New York State Trauma Registry

Statistical Report 1/1/2014-12/31/2015

New York State Department of Health
Office of Primary Care and Health Systems Management

Bureau of Emergency Medical Services and Trauma &
Data Management, Analytics, and Research Group

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Executive Summary

Introduction

The purpose of this report is to present summary statistics of trauma-related injuries and outcomes of the care provided in the 43 trauma centers designated in New York State for the calendar years 2014-2015. For this reporting period, the 43 trauma centers were grouped into three types: Regional – trauma center with level one designation by American College of Surgeon, Area – trauma centers with level two designation by American College of Surgeon, and Provisional – facilities in the process of becoming a trauma center.

Trauma clinicians, administrators and policy makers may use this report to identify important areas and issues for enhancing systems development and clinical quality improvement; the public may use this report to learn more about the trauma system in New York State. As trauma centers in New York State transition to the standards of the American College of Surgeons Committee on Trauma, and additional levels of trauma center are added to the State system, this report will serve as a baseline for measuring improvements in outcome and injury prevention.

Major Findings

For the discharge years 2014-2015, the New York State Trauma Registry received a total of 97,221 trauma cases submitted by the 43 trauma centers across the state. The key findings are:

- Annually, there were an average of 48,610 trauma incidents with a 3.35% case fatality rate.
- Most trauma (81%) is unintentional. 33% of trauma occurs in the home, and 29% on the street or highway.
- Trauma incidence and case fatality rate increased with patient's age.
- Males had a higher trauma incidence than females, particularly for ages 65 and under. Additionally, males have a higher case fatality rate than females, a difference which widens with age.
- Black young adults had a higher trauma incidence and case fatality rate than young adults of other races. Compared to non-Hispanics, Hispanics had higher trauma incidence and lower case fatality rate.
- Trauma is 1.1% of total deaths. Trauma accounts for 13% of teenage deaths statewide.
- Trauma is most likely to happen on the weekends, in summer months, and in the afternoon (peaking at 5pm).
- The leading causes of trauma were falls (54.0% of total) and motor vehicle accidents (20.5% trauma). These were also the leading causes of trauma deaths. Case fatality rates were 3.4% and 3.7% respectively.
- Motor vehicle trauma was the leading cause of trauma and trauma death for people under 40 years old. Firearm trauma was the second leading cause of trauma deaths for people between 10 - 40 years old.
- The median EMS response time was 7 minutes. The New York City Region had the shortest (6 minutes), while the Hudson Valley and Central New York Regions had the longest (9 minutes).
- The median EMS transport time was 17 minutes for moderate to low severity trauma, and 12 minutes for the most severe trauma cases. The New York City and Long Island Regions had the shortest EMS transport times (15 minutes), and the Northeast Region has the longest (28 minutes).
- The median time at a referring hospital inversely correlates with injury severity; 5 hours for low severity trauma and 3 hours for most severe trauma. Finger Lakes Region trauma patients had the shortest times (2.75 hours), and New York City Region trauma patients had the longest (6.5 hours).
- Similarly, median time in a trauma center emergency department decreases with increasing injury severity. Low severity injuries spend 6 hours in the EDwhile highest severity injuries only spend 2.5 hours in the ED.
- 52% of trauma patients were discharged to home with no services, 17% to inpatient rehabilitation, 9% to home with home health services, 5% to a Skilled Nursing Facility, and 2% left against medical advice.
- Trauma centers in the Northeastern and Hudson Valley Regions had overall risk-adjusted mortality rates that fell below the state average while the Central New York Region had an above average overall risk-adjusted mortality rate.

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Materials and Methods

Materials and Methods

1. Data Sources

Trauma Registry - Established in 1993, the New York State Trauma Registry (NYSTR) receives reports from designated trauma centers on patients identified and treated as being for traumatic injury (Inclusion Criteria in Appendix Inclusion Criteria in Appendix). The reports contain variables specified by the New York State Trauma Registry including patients' demographic information, diagnoses and treatments. A very small portion of the trauma reports in the NYSTR were submitted from several non-trauma centers/hospitals.

Statewide Planning and Research Cooperative System (SPARCS) - Implemented by the New York State Department of Health (NYSDOH) in 1979, SPARCS is a comprehensive, integrated information system available to assist hospitals and organizations in the health care industry with healthcare resource planning, financial analysis, decision making, and surveillance of New York State. SPARCS receives, processes, stores, and analyzes the inpatient and emergency department data from all hospitals in New York. Each health care provider submits its SPARCS data, as mandated, in the uniform, computer-readable format described in the Universal Data Set.

Surveillance, Epidemiology, and End Results Program (SEER) - The population estimates used to calculate trauma incidence and mortality were from Surveillance, Epidemiology, and End Results Program (SEER) of the National Cancer Institute. This data was produced by the US Census Bureau's Population Estimates Program, in collaboration with the National Center for Health Statistics and with support from the National Cancer Institute.[3]

National Trauma Data Bank (NTDB) - NTDB collects trauma registry data from participating trauma centers across the U.S. on an annual basis. [4]

2. The Cohort

A cohort used for generating the NYSTR Summary Report was constructed with NYSTR data submitted from the certified trauma centers. Trauma records submitted by non-trauma centers were excluded in the data analyses.

3. Data Matching

A dataset containing all patients diagnosed with traumatic injuries and who were treated in New York State trauma centers was created from SPARCS hospital inpatients and emergency department (ED) discharge files. This data file was matched to Trauma Registry records for the same discharge year period by using identifying variables such as hospital's Permanent Facility Identifier, admission dates, discharge dates, hospital's medical record numbers, patients' date of birth, etc. The matches were conducted without using patient name and address, because SPARCS does not contain patient name and SPARCS ED data does not have patient address information. The records found in the SPARCS hospital data files or ED data files but not in the Trauma Registry database were defined as unmatched/missed reports and were sent to hospitals for audits. After checking their own unmatched/missed reports, hospitals resubmitted the missing trauma cases and corrected trauma cases to TraumaRegistry.

Materials and Methods

4. Statistical Analysis

Descriptive Analysis. Standard linear and weighted loess regression techniques were used. All confidence intervals shown represent a 95% confidence interval of the sample population. Box plots omit outliers, defined as 1.5 times the interquartile range.

Predictive Analysis. Predictive analysis of risk of mortality was performed to develop a risk-adjusted model that provides unbiased estimates of trauma case fatality rates. The detailed description of the risk adjustment methodology was provided in the Risk Adjustment Methodology section in the Appendix.

5. Specific Notes

EMS Time Variables. Many omissions were present in the EMS time variables; additionally, negative time values and excessively long time values were excluded. Therefore, when time variables were quoted, a subset excluding the records with missing values was used.

E-codes. In the cohort, some patients have more than one E code for cause of injury. In this analysis, only the primary E code cause was used, in the Injury Categories section, page 24

Comparison to the Nation. Slightly different inclusion criteria is used by the NYSTR and NTBD.

6. Software

All figures, tables, maps, and calculations were created with R statistical software[5]. This document was typeset with LaTeX. The two scripts were combined into a single program with Sweave[7].

7. Definitions

Pediatric patents. In this report, the pediatric patients were defined as those aged 14 years or younger.

Region and Area Trauma Centers. As the registry switches to American College of Surgeon trauma center designations, those facilities who achieved designation of level 1 will be referred to as regional center, and level 2 as area center to maintain consistency for this reporting period.

Injury Severity Score. An established medical score to assess trauma severity. It correlates with mortality, morbidity and hospitalization time after trauma. It ranges from 1 to 75, where 75 is considered non-survivable.

Case Fatality Rate. Number of deaths divided by total cases.

Race. Patient self-identified race as White, Black, Asian/Pacific Islander, American Indian/Alaska Native, multi-race or others.

Ethnicity. Patient self-identified as Spanish/Hispanic origin or non-Spanish/non-Hispanic origin.

Facility Information

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Geographic Distribution of Upstate Trauma Centers

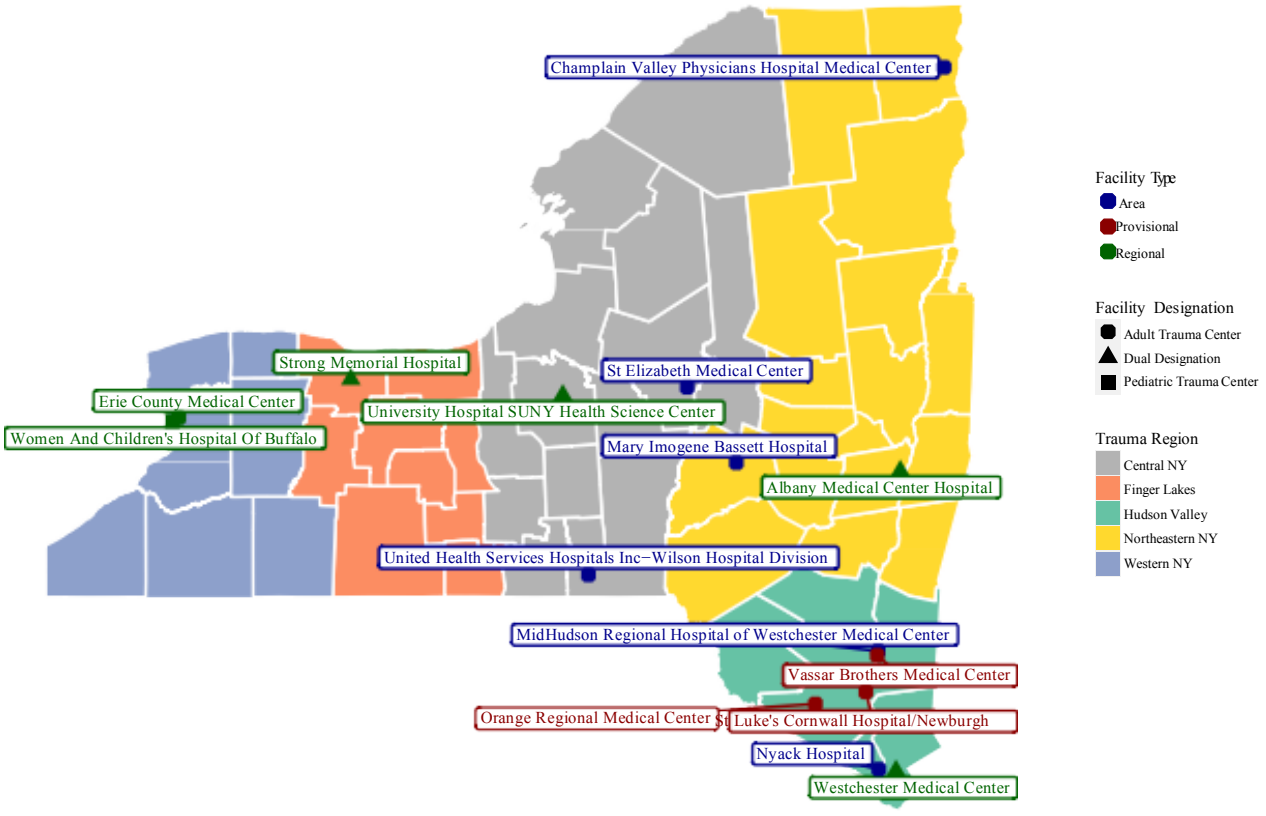

Figure 1

There are 15 trauma centers in Upstate New York: 6 Regional, 6 Area, and 3 Provisional centers. Of the 15 centers, 5 centers are approved to treat pediatric trauma. Provisional refers to a hospital that has begun the process of becoming a Trauma Center but has not conducted their verification visit.

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Geographic Distribution of New York City Trauma Centers

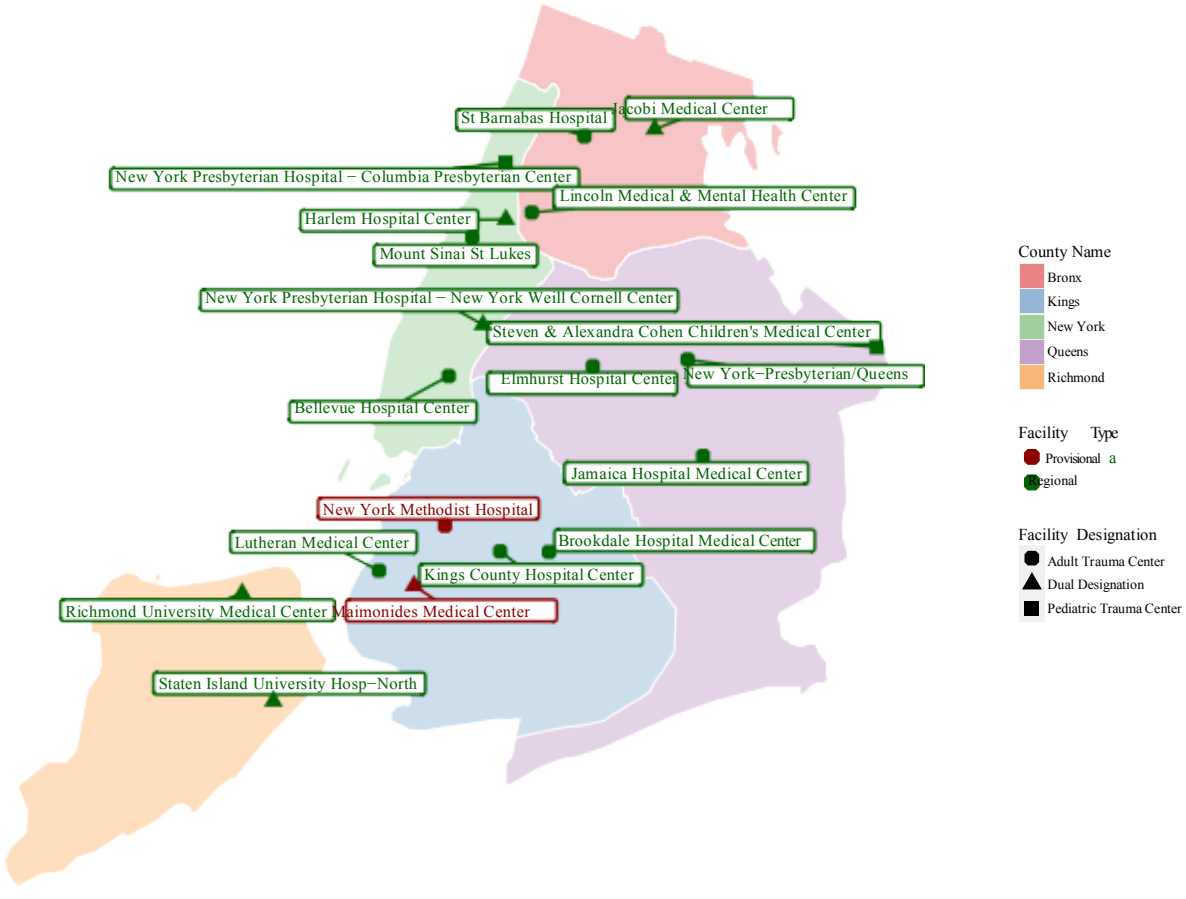

Figure 2

There are 19 trauma centers in New York City: 17 Regional and 2 Provisional centers. Of the 19 centers, 8 centers are approved to treat pediatric trauma. Provisional refers to a hospital that has begun the process of becoming a Trauma Center but has not conducted their verification visit.

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Geographic Distribution of Long Island Trauma Centers

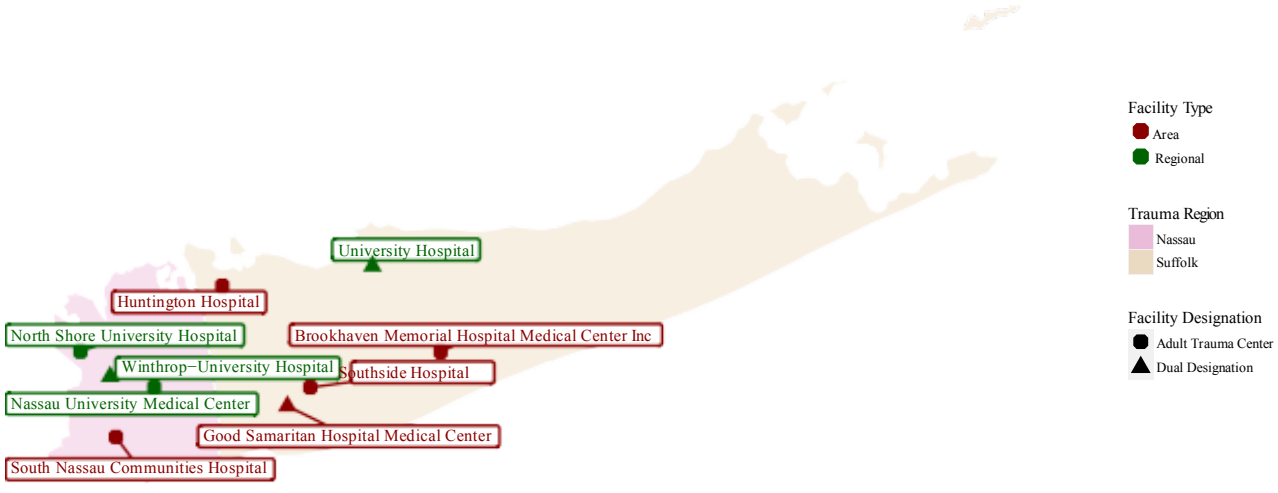

Figure 3

There are 9 trauma centers in Long Island: 4 Regional and 5 Area centers. Of the 9 centers, 3 centers are approved to treat pediatric trauma.

