0.006

Intercept = 3.487611
***C* = 0.957**

[12] For an explanation of ICISS, see Footnote #3.

GLOSSARY

MOI – mechanism of injury

NYSTR – New York State Trauma Registry

OMR – observed mortality rate – the number of inpatient deaths in the group divided by the number of patients in the group

SPARCS – Statewide Planning and Research Co-operative System

RAMR – risk-adjusted mortality rate – the product of the ratio of a group's observed to expected mortality rates and the statewide mortality rate

End of report