New York City Trauma Center Case Loads

Region	Total Cases		Adult Cases		Pediatric Cases		Facility	
	2014	2015	2014	2015	2014	2015	Type	Designation
Bronx								
Lincoln Medical & Mental Health Center	1,079	1,154	999	1,092	80	62	Regional	Adult Trauma Center
St Barnabas Hospital	773	846	751	821	21	25	Regional	Adult Trauma Center
Jacobi Medical Center	1,707	1,366	1,543	1,258	163	108	Regional	Dual Designation
Total - Bronx	3,559	3,366	3,293	3,171	264	195		
Kings								
New York Methodist Hospital	0	558	0	507	0	51	Provisional	Adult Trauma Center
Maimonides Medical Center	620	596	546	539	74	57	Provisional	Dual Designation
Brookdale Hospital Medical Center	884	953	820	897	64	56	Regional	Adult Trauma Center
Kings County Hospital Center	1,214	907	1,144	842	70	65	Regional	Adult Trauma Center
Lutheran Medical Center	1,545	1,815	1,513	1,743	32	72	Regional	Adult Trauma Center
Total - Kings	4,263	4,829	4,023	4,528	240	301		
New York								
Bellevue Hospital Center	1,696	1,436	1,601	1,348	87	88	Regional	Adult Trauma Center
Mount Sinai St Lukes	551	771	546	768	5	3	Regional	Adult Trauma Center
Harlem Hospital Center	769	396	686	350	83	46	Regional	Dual Designation
New York Presbyterian Hospital - New York Weill Cornell Center	1,929	1,518	1,764	1,349	165	169	Regional	Dual Designation
New York Presbyterian Hospital - Columbia Presbyterian Center	166	194	28	43	138	151	Regional	Pediatric Trauma Center
Total - New York	5,111	4,315	4,625	3,858	478	457		
Queens								
Elmhurst Hospital Center	1,350	1,498	1,250	1,421	100	77	Regional	Adult Trauma Center
Jamaica Hospital Medical Center	2,121	2,251	2,046	2,166	72	85	Regional	Adult Trauma Center
New York-Presbyterian/Queens	1,275	1,235	1,233	1,225	42	10	Regional	Adult Trauma Center
Steven & Alexandra Cohen Children's Medical Center	470	503	83	99	387	404	Regional	Pediatric Trauma Center
Total - Queens	5,216	5,487	4,612	4,911	601	576		
Richmond								
Richmond University Medical Center	967	1,491	895	1,350	72	141	Regional	Dual Designation
Staten Island University Hosp-North	1,999	2,253	1,743	2,016	255	236	Regional	Dual Designation
Total - Richmond	2,966	3,744	2,638	3,366	327	377		

Table 1

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Long Island Trauma Center Case Loads

Region	Total Cases		Adult Cases		Pediatric Cases		Facility	
	2014	2015	2014	2015	2014	2015	Type	Designation
Nassau								
South Nassau Communities Hospital	737	1,105	725	1,095	11	8	Area	Adult Trauma Center
Nassau University Medical Center	1,700	1,693	1,628	1,616	72	77	Regional	Adult Trauma Center
North Shore University Hospital	2,184	2,409	2,182	2,408	2	1	Regional	Adult Trauma Center
Winthrop-University Hospital	1,252	1,278	1,143	1,154	109	124	Regional	Dual Designation
Total - Nassau	5,873	6,485	5,678	6,273	194	210		
Suffolk								
Brookhaven Memorial Hospital Medical Center Inc	1,011	582	998	576	13	4	Area	Adult Trauma Center
Huntington Hospital	709	903	694	877	15	26	Area	Adult Trauma Center
Southside Hospital	1,026	1,005	1,006	985	19	20	Area	Adult Trauma Center
Good Samaritan Hospital Medical Center	1,528	1,532	1,435	1,444	93	88	Area	Dual Designation
University Hospital	1,611	1,828	1,460	1,628	151	200	Regional	Dual Designation
Total - Suffolk	5,885	5,850	5,593	5,510	291	338		

Table 2

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Upstate Trauma Center Case Loads

Region	Total Cases		Adult Cases		Pediatric Cases		Facility	
	2014	2015	2014	2015	2014	2015	Type	Designation
Central NY								
St Elizabeth Medical Center	624	557	605	540	19	17	Area	Adult Trauma Center
United Health Services Hospitals Inc-Wilson Hospital Division	973	897	933	851	40	45	Area	Adult Trauma Center
University Hospital SUNY Health Science Center	2,177	2,308	1,856	2,001	321	307	Regional	Dual Designation
Total - Central NY	3,774	3,762	3,394	3,392	380	369		
Finger Lakes								
Strong Memorial Hospital	1,019	1,098	930	1,003	89	95	Regional	Dual Designation
Total - Finger Lakes	1,019	1,098	930	1,003	89	95		
Hudson Valley								
MidHudson Regional Hospital of W estchester Medical Center	1,092	705	1,046	701	46	4	Area	Adult Trauma Center
Nyack Hospital	138	599	136	585	1	14	Area	Adult Trauma Center
Orange Regional Medical Center	376	141	365	136	11	5	Provisional	Adult Trauma Center
St Luke's Cornwall Hospital/Newburgh	339	707	327	668	11	32	Provisional	Adult Trauma Center
Vassar Brothers Medical Center	129	0	127	0	2	0	Provisional	Adult Trauma Center
Westchester Medical Center	1,943	1,979	1,663	1,643	280	336	Regional	Dual Designation
Total - Hudson Valley	4,017	4,131	3,664	3,733	351	391		
Northeastern NY								
Champlain Valley Physicians Hospital Medical Center	354	376	349	360	5	16	Area	Adult Trauma Center
Mary Imogene Bassett Hospital	477	689	468	641	9	47	Area	Adult Trauma Center
Albany Medical Center Hospital	2,531	2,890	2,303	2,565	228	323	Regional	Dual Designation
Total - Northeastern NY	3,362	3,955	3,120	3,566	242	386		
Western NY								
Erie County Medical Center	2,191	2,136	2,188	2,128	3	8	Regional	Adult Trauma Center
Women and Children's Hospital Of Buffalo	408	419	62	64	346	355	Regional	Pediatric Trauma Center
Total - Western NY	2,599	2,555	2,250	2,192	349	363		

Table 3

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Patient Characteristics

Summary of Patient Characteristics

	Incidents		Percent		Incidence		Deaths		Fatality Rate(%)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Age										
0-14	3,821	4,088	8.02	8.25	1.09	1.17	28	39	0.73	0.95
15-29	8,886	8,335	18.65	16.81	2.12	2.00	234	204	2.63	2.45
30-44	6,869	6,672	14.42	13.46	1.77	1.72	154	151	2.24	2.26
45-59	8,137	8,056	17.08	16.25	1.96	1.95	200	217	2.46	2.69
60-74	7,604	7,969	15.96	16.07	2.77	2.81	280	299	3.68	3.75
75-84	6,003	6,217	12.60	12.54	6.94	7.14	337	295	5.61	4.75
85+	6,298	6,828	13.22	13.77	14.80	15.75	354	382	5.62	5.59
Sex										
Female	19,648	20,385	41.24	41.12	1.93	2.00	572	580	2.91	2.85
Male	27,970	29,185	58.71	58.87	2.92	3.04	1,015	1,026	3.63	3.52
Race										
American Indian or Alaska Native	19	38	0.05	0.09	0.09	0.17	0	4	0.00	10.53
Asian or Pacific Islander	1,551	1,673	4.00	4.04	0.87	0.92	53	56	3.42	3.35
Black	4,952	5,517	12.78	13.33	1.36	1.51	153	184	3.09	3.34
White	25,676	26,992	66.27	65.20	1.82	1.92	926	901	3.61	3.34
Ethnicity										
Hispanic or Latino	6,162	8,509	12.93	17.16	2.20	2.99	154	208	2.50	2.44
Not Hispanic or Latino	35,101	33,951	73.67	68.48	2.18	2.11	1,217	1,167	3.47	3.44
Region										
Central NY	3,553	3,574	7.46	7.21	2.04	2.06	142	142	4.00	3.97
Finger Lakes	936	1,012	1.96	2.04	0.73	0.79	46	49	4.91	4.84
Hudson Valley	4,148	4,074	8.71	8.22	1.78	1.75	135	115	3.25	2.82
Nassau	4,744	5,151	9.96	10.39	3.49	3.78	154	187	3.25	3.63
New York City	20,571	20,896	43.18	42.15	2.42	2.44	588	595	2.86	2.85
Northeastern NY	2,901	3,335	6.09	6.73	1.93	2.22	128	157	4.41	4.71
Suffolk	5,918	5,849	12.42	11.80	3.94	3.90	215	166	3.63	2.84
Western NY	2,576	2,547	5.41	5.14	1.68	1.66	120	101	4.66	3.97
Total										
	47,644	49,577	100.00	100.00	2.41	2.50	1,588	1,606	3.33	3.24

Table 4

Null value counts are omitted from subcategories, but are contained in the total.

Fatality rate is $\frac{Deaths}{Incidents} \times 100$. Incidence is $\frac{Incidents}{Population} \times 1,000$. Percent is $\frac{Incidents}{Total\ incidents} \times 100$.

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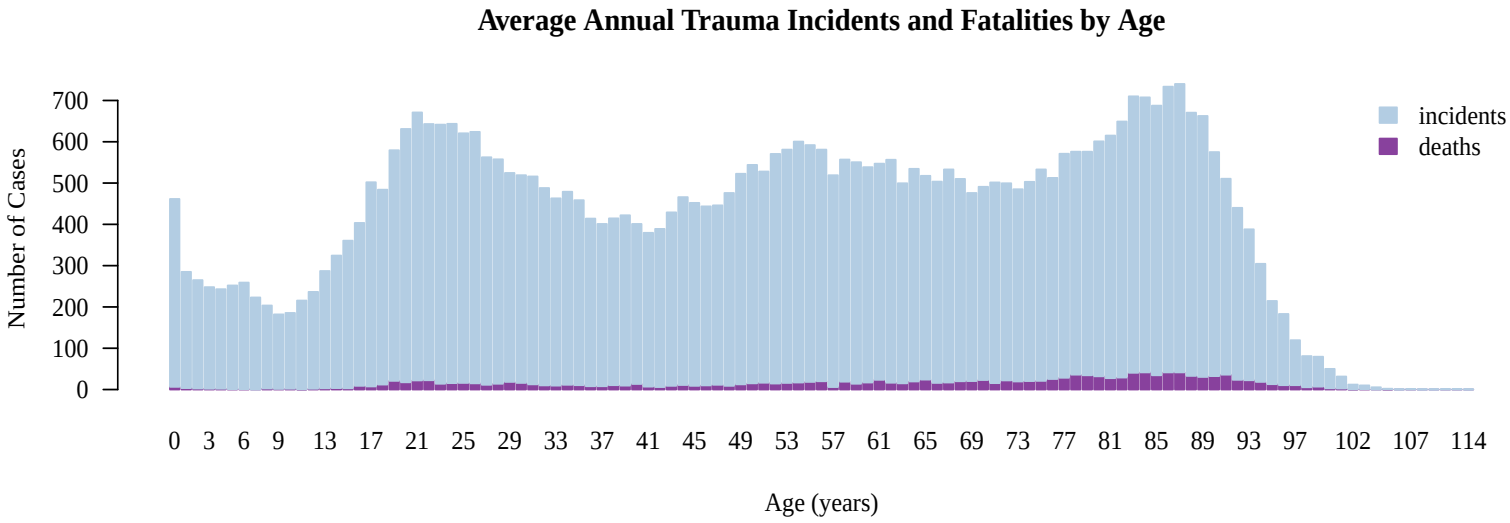

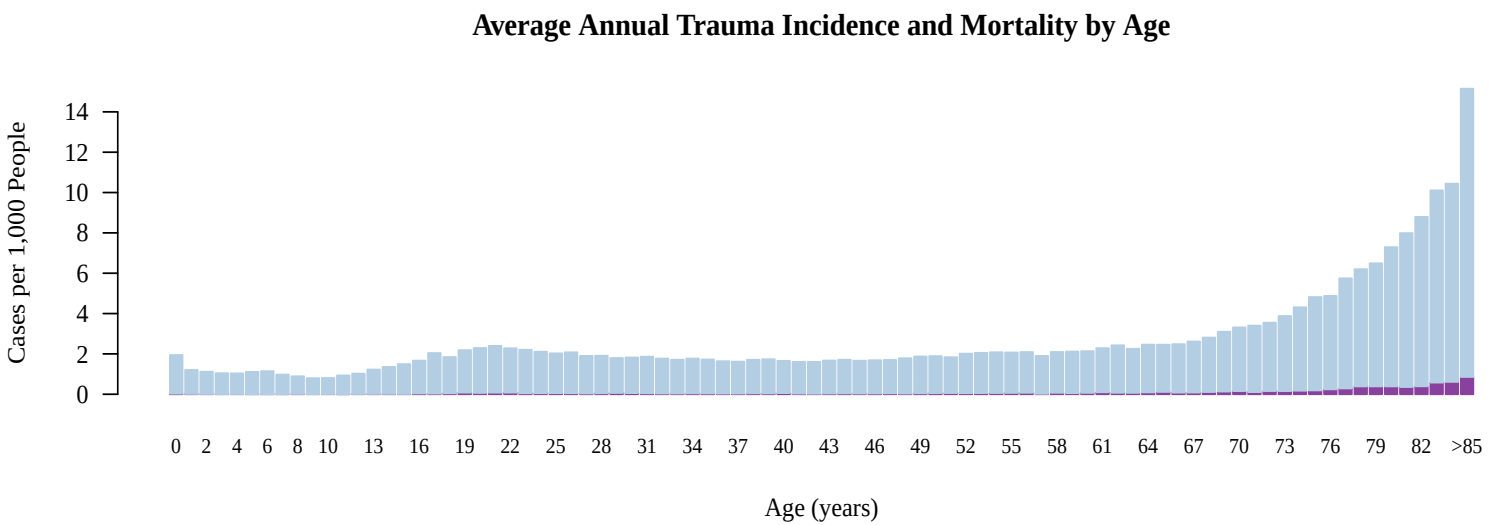

Figure 4

Trauma Incidents have three modes: at 20, 55, and 85 years of age. Population adjusted incidence shows population risk increase throught the teen years, peaking at 21 years of age with a rate of 2.4 per 10,000 people, declining to a local minimum at 41 years old with a rate of 1.6 incidents per 1,000 people, then increasing exponentially.

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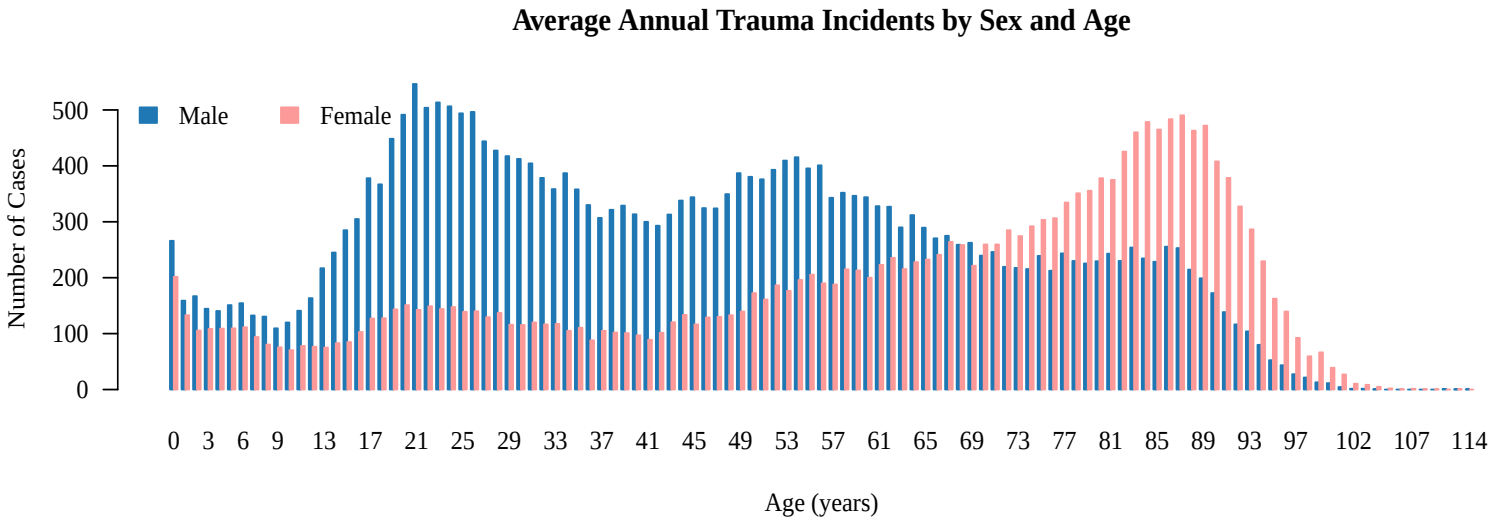

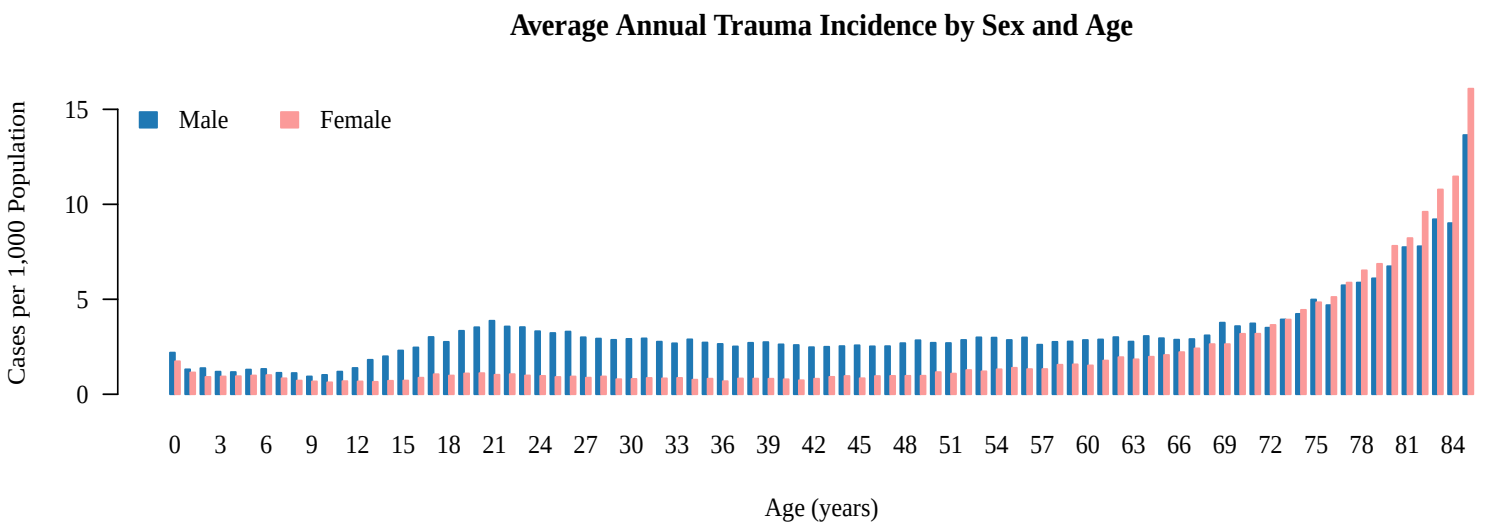

Figure 5

Trauma patients under 70 are largly male, older than 70 are largely female. Males have a significantly higher population incidence than women. However among the 70+ population, both sexes see equal population adjusted incidence.

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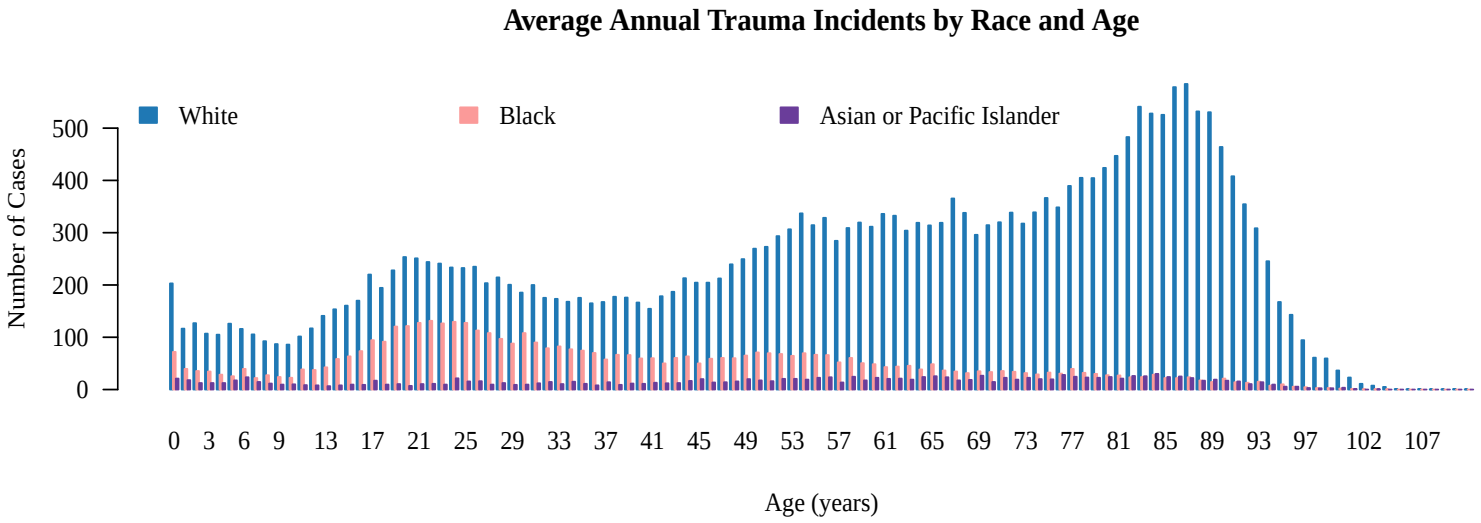

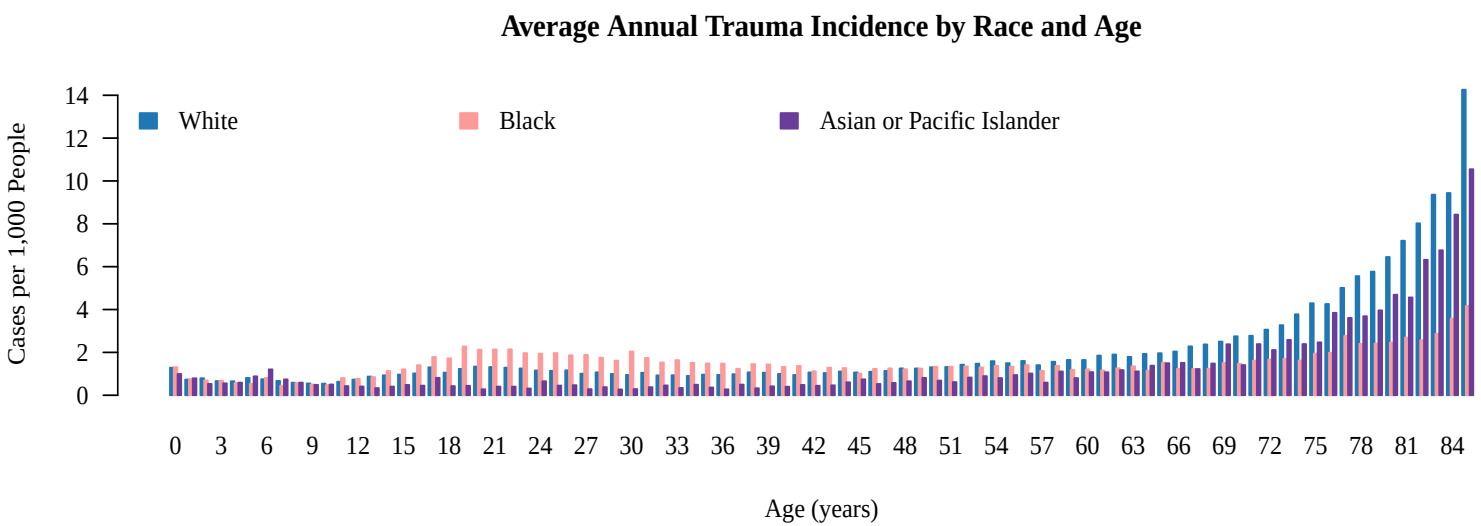

Figure 6

Black young adults see a much higher population incidence rate than white and Asian or Pacific islander young adults. American indian or Alaska native were not included due to small numbers.

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Case Fatality Rates by Age, Gender and Race

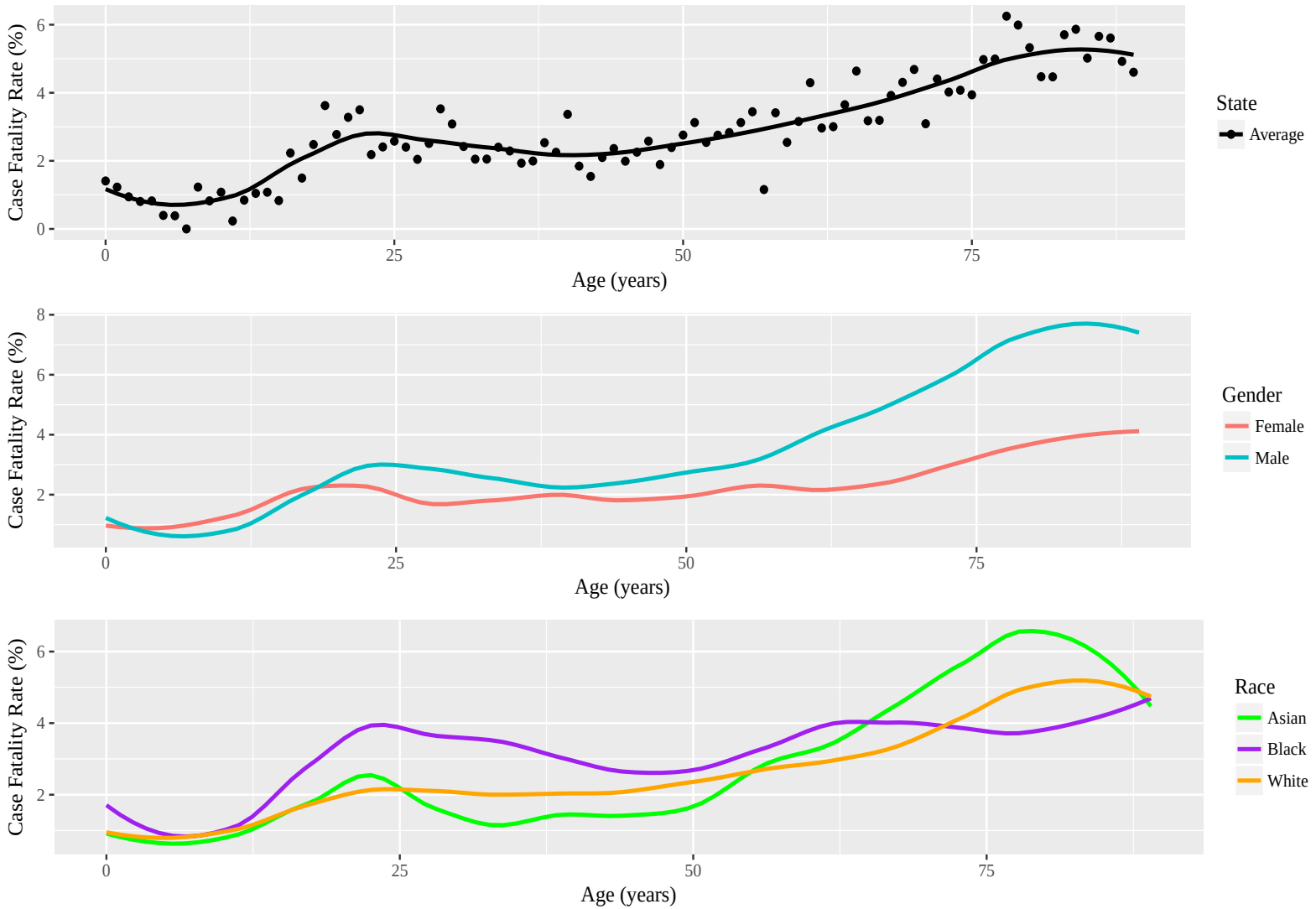

Figure 7

Case fatality rates increase with age. Males see increasingly higher fatality rates than women begining at 15 but becoming significant at 50. Young black people see significantly higher fatality rates than young white people.

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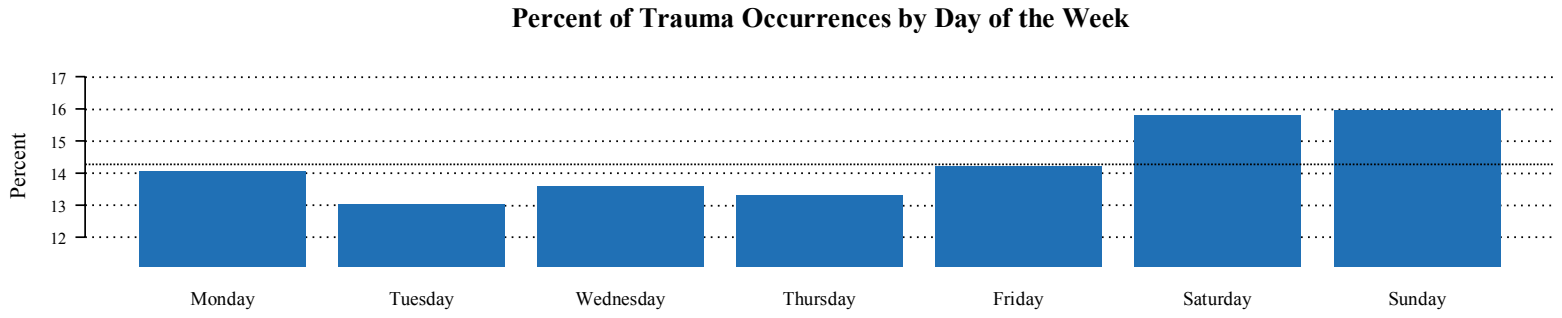
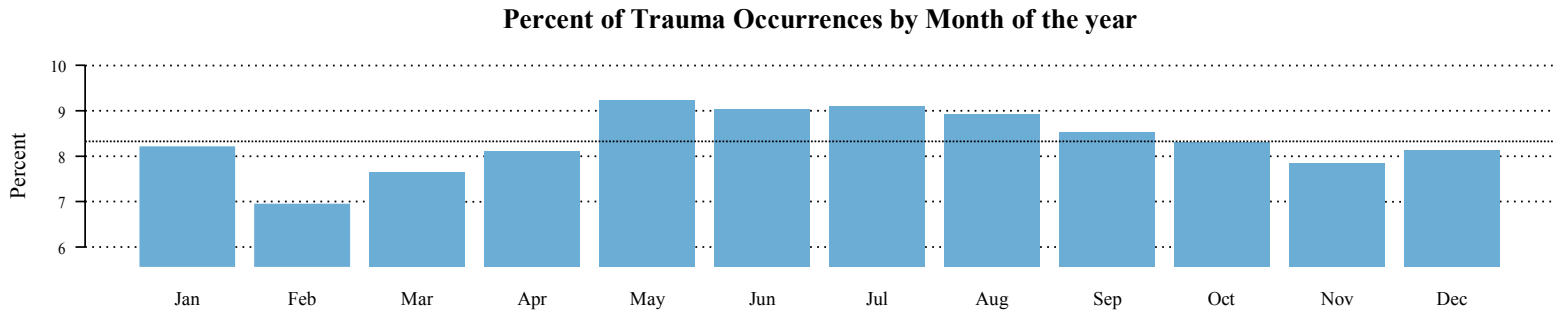
Trauma and Total New York State Deaths by Age Group

	Trauma Deaths		Statewide Deaths		Percent of Deaths	
	2014	2015	2014	2015	2014	2015
Age Groups						
<1	4	9	1,090	1,088	0.4	0.8
1-9	14	18	305	283	4.6	6.4
10-19	57	70	506	530	11.3	13.2
20-24	98	85	916	990	10.7	8.6
25-34	149	120	2,205	2,481	6.8	4.8
35-44	94	92	3,334	3,457	2.8	2.7
45-54	129	133	9,028	9,021	1.4	1.5
55-64	149	189	18,010	18,059	0.8	1.0
65-74	202	194	25,027	26,191	0.8	0.7
75-84	337	295	35,378	36,222	1.0	0.8
85+	354	382	53,234	56,105	0.7	0.7
Total						
Total	1,588	1,606	149,037	154,431	1.1	1.0

Table 5

Statewide deaths from NYS Vital Records - Health Data NY. Trauma, although only 1% of total deaths is a significantly higher percentage of total deaths for ages 1-34.





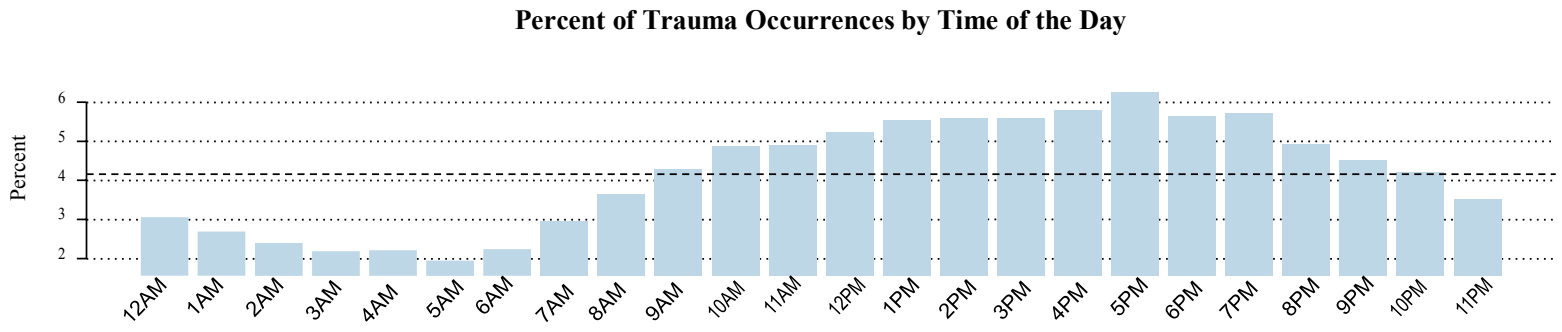


Figure 8

Dashed black lines represent an average trauma volume.
Trauma incidents surge on weekends and in the warmer months. Trauma incidents are more prevalent in usual daytime hours, peaking at 5PM.

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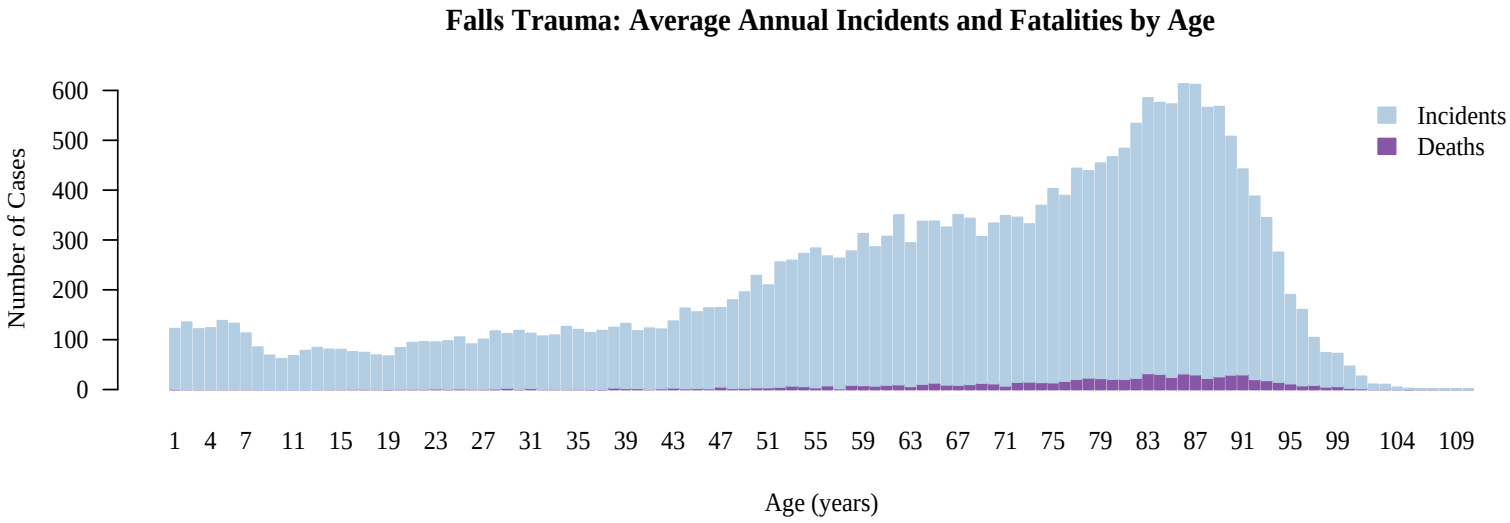
Injury Statistics

Average Annual Trauma Incidents by Category, Intention and Place

Region	Annual Incidents		Annual Deaths		Fatality rate
	N	pct	N	pct	pct
Intention					
Unintentional	39,239	80.7	1,248	78.1	3.18
Assault	5,194	10.7	169	10.6	3.25
Other	3,505	7.2	110	6.9	3.15
Self-Inflicted	522	1.1	55	3.4	10.55
Undetermined	151	0.3	14	0.9	9.60
Category					
Falls	24,234	49.9	806	50.4	3.32
Motor Vehicle Traffic	9,260	19.0	340	21.3	3.67
Other	3,895	8.0	147	9.2	3.77
Struck by/against	3,229	6.6	34	2.1	1.05
Cut/Pierce	2,241	4.6	40	2.5	1.78
Pedal cyclist, Non Traffic	719	1.5	7	0.4	0.97
Machinery	278	0.6	2	0.1	0.72
Natural, environmental	233	0.5	1	0.1	0.43
Fire, burn	232	0.5	8	0.5	3.44
Overexertion	174	0.4	0	0.0	0.29
Pedestrian, non traffic	162	0.3	8	0.5	4.95
Place					
Home	16,452	33.8	644	40.3	3.90
Street and highway	14,006	28.8	482	30.2	3.40
Other unspecified	7,781	16.0	226	14.1	2.90
Other specified	3,768	7.8	82	5.1	2.20
Recreation and sport	2,003	4.1	14	0.8	0.70
Public Building	1,937	4.0	42	2.7	2.20
Residential Institution	1,816	3.7	96	6.0	5.30
Industrial	716	1.5	8	0.5	1.10
Farm	118	0.2	4	0.3	3.40
Mine and quarry	14	0.0	0	0.0	3.40

Table 6

The large majority of trauma is unintentional. Falls are the most common category of trauma injuries. Most trauma occurs either at home or on the streets. Self-Inflicted trauma has the highest case fatality rates.



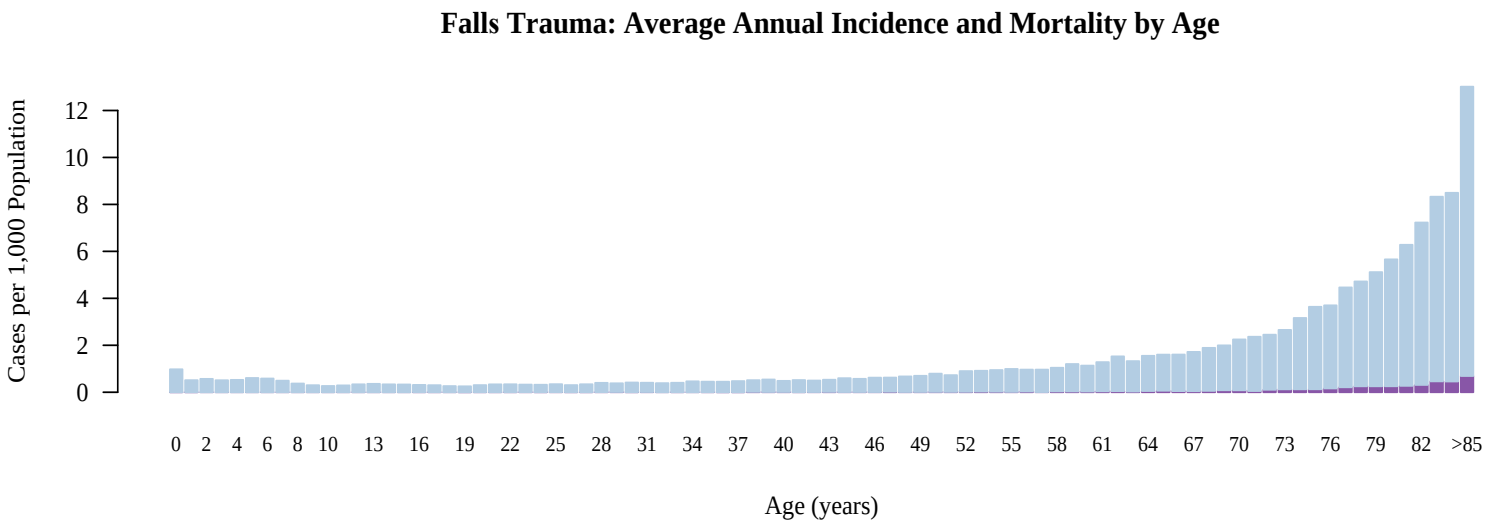
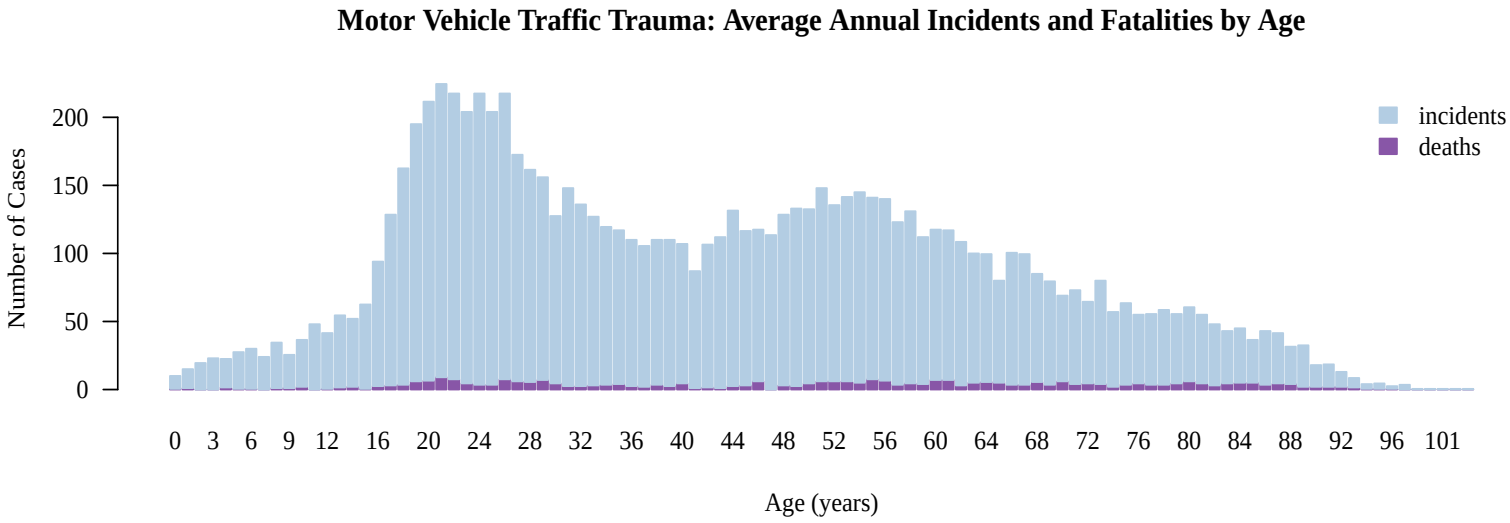


Figure 9

Falls, although common in the young, are most common with elderly. Deaths from falls are much more common among elderly patients. Falls incidence increases rapidly with patient age, although falls incidence rates are slightly elevated in the 10 and under age cohort.

NEW YORK STATE OF OPPORTUNITY. Department of Health



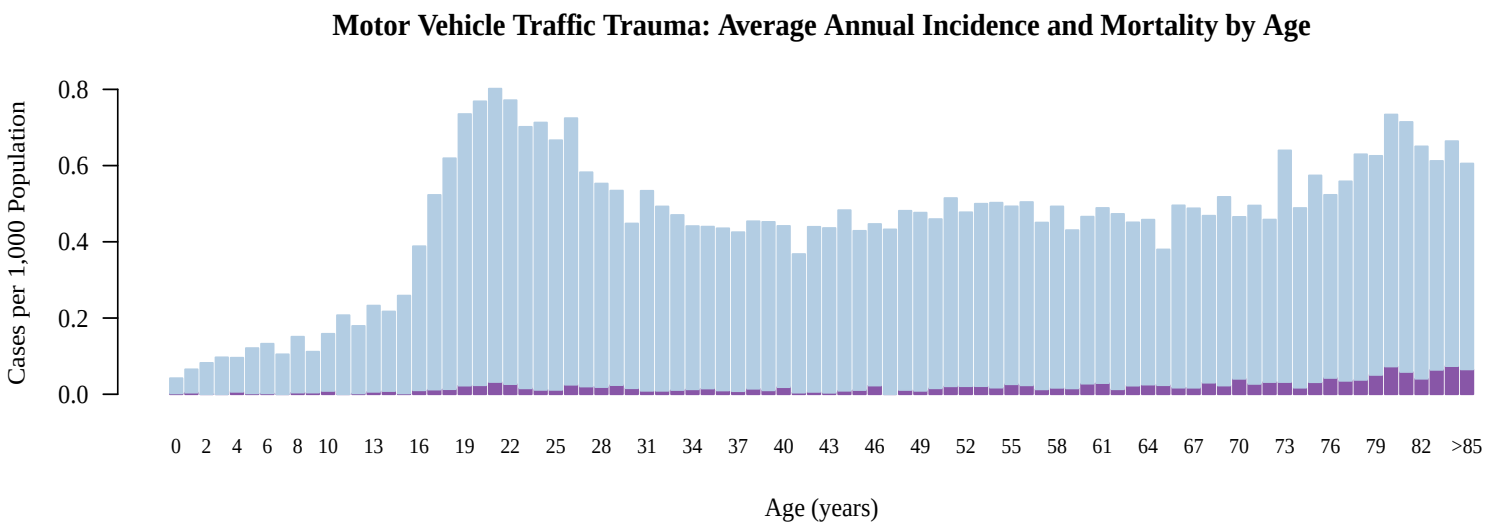
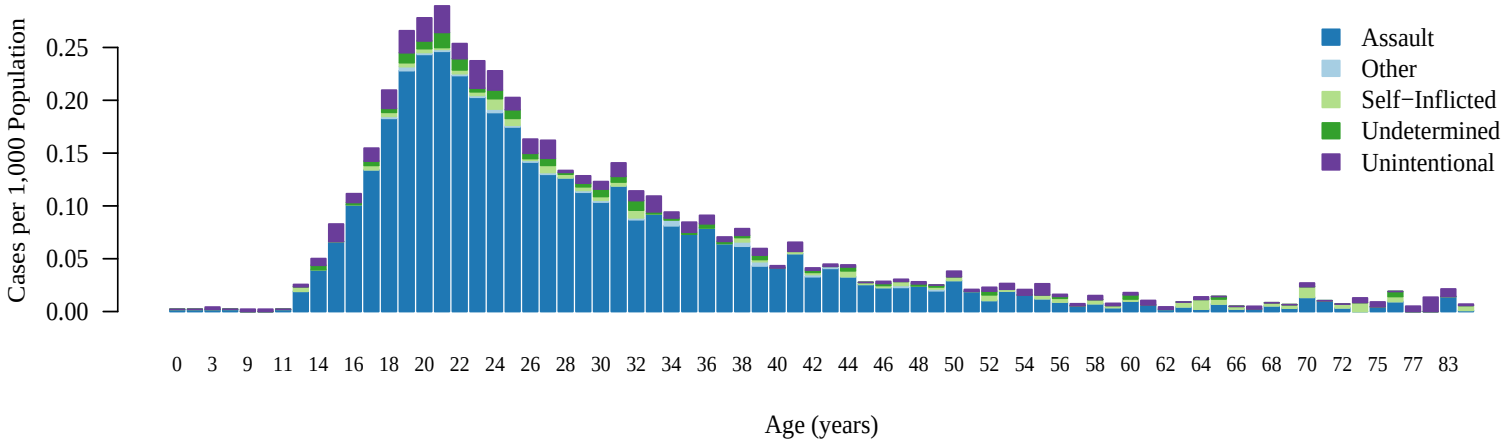


Figure 10

Motor vehicle trauma incidents see sharp peak in the early 20s and steady decline thereafter. Motor vehicle trauma incidence rates see a drop after the 20s and a slight increase in the 70+ age cohort.

NEW YORK STATE OF OPPORTUNITY. Department of Health

Firearm Trauma: Average Annual Incidence by Age and Intention



Firearm Trauma: Average Annual Incidence by Region and Intention

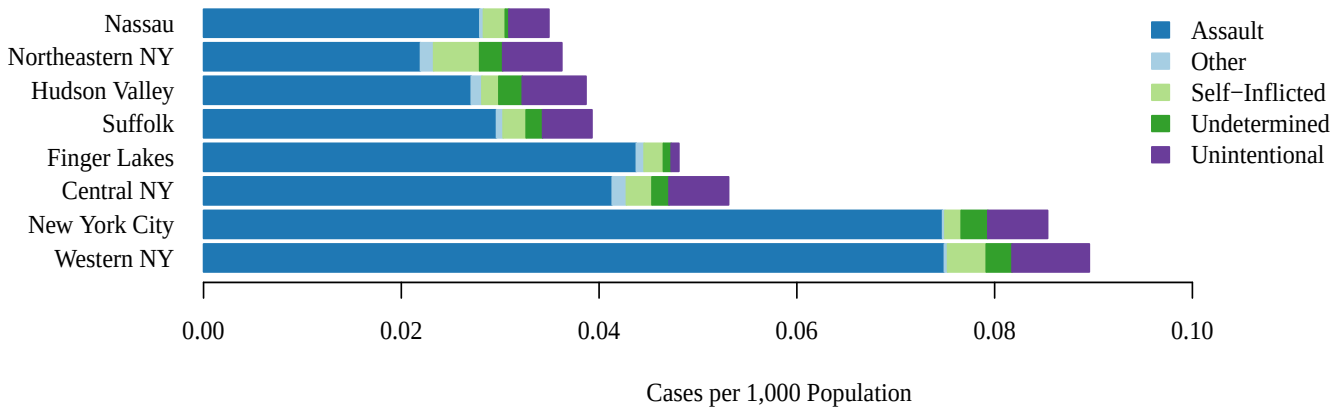


Figure 11

Firearm trauma incidence sees a sharp peak in the early 20s and steady decline thereafter.

NEW YORK STATE OF OPPORTUNITY. Department of Health

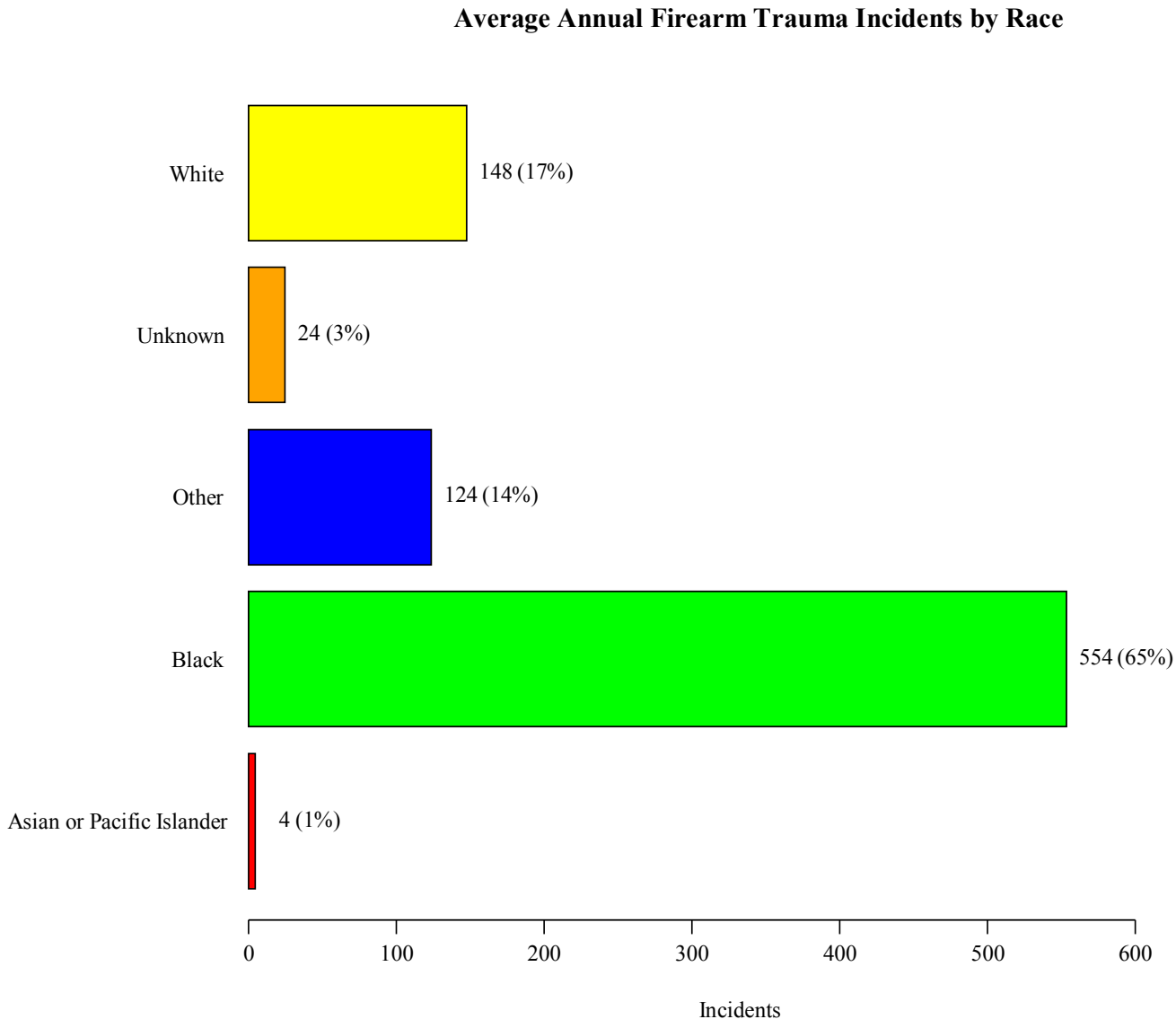


Figure 12

Black people are the most common victims of firearm trauma. This accounts for 65% of total firearm trauma cases.

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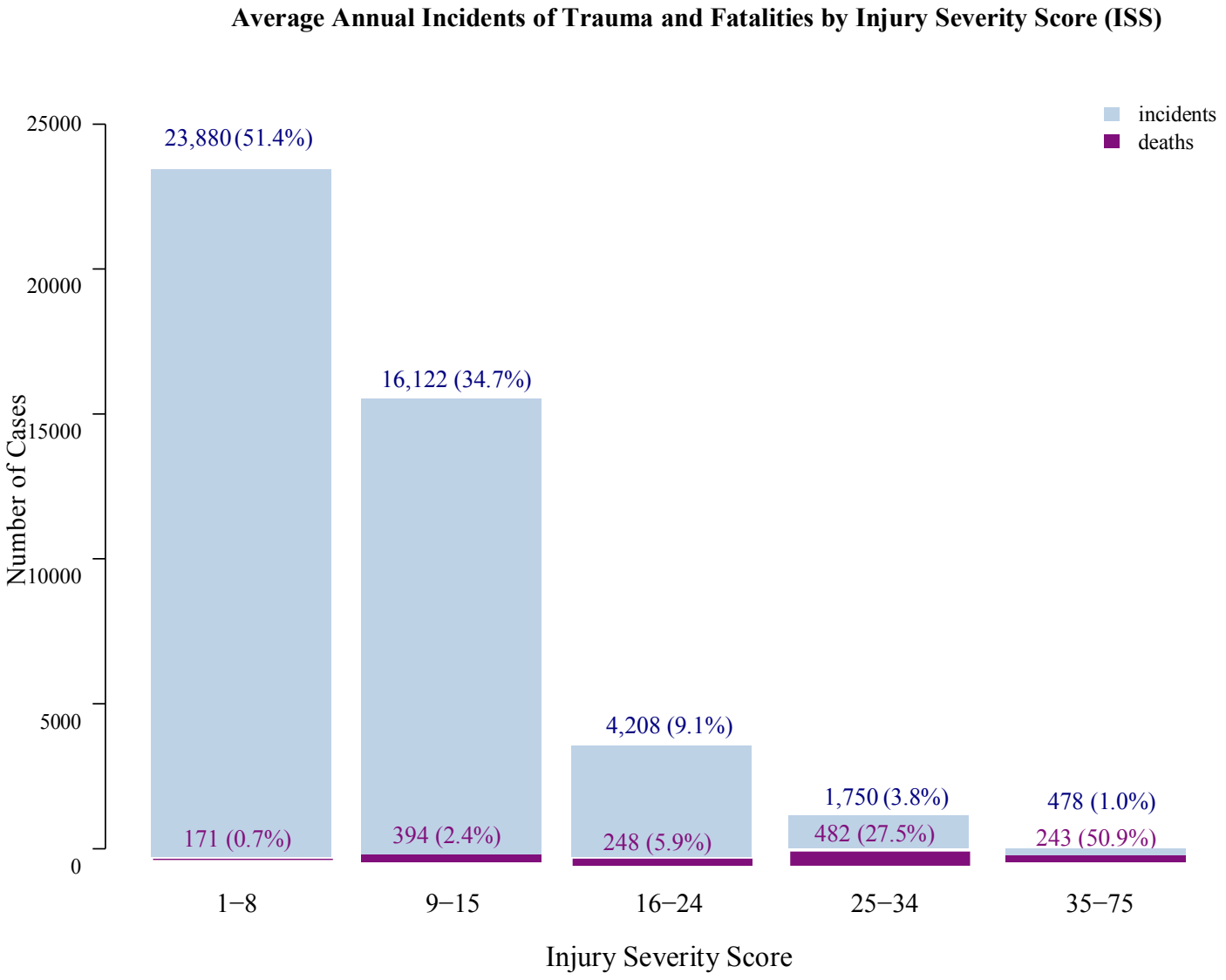

Figure 13

51.4% of trauma incidents had an ISS in the range 1-8. Incidents with an injury severity score of 35-75 had a case fatality rate of 50.9%.

NEW YORK STATE OF OPPORTUNITY. Department of Health

Average Annual Trauma Case Fatality Rate by Age and Injury Severity Score (ISS)

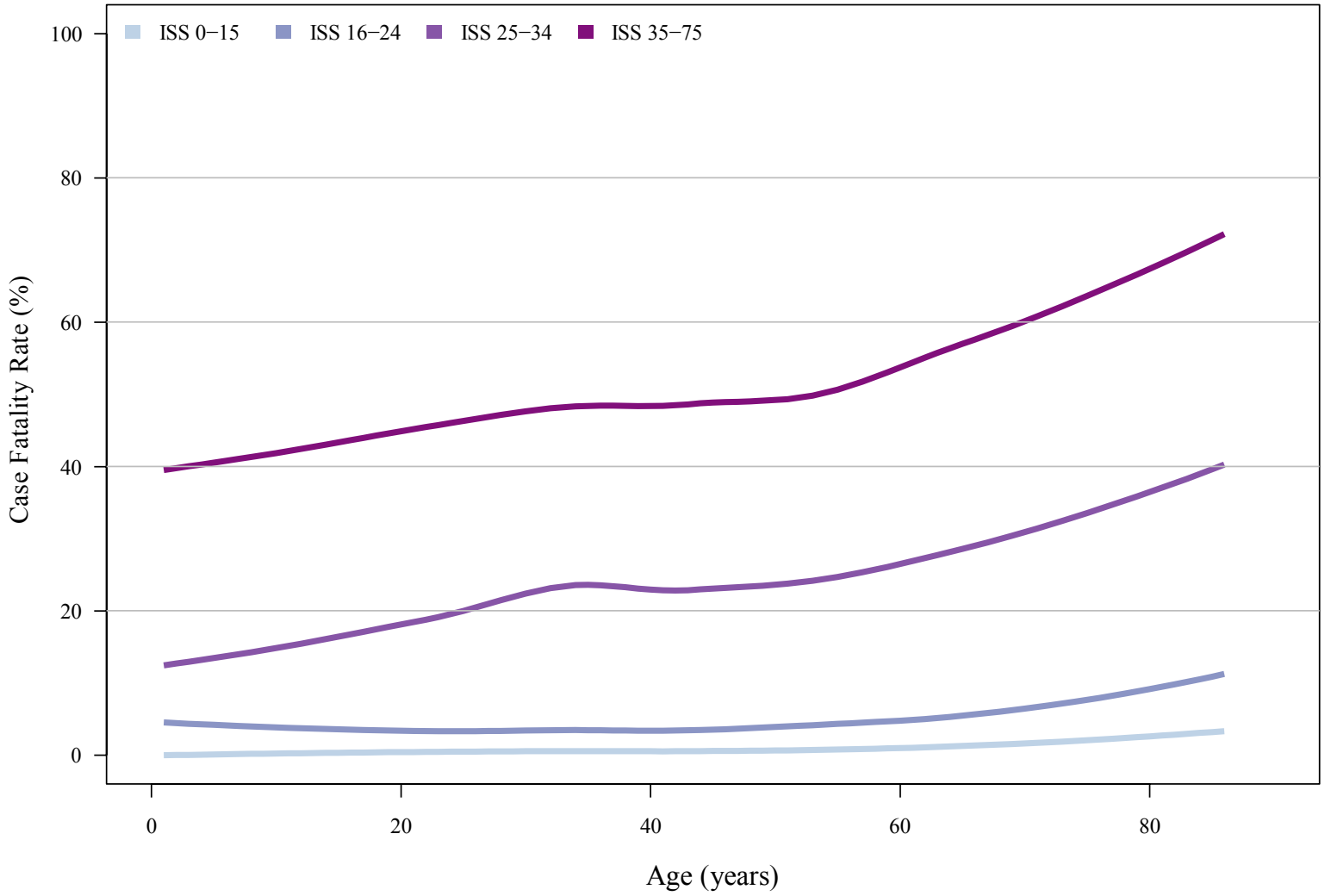

Figure 14

For ISS 0-15 case fatality rates range from 0% at age 0 to 3% for patients 85+ years.
For ISS 16-24 case fatality rates range from 5% at age 0 to 11% for patients 85+.
For ISS 25-34 case fatality rates range from 12% at age 0 to 40% for patients 85+.
For ISS 35-75 case fatality rates range from 40% at age 0 to 72% for patients 85+.

NEW YORK STATE OF OPPORTUNITY. Department of Health

Incidence By Trauma Mechanism and County

Falls Trauma: Average Annual Incidence by County of Residence

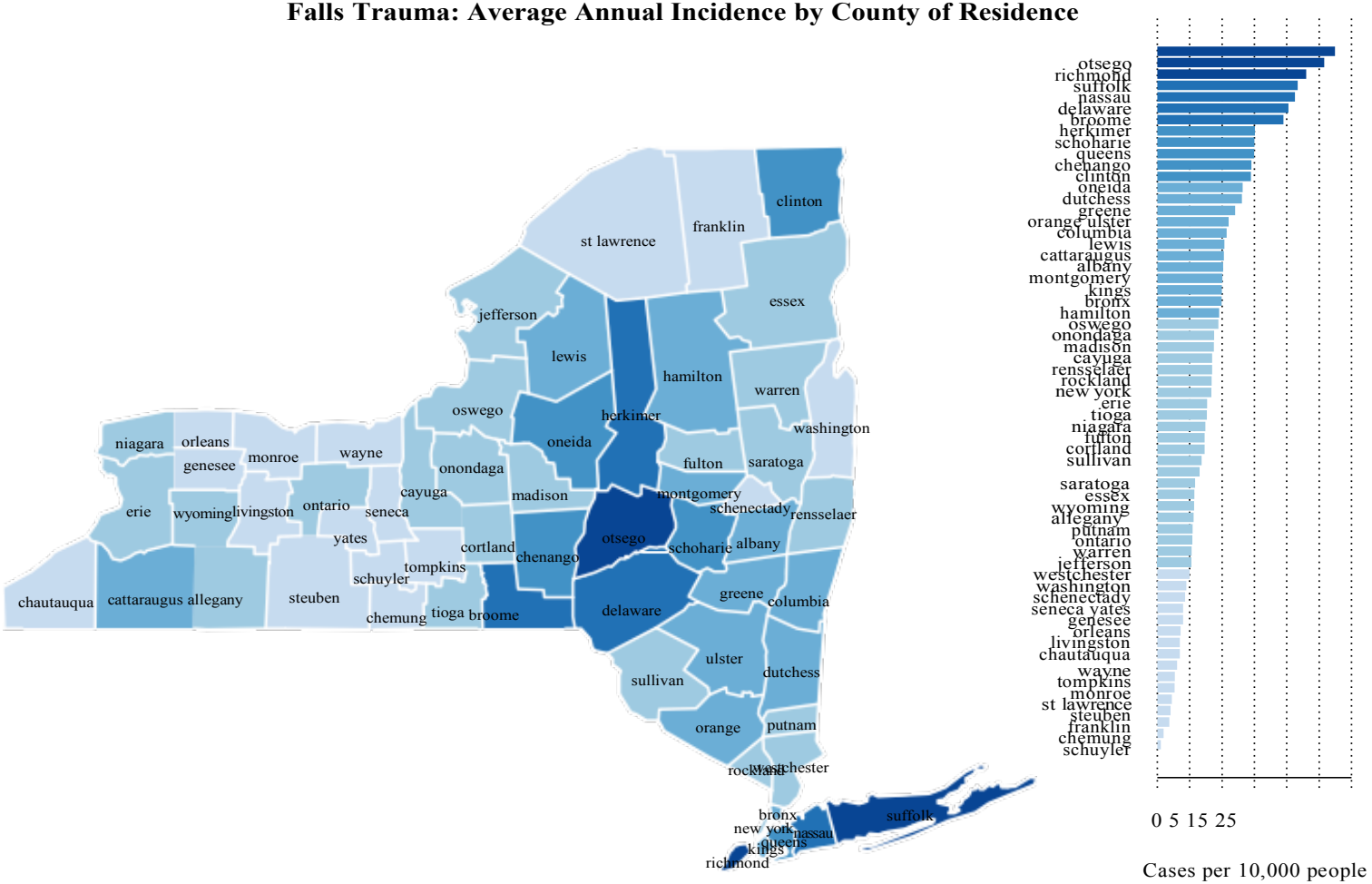

Figure 15

Falls trauma Incidence is most prevalent in Otsego, Richmond, and Suffolk counties.

NEW YORK STATE OF OPPORTUNITY. Department of Health

Motor Vehicle Traffic Trauma: Average Annual Incidence by County of Residence

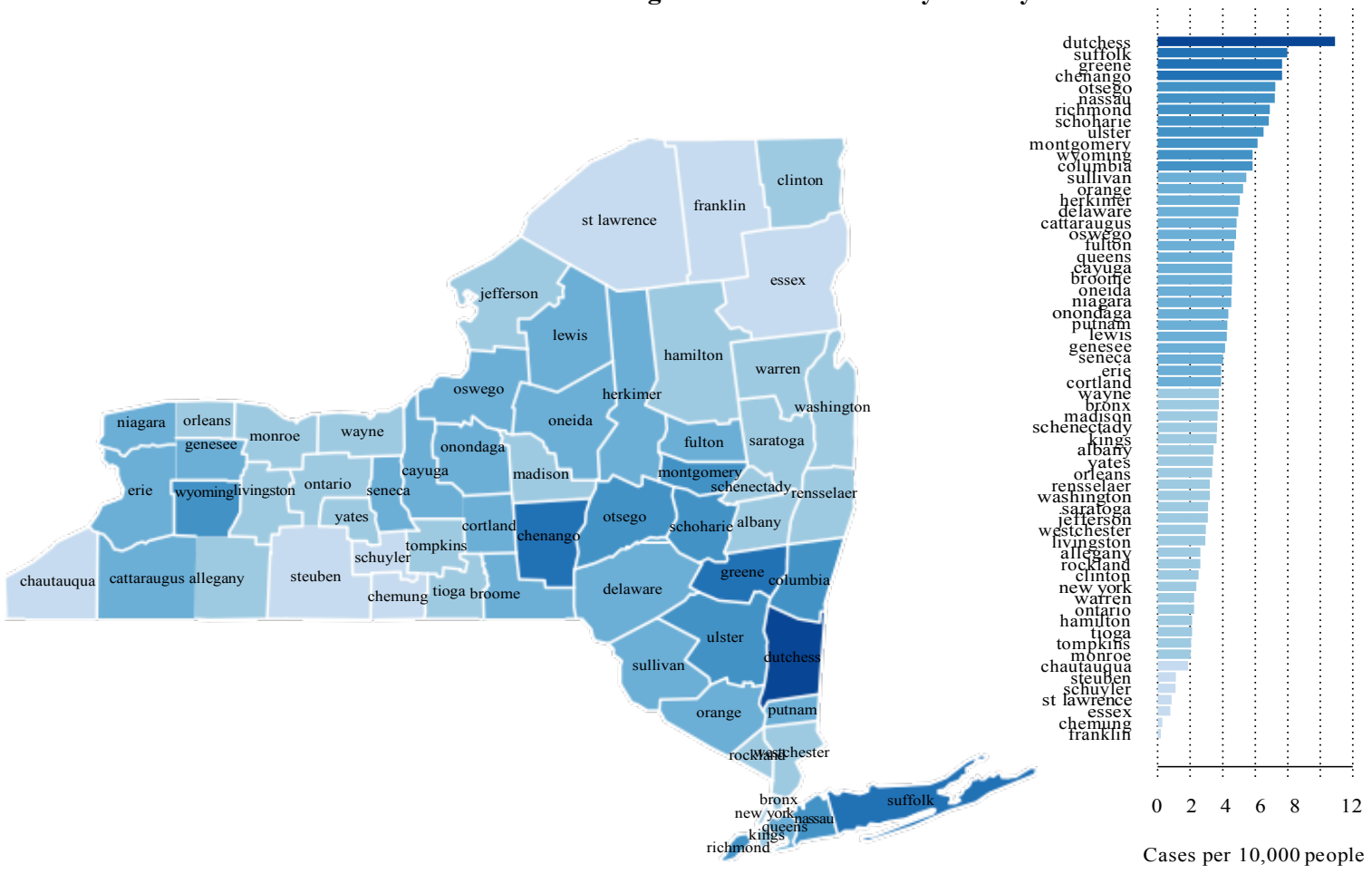

Figure 16

Motor Vehicle Traffic trauma Incidence is most prevalent in Dutchess, Suffolk, and Greene counties.

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Firearm Trauma: Average Annual Incidence by County of Residence

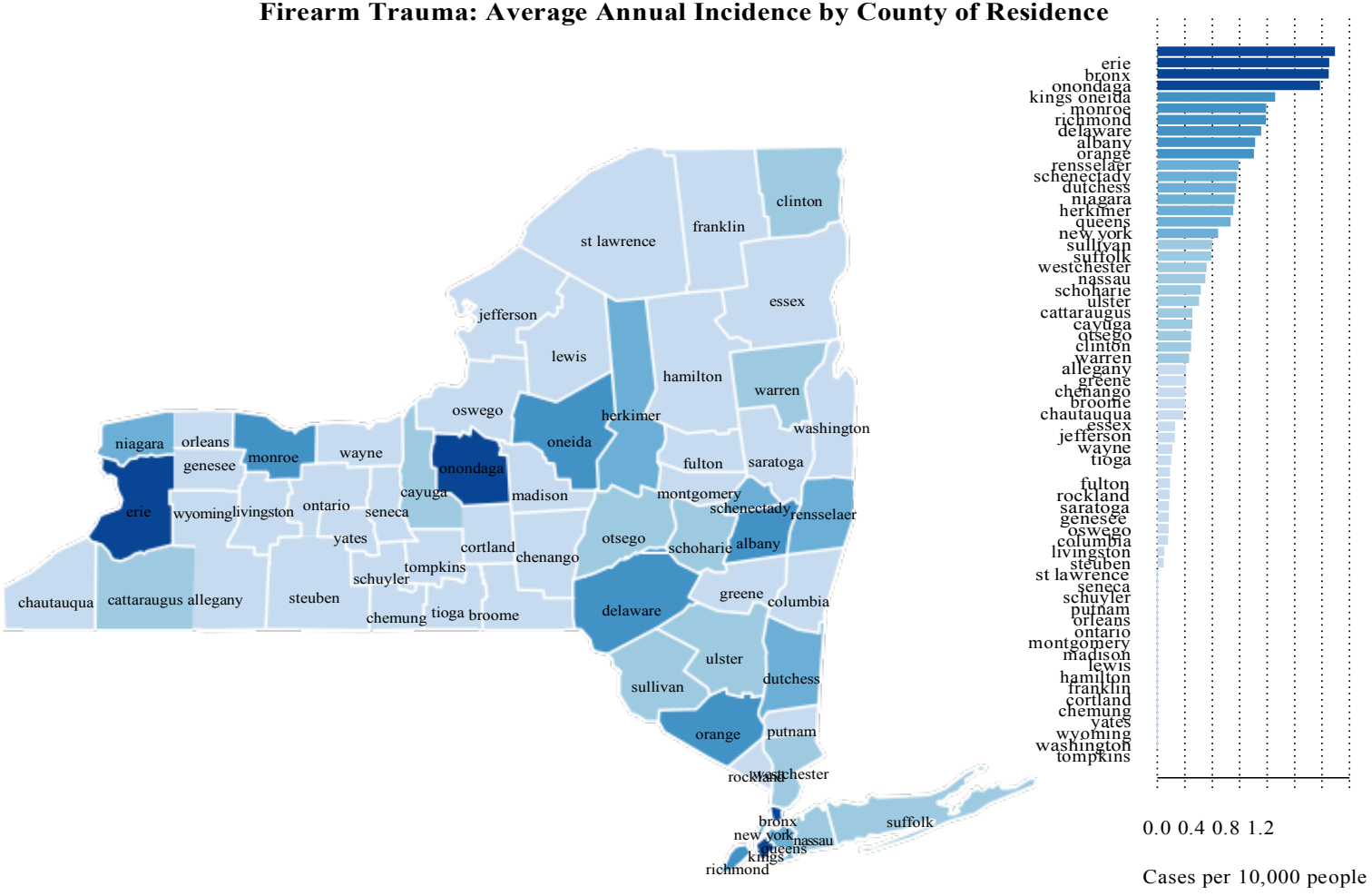

Figure 17

Firearm trauma Incidence is most prevalent in Erie, Bronx, and Onondaga counties.

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Cut/Pierce Trauma: Average Annual Incidence by County of Residence

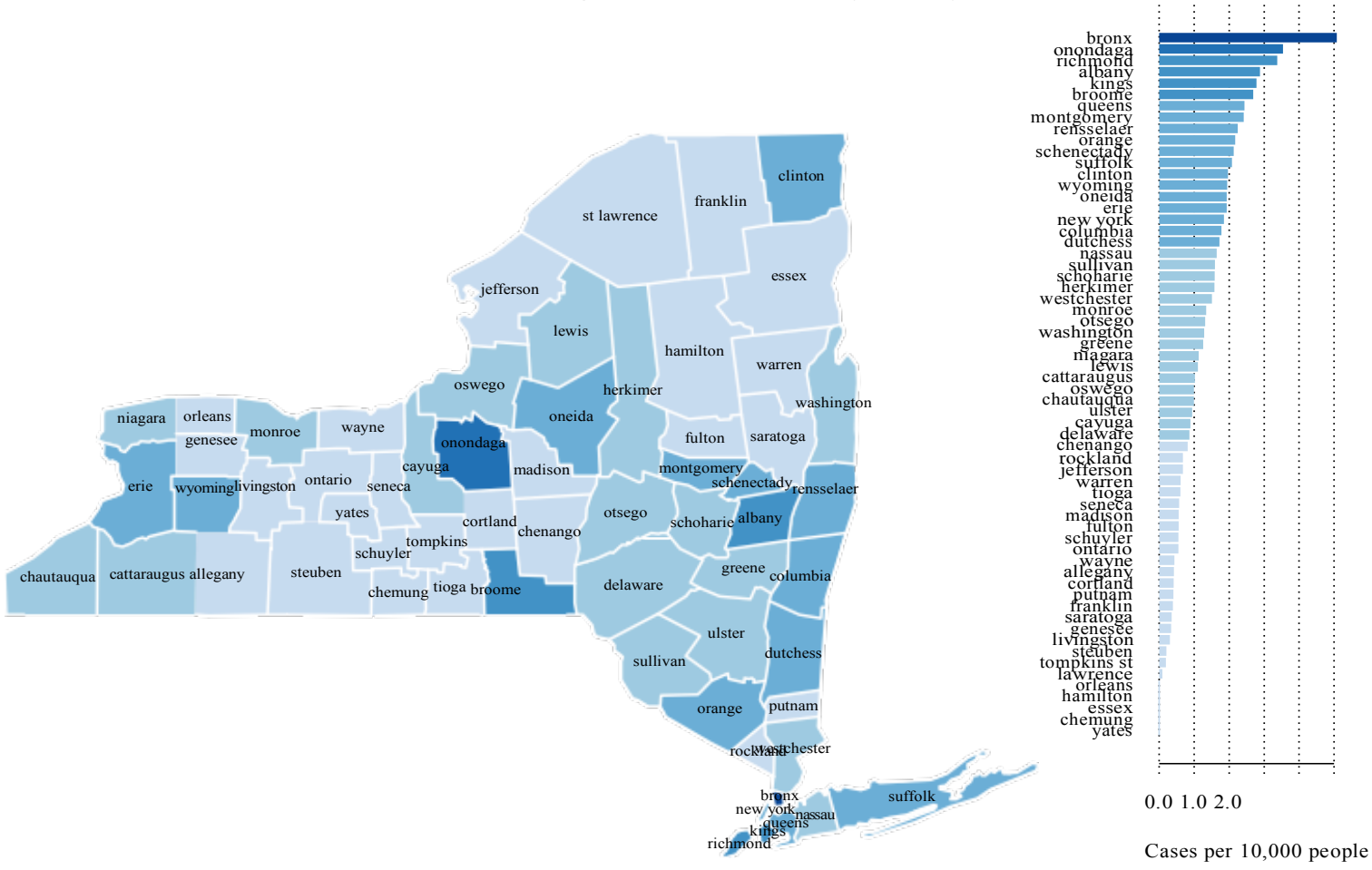

Figure 18

Cut/Pierce trauma Incidence is most prevalent in Bronx, Onondaga, and Richmond counties.

NEW YORK STATE OF OPPORTUNITY. Department of Health

Machinery Trauma: Average Annual Incidence by County of Residence

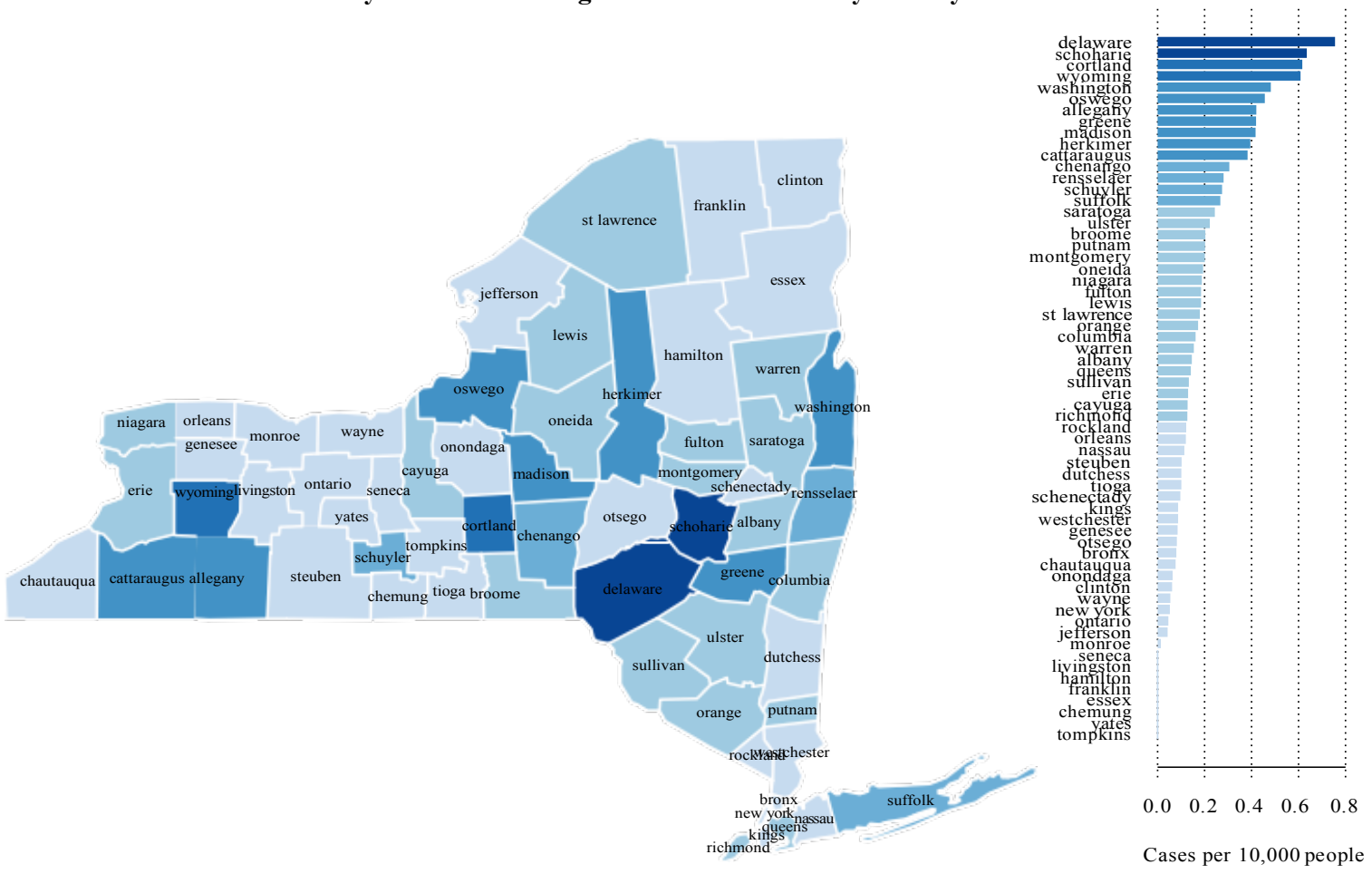

Figure 19

Machinery trauma Incidence is most prevalent in Delaware, Schoharie, and Cortland counties.

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Emergency Medical Services

NEW YORK STATE OF OPPORTUNITY. Department of Health

Summary of EMS Statistics

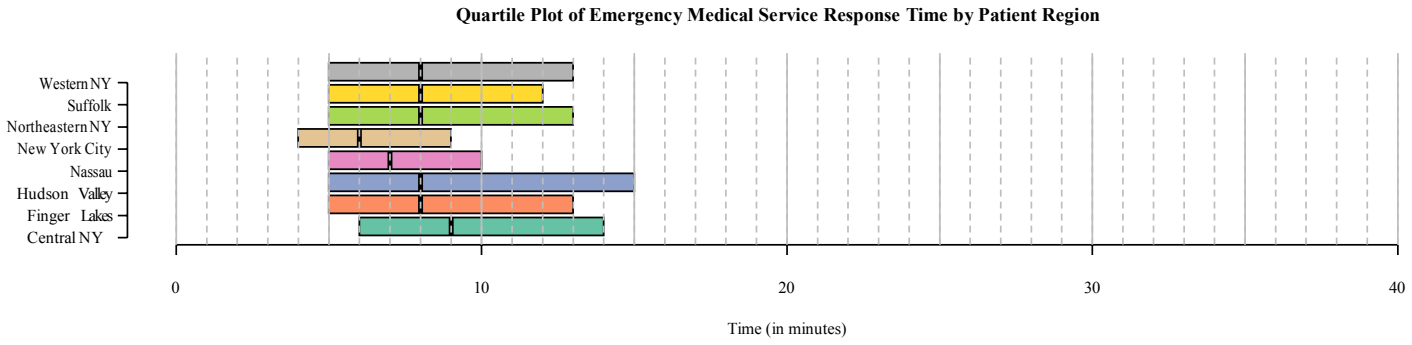
	Incidents handled by EMS			Median Time (in minutes)		
	Total Incidents	EMS Responses	Percent of Total	Response	At Scene	Transport
ISS						
[0,9)	49,643	36,948	74.4%	7	17	16
[9,16)	32,676	27,580	84.4%	8	18	17
[16,25)	8,570	7,594	88.6%	7	17	16
[25,35)	3,605	3,253	90.2%	7	16	14
[35,75]	993	958	96.5%	6	13	12
Region						
Central NY	7,127	5,766	80.9%	9	17	19
Finger Lakes	1,948	1,668	85.6%	9	18	19
Hudson Valley	8,222	6,527	79.4%	9	16	22
Nassau	9,895	8,080	81.7%	7	15	15
New York City	41,467	32,991	79.6%	7	19	15
Northeastern NY	6,236	4,922	78.9%	8	17	28
Suffolk	11,767	9,316	79.2%	8	15	15
Western NY	5,123	4,557	89.0%	8	16	17
Total						
	97,221	77,754	80.0%	7	17	16

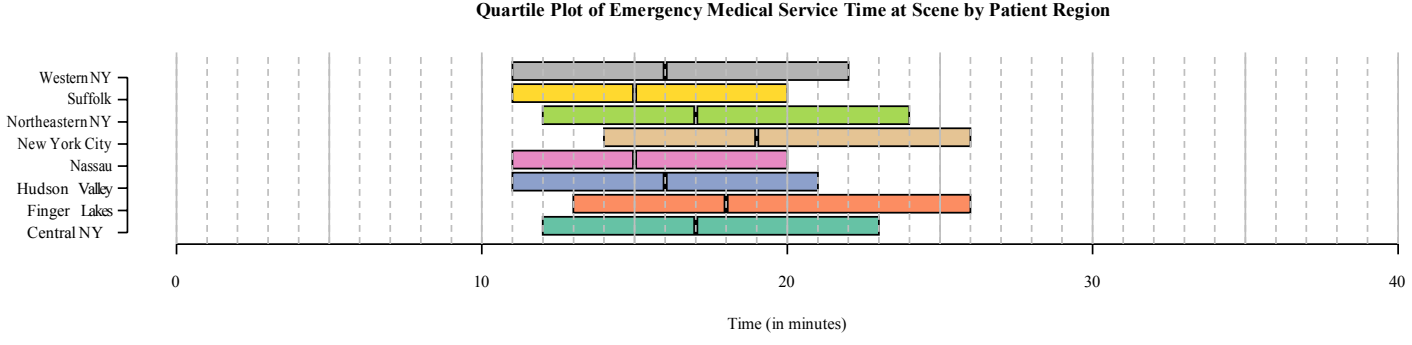
Table 7

The statewide median response time is 7 minutes. By region, it ranges from 7 minutes in Nassau and New York City to 9 minutes in Central NY, Finger Lakes and Hudson Valley regions.

The statewide median time at scene is 17 minutes. By region, it ranges from 15 minutes in Nassau and Suffolk to 19 minutes in New York City region.

The statewide median transport time is 16 minutes. By region, it ranges from 15 minutes in Nassau, New York City and Suffolk regions to 28 minutes in Northeastern NY region.





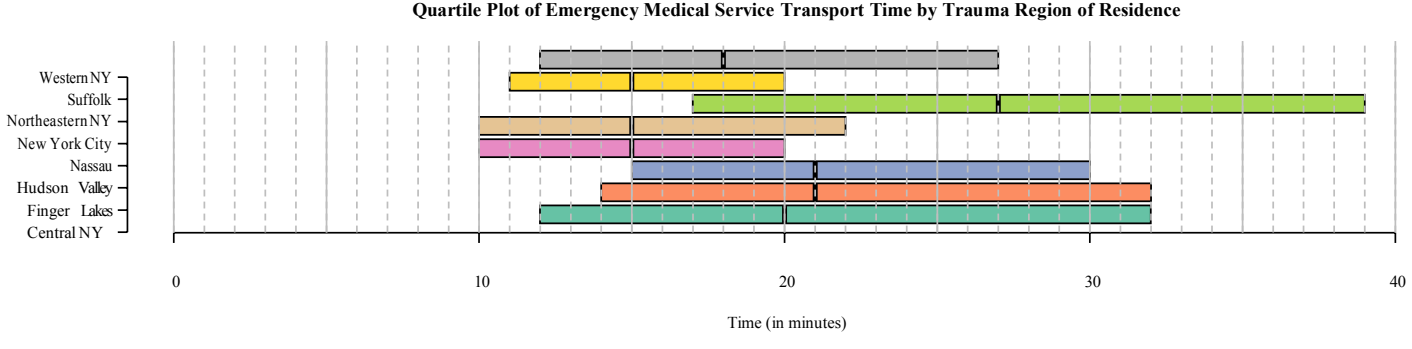


Figure 20

New York City has the shortest EMS response times at 6 minutes, Central New York has the highest.
New York City see the longest times at scene and Long Island sees the shortest.
Downstate (NYC and LI) has the shortest EMS transport times (15 minutes), Northeastern New York has the longest transport times (28 minutes).

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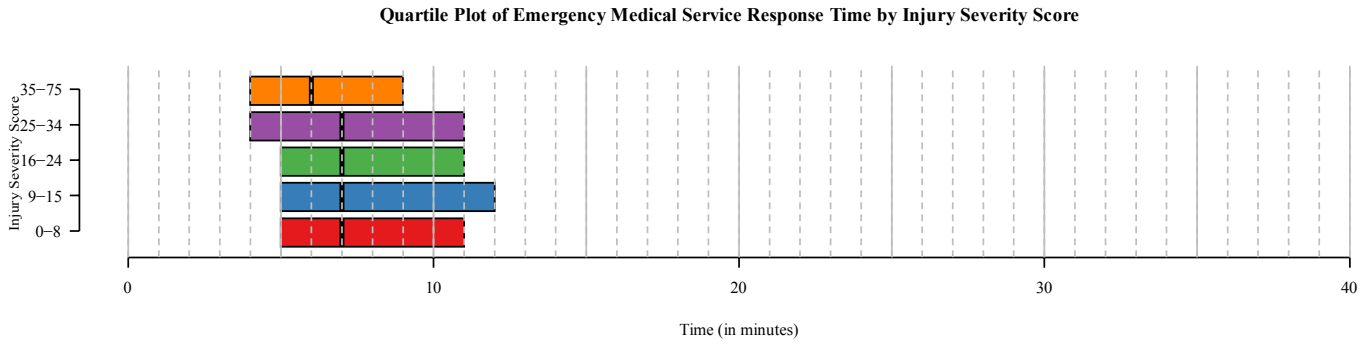
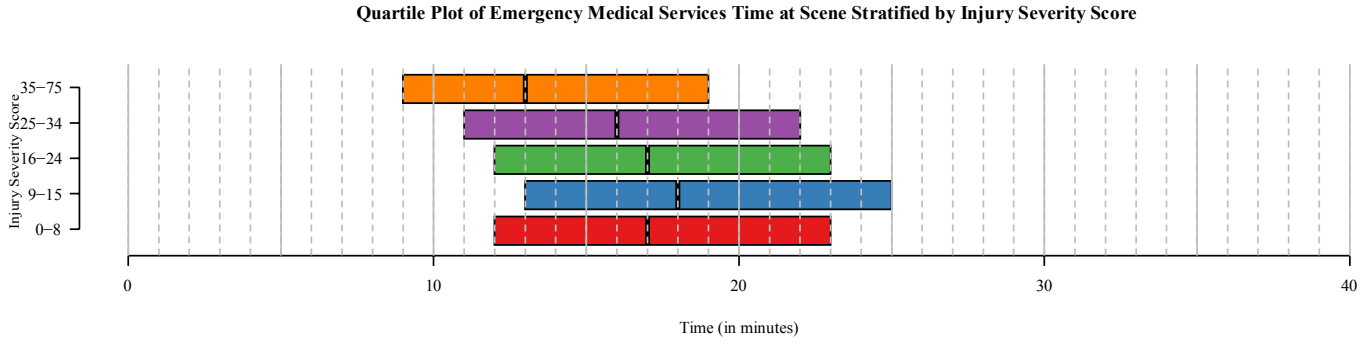




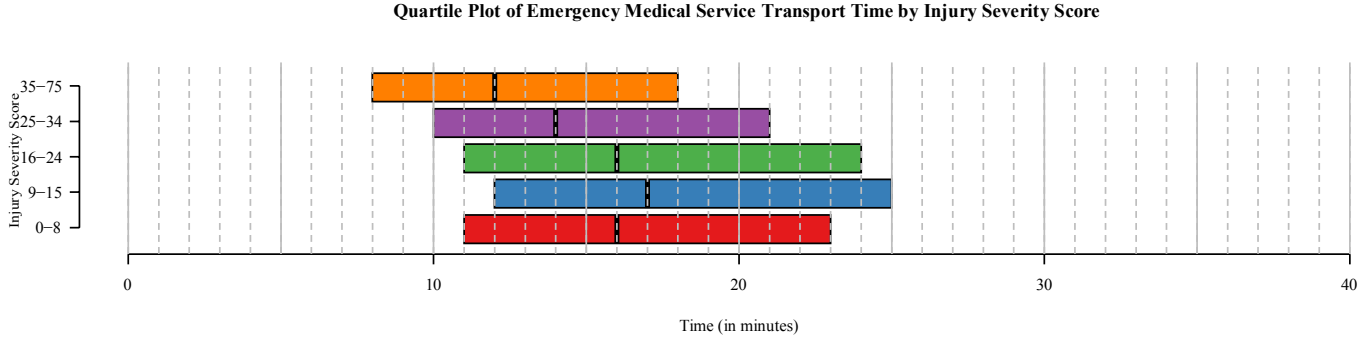


Figure 21

EMS response, at scene, and transport times all decrease as injury severity increases.

NEW YORK STATE OF OPPORTUNITY. Department of Health

Referring Hospitals

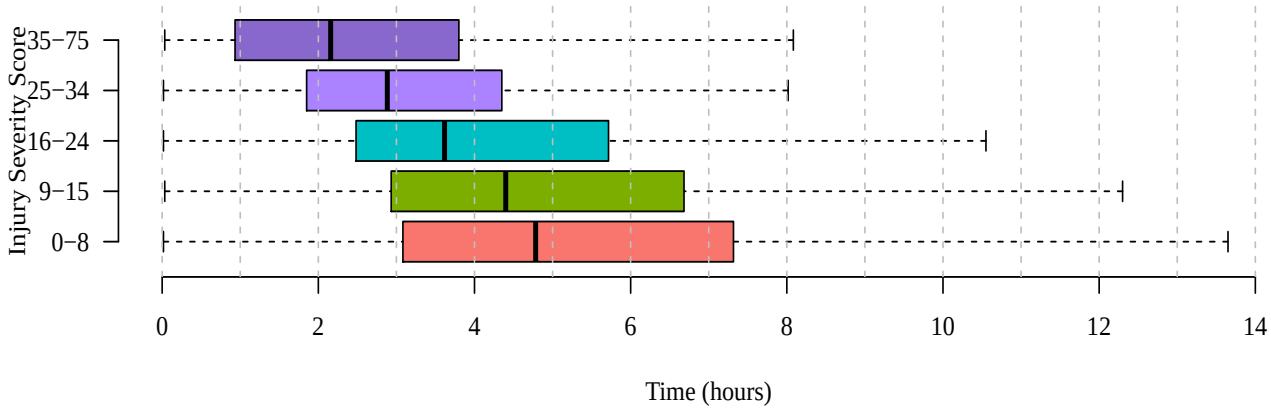
Summary of Referring Hospital Statistics

	Total Incidents	Patient Referred from initial destination	Percent of patients referred	Median Time at Referring Hospital (hours)
ISS				
[0,9)	49,643	8,876	18%	5
[9,16)	32,676	6,835	21%	4
[16,25)	8,570	2,072	24%	4
[25,35)	3,605	793	22%	3
[35,75]	993	150	15%	2
Region				
Central NY	7,127	2,916	41%	4
Finger Lakes	1,948	272	14%	3
Hudson Valley	8,222	2,706	33%	4
Nassau	9,895	868	9%	4
New York City	41,467	6,929	17%	6
Northeastern NY	6,236	1,742	28%	3
Suffolk	11,767	1,009	9%	4
Western NY	5,123	1,454	28%	3
Total				
	97,221	18,960	20%	4

Table 8

Time at a referring hospital correlates to injury severity. Lowest severity injuries spent 5 hours at the referring hospital, highest severity injuries only spent 2 hours at a referring hospital. New York City patients spent the longest time.

Time at Referring Hospital by Injury Severity Score
(for patients who where referred to a trauma center)



Time at Referring Hospital by Referring Hospital Trauma Region
(for patients who where referred to a trauma center)

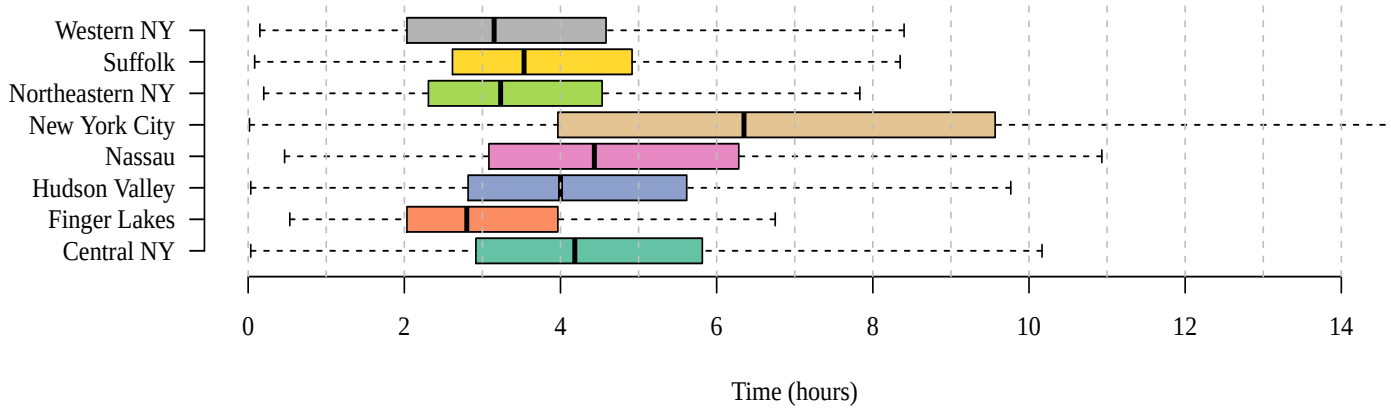


Figure 17

Median time at referring hospitals is 4:47 for lowest severity injuries and 2:09 for highest severity injuries.
Finger Lakes trauma patients see the shortest times spent at a referring hospital (2:48). New York City trauma patients see the longest times spent at a referring hospital (6:21).
Time data was filtered to be within 0-24 hours.

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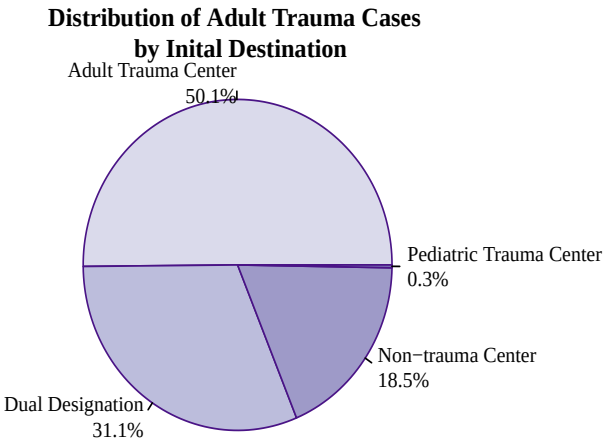
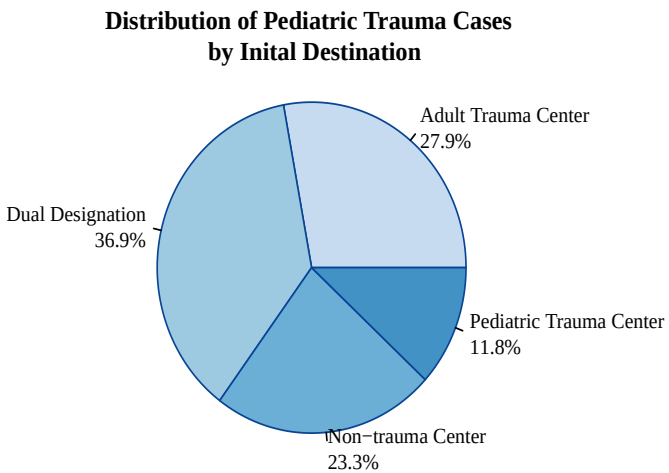




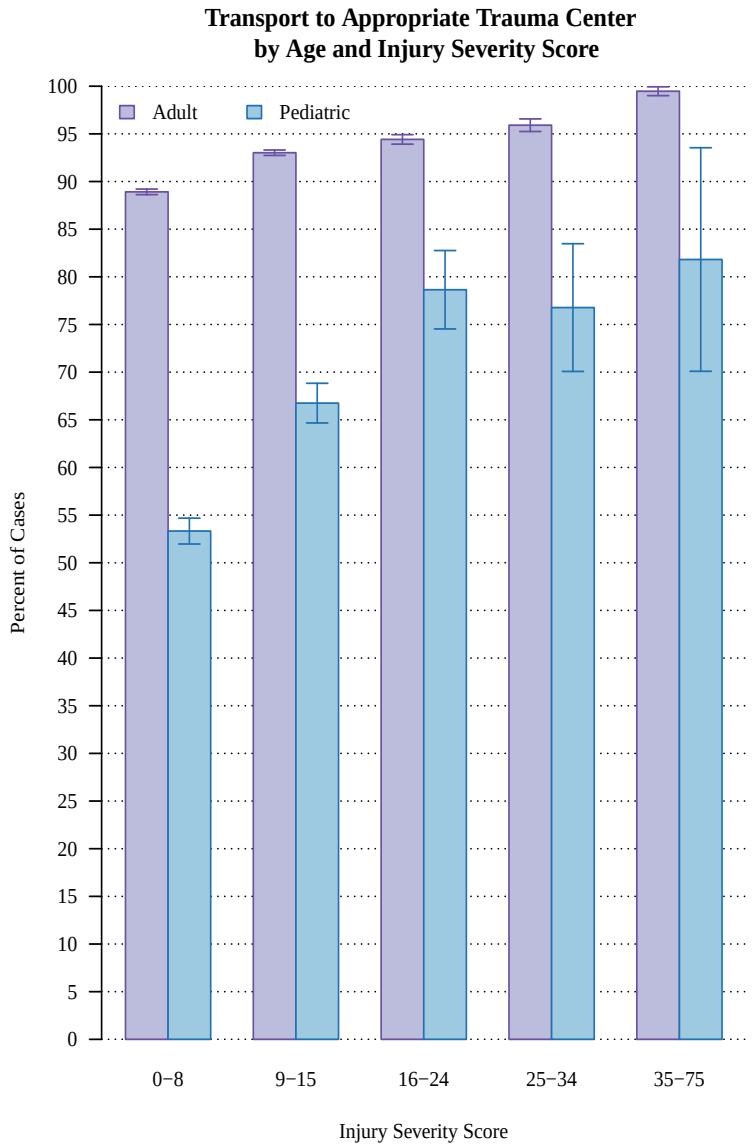


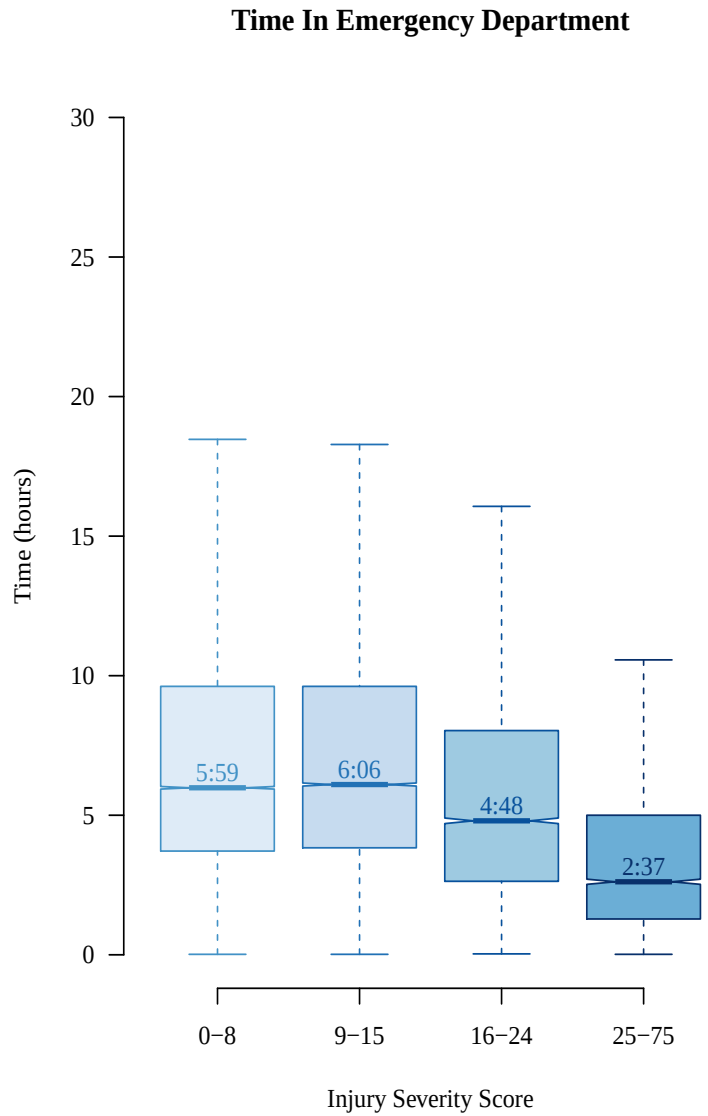
Figure 23

Both adult and pediatric patients are transported to an appropriate trauma center more regularly as injury severity increases. Pediatric trauma patients are much more likely to need transfer than adult patients.

NEW YORK STATE OF OPPORTUNITY. Department of Health

Final Hospital Statistics

NEW YORK STATE OF OPPORTUNITY. Department of Health



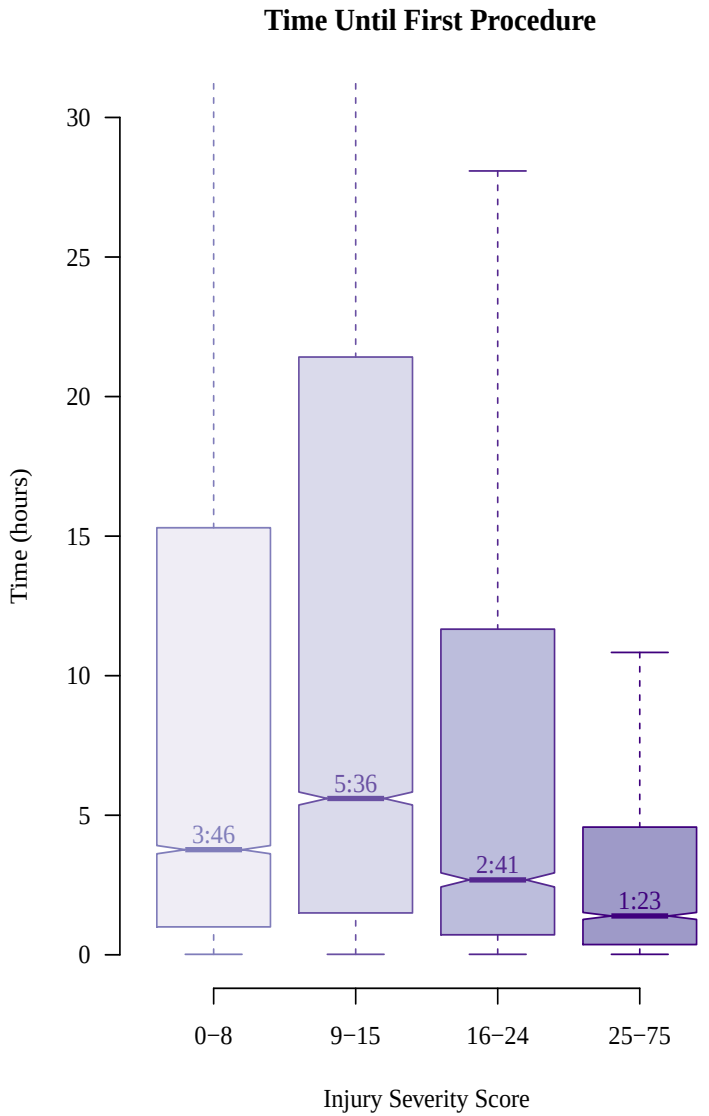
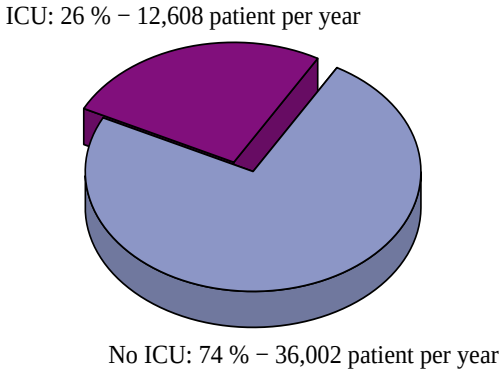


Figure 24

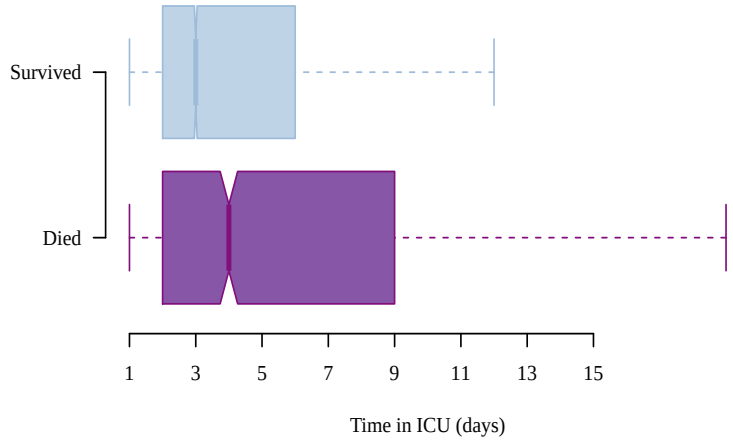
Median time in ED for lowest severity injuries is 5 hours and 59 minutes and 2 hours 37 minutes for highest severity injuries.

NEW YORK STATE OF OPPORTUNITY. Department of Health

Trauma Patients Admitted to the Intensive Care Unit (ICU)



Days in the Intensive Care Unit (ICU)



Average Annual ICU Cases and Fatalities by Age

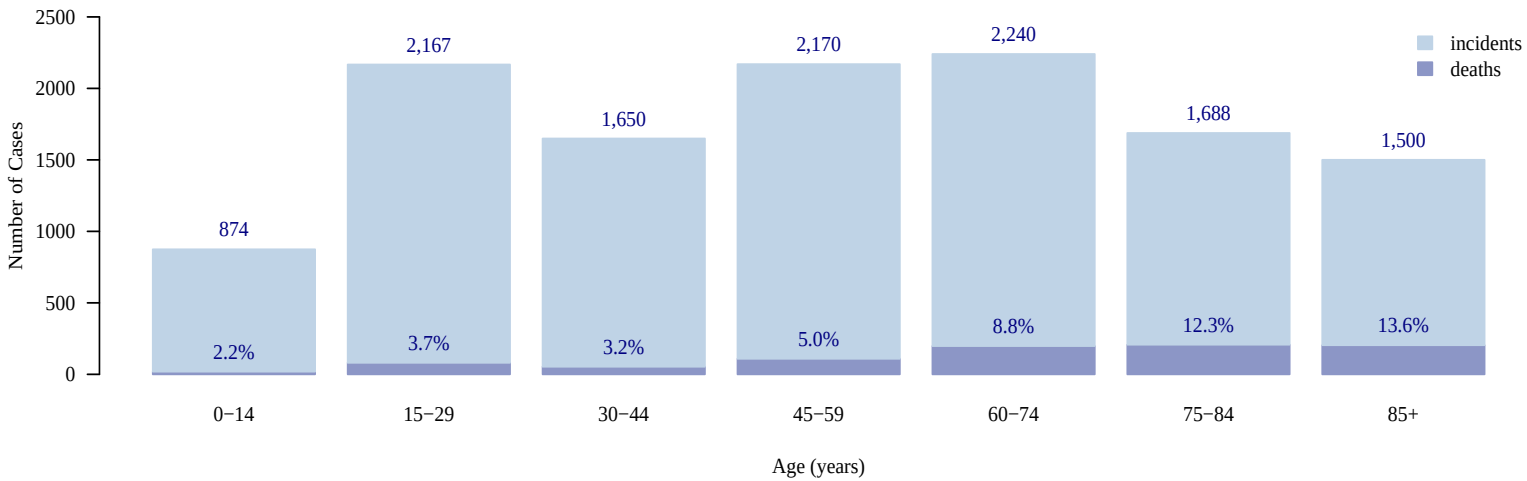


Figure 25

In 2014-2015, 26% of trauma patients spend time in the ICU. This is about 12,608 patients per year. The average time in the ICU is 4 days for patients who live, and 3 days for patients who do not. Case fatality rates of patients who require an ICU stay during their treatment increase with age: 2% for patients 0-14 years old and 14% for patients 85+ years old.

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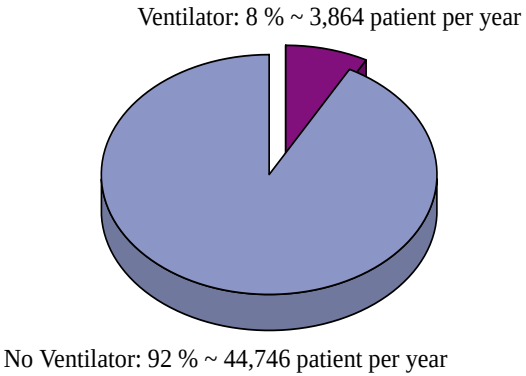
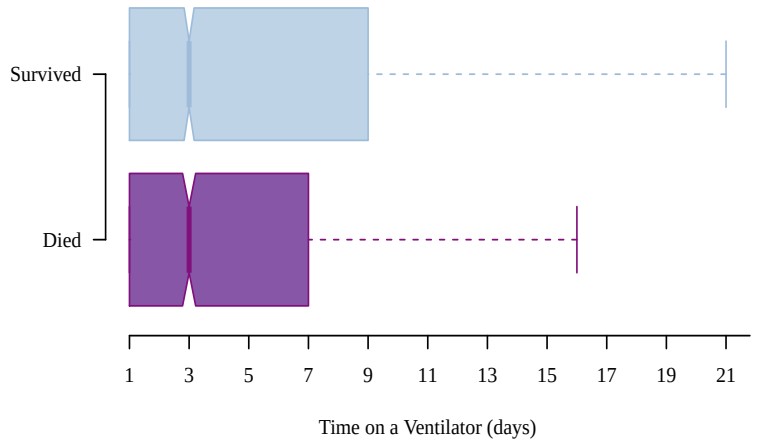
Trauma Patients Requiring a Ventilator



Days on a Ventilator



Average Annual Ventilator Cases and Fatalities by Age

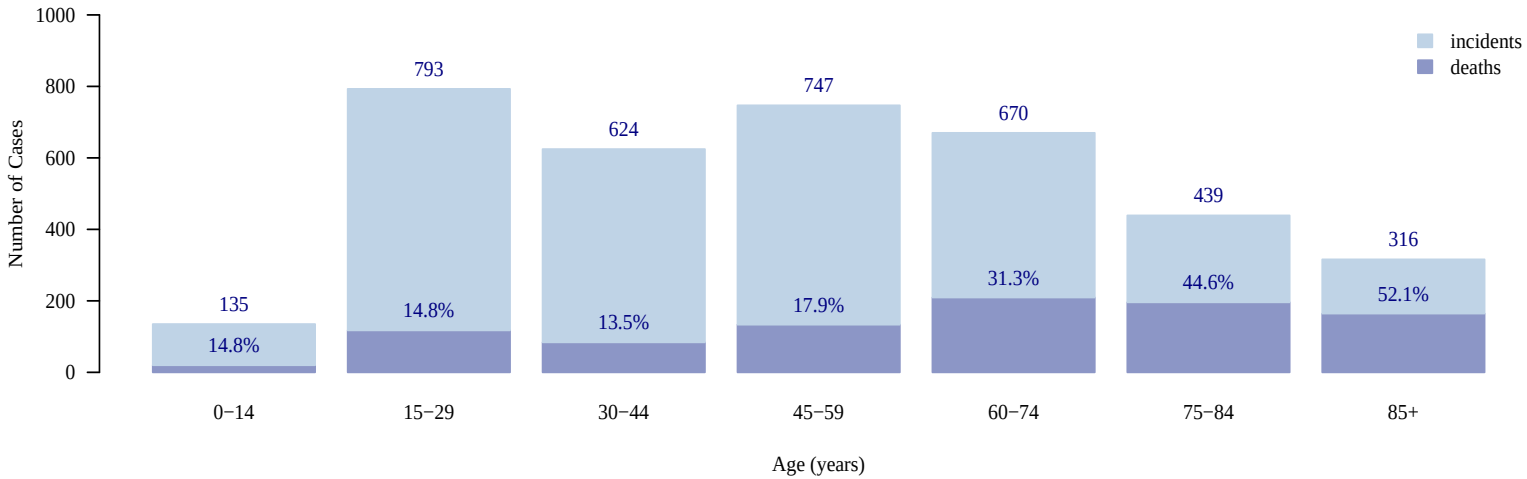


Figure 26

8% of trauma patients spend time on a Ventilator. This is about 3,864 patients per year. The average time (median) on a ventilator is 3 days for patients who live, and 3 days for patients who do not. Case fatality rates of patients who require a ventilator during their treatment increase with age: 15% for patients 0-14 years old and 52% for patients 85+ years old.

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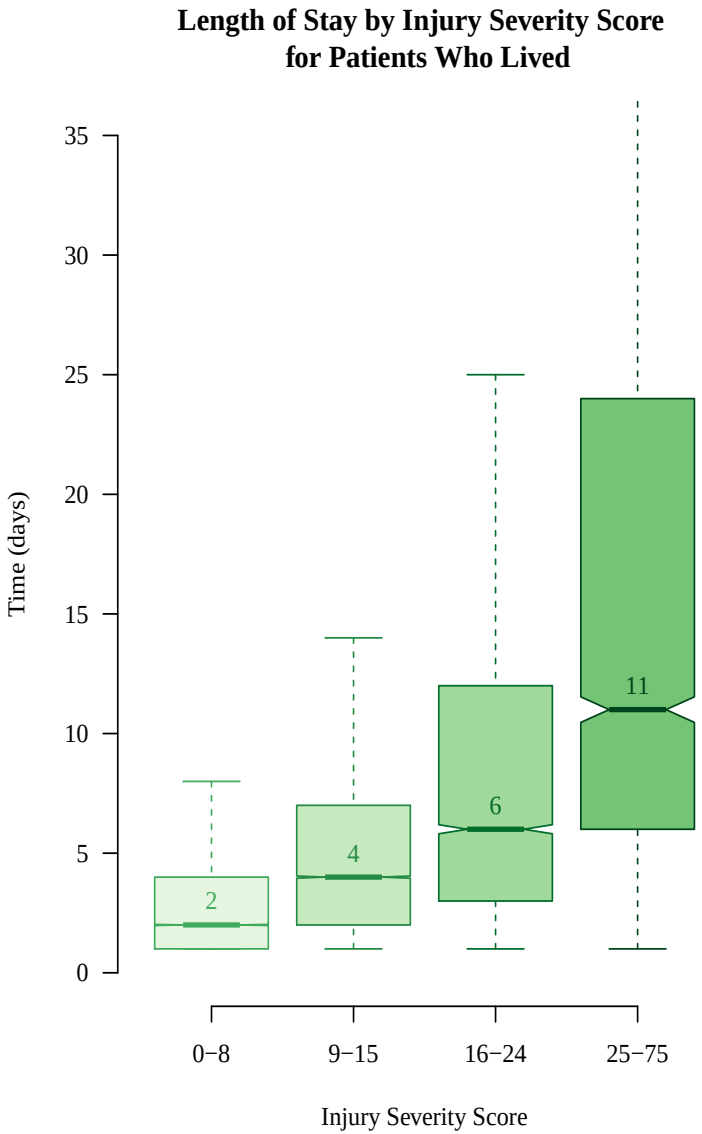

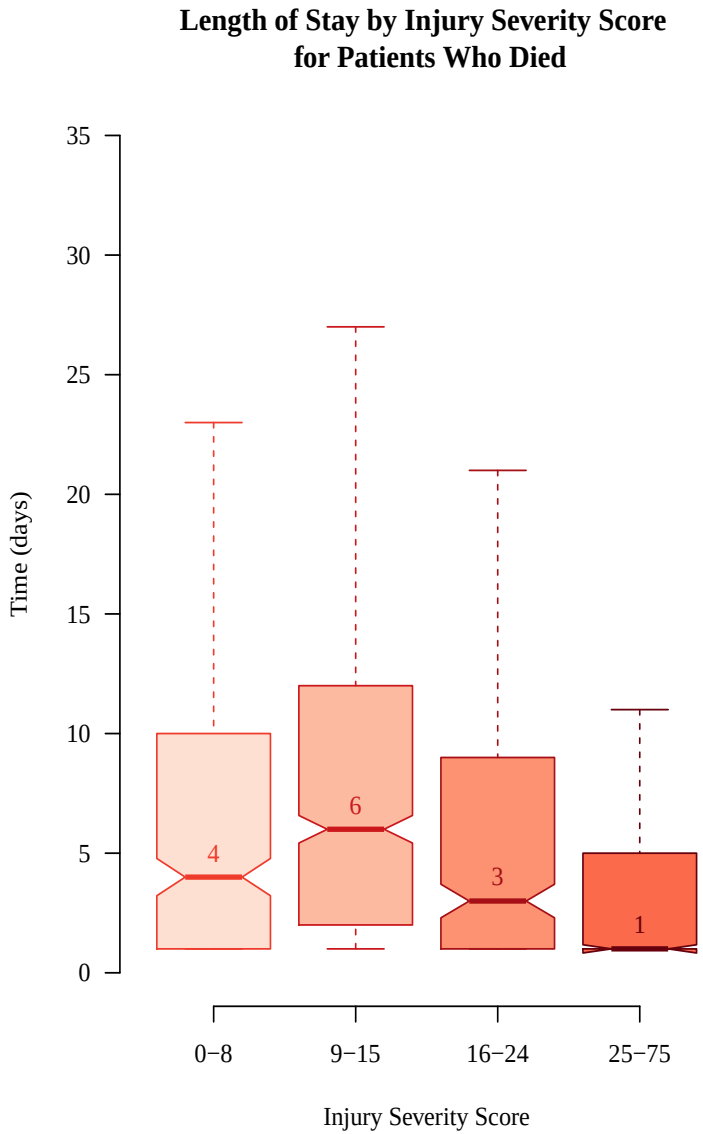

Figure 27

For patients discharged alive, the median length of hospital stay was 2 days for lowest severity injuries and 11 days for highest severity injuries. For patients who died, the median length of hospital stay was 4 days for lowest severity injuries and 1 days for highest severity injuries.

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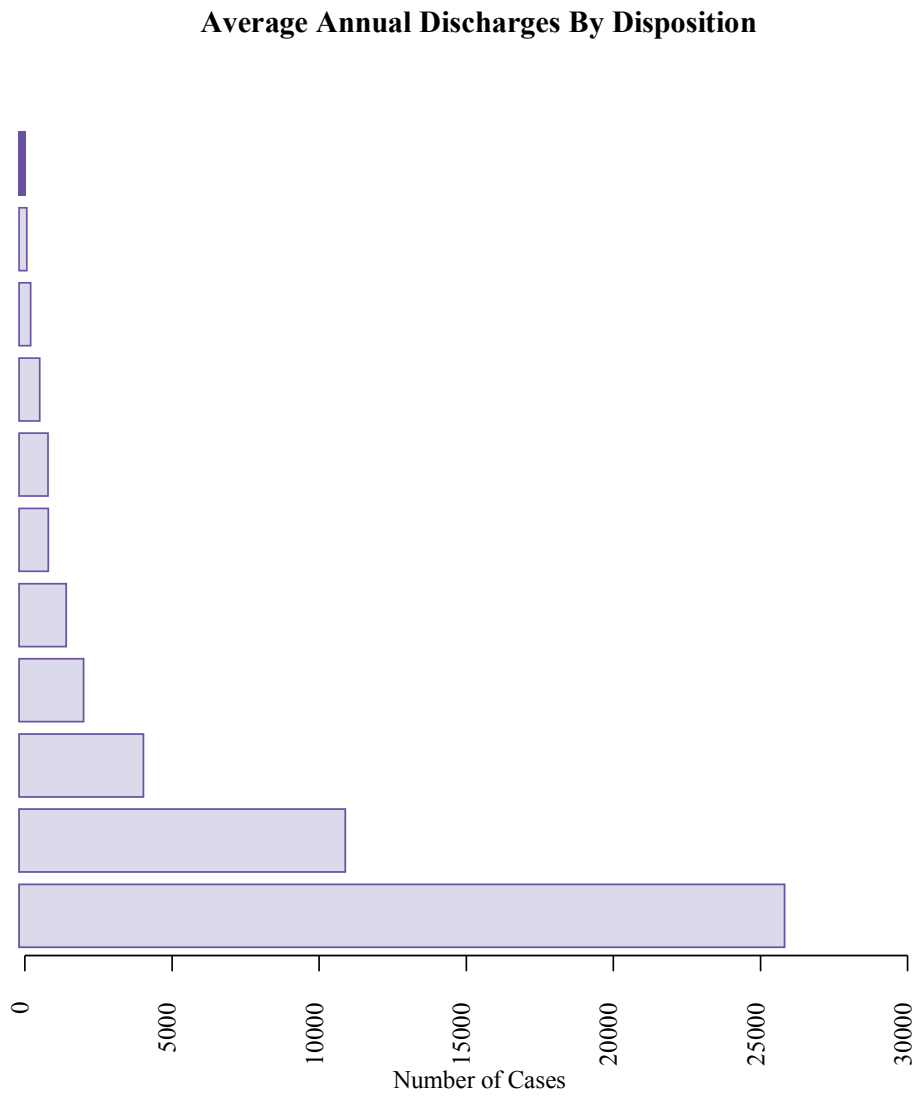


Figure 28

Over half of trauma patients are discharged home, with no services. Inpatient rehab is the second most common discharge disposition, accounting for just under a quarter of discharges. Nearly 10% of trauma patients are discharged home with home health services, and 5% are discharged to a nursing home.

NEW YORK STATE OF OPPORTUNITY. Department of Health

Risk-Adjusted Comparisons

Risk-Adjusted Mortality Ratios

	Facilities	Volume	Deaths	Observed Fatality Rate	Expected Fatality Rate	Risk Ratio	Confidence Interval
Designation							
Adult Trauma Center	26	41,835	1,351	3.2	3.0	1.07	(0.94 - 1.24)
Dual Designation	12	31,935	1,129	3.5	3.8	0.93	(0.82 - 1.06)
Pediatric Trauma Center	3	1,716	12	0.7	0.8	0.91	(0.73 - 1.21)
Facility Type							
Area	11	13,008	391	3.0	2.7	1.10	(0.96 - 1.30)
Provisional	3	992	24	2.4	1.7	1.43	(1.22 - 1.73)
Regional	27	61,486	2,077	3.4	3.5	0.98	(0.87 - 1.12)
Region							
Central NY	3	5,176	219	4.2	3.4	1.25	(1.10 - 1.46)
Hudson Valley	5	6,399	199	3.1	3.5	0.89	(0.79 - 1.02)
Nassau	4	11,623	378	3.3	3.3	1.00	(0.89 - 1.14)
New York City	18	29,015	817	2.8	2.7	1.06	(0.93 - 1.23)
Northeastern NY	3	6,733	273	4.1	4.3	0.94	(0.83 - 1.09)
Suffolk	5	9,733	314	3.2	3.7	0.87	(0.77 - 1.00)
Western NY/ Finger Lakes	3	6,807	292	4.3	4.3	0.99	(0.88 - 1.13)

Table 9

A risk ratio greater than one indicates a higher than expected mortality rate, a risk ratio less than one indicates a lower than expected mortality rate. The Suffolk region has the lowest risk ratio: 0.87, and the Central NY region has the highest: 1.25.

Note: 41 trauma centers are included in the table; 2 trauma centers were excluded due to missing variables used for the risk-adjusted model.

Pediatric Risk-Adjusted Mortality Ratios

	Facilities	Volume	Deaths	Observed Fatality Rate	Expected Fatality Rate	Risk Ratio	Confidence Interval
Designation							
Adult Trauma Center	24	1,124	11	1.0	0.7	1.33	(1.14 - 1.59)
Dual Designation	12	3,078	30	1.0	1.2	0.82	(0.69 - 1.02)
Pediatric Trauma Center	3	1,408	9	0.6	0.8	0.77	(0.62 - 1.04)
Facility Type							
Area	10	324	2	0.6	0.3	2.06	(1.59 - 2.91)
Provisional	3	41	0	0.0	0.1	0.00	(0.00 - 0.00)
Regional	26	5,245	48	0.9	1.1	0.87	(0.72 - 1.08)
Region							
Central NY	2	563	10	1.8	1.4	1.27	(1.05 - 1.61)
Hudson Valley	5	681	5	0.7	1.5	0.49	(0.41 - 0.61)
Nassau	4	374	2	0.5	0.8	0.67	(0.57 - 0.83)
New York City	17	2,337	16	0.7	0.6	1.23	(1.00 - 1.62)
Northeastern NY	3	508	7	1.4	1.8	0.75	(0.66 - 0.87)
Suffolk	5	437	2	0.5	0.7	0.62	(0.51 - 0.78)
Western NY/ Finger Lakes	3	710	8	1.1	1.4	0.81	(0.66 - 1.03)

Table 10

A risk ratio greater than one indicates a higher than expected mortality rate, a risk ratio less than one indicates a lower than expected mortality rate. The Hudson Valley region has the lowest risk ratio: 0.49, and the Central NY region has the highest: 1.27. Pediatric is defined here as 14 years old and younger.

Note: 39 trauma centers are included in the table; 4 trauma centers do not have pediatric trauma patients.

High Severity Injury Risk-Adjusted Mortality Ratios

	Facilities	Volume	Deaths	Observed Fatality Rate	Expected Fatality Rate	Risk Ratio	Confidence Interval
Designation							
Adult Trauma Center	25	1,781	613	34.4	32.3	1.07	(0.97 - 1.18)
Dual Designation	12	1,895	572	30.2	32.4	0.93	(0.86 - 1.02)
Pediatric Trauma Center	3	57	8	14.0	13.7	1.03	(0.84 - 1.32)
Facility Type							
Area	11	414	133	32.1	30.2	1.06	(0.97 - 1.18)
Provisional	3	30	7	23.3	18.5	1.26	(1.08 - 1.51)
Regional	26	3,289	1,053	32.0	32.4	0.99	(0.91 - 1.09)
Region							
Central NY	3	227	71	31.3	28.6	1.09	(0.99 - 1.22)
Hudson Valley	5	437	114	26.1	29.5	0.89	(0.80 - 0.99)
Nassau	4	494	162	32.8	33.0	0.99	(0.92 - 1.08)
New York City	17	1,204	410	34.1	31.8	1.07	(0.98 - 1.18)
Northeastern NY	3	367	125	34.1	35.5	0.96	(0.88 - 1.05)
Suffolk	5	476	144	30.3	33.6	0.90	(0.83 - 0.98)
Western NY/ Finger Lakes	3	528	167	31.6	31.5	1.00	(0.92 - 1.11)

Table 11

A risk ratio greater than one indicates a higher than expected mortality rate, a risk ratio less than one indicates a lower than expected mortality rate. The Hudson Valley region has the lowest risk ratio: 0.89, and the Central NY region has the highest: 1.09. High severity trauma is defined here as a patient having an injury severity score of 25 or above.

Note: 40 trauma centers are included in the table; 3 trauma centers were excluded due to missing variables used for the risk-adjusted model.

Firearm Risk-Adjusted Mortality Ratios

	Facilities	Volume	Deaths	Observed Fatality Rate	Expected Fatality Rate	Risk Ratio	Confidence Interval
Designation							
Adult Trauma Center	25	1,346	123	9.1	8.7	1.06	(0.94 - 1.20)
Dual Designation	12	705	63	8.9	9.9	0.91	(0.82 - 1.02)
Pediatric Trauma Center	1	10	0	0.0	7.6	0.00	(0.00 - 0.00)
Facility Type							
Area	11	156	20	12.8	10.8	1.19	(1.06 - 1.35)
Provisional	3	23	2	8.7	7.8	1.12	(0.97 - 1.31)
Regional	24	1,882	164	8.7	8.9	0.97	(0.87 - 1.10)
Region							
Central NY	3	159	22	13.8	11.4	1.22	(1.07 - 1.41)
Hudson Valley	5	86	7	8.1	9.4	0.86	(0.76 - 1.00)
Nassau	4	94	15	16.0	13.5	1.18	(1.04 - 1.36)
New York City	15	1,143	78	6.8	6.5	1.06	(0.94 - 1.20)
Northeastern NY	3	106	5	4.7	11.3	0.42	(0.38 - 0.47)
Suffolk	5	89	13	14.6	12.7	1.15	(1.07 - 1.25)
Western NY/ Finger Lakes	3	384	46	12.0	13.2	0.90	(0.81 - 1.02)

Table 12

A risk ratio greater than one indicates a higher than expected mortality rate, a risk ratio less than one indicates a lower than expected mortality rate. The Northeastern NY region has the lowest risk ratio: 0.42, and the Central NY region has the highest: 1.22.

Note: 38 trauma centers are included in the table; 5 trauma centers were excluded due to missing variables used for the risk-adjusted model.

Motor Vehicle Traffic Risk-Adjusted Mortality Ratios

	Facilities	Volume	Deaths	Observed Fatality Rate	Expected Fatality Rate	Risk Ratio	Confidence Interval
Designation							
Adult Trauma Center	25	8,546	271	3.2	3.1	1.03	(0.93 - 1.16)
Dual Designation	12	6,423	268	4.2	5.0	0.84	(0.75 - 0.94)
Pediatric Trauma Center	3	131	1	0.8	1.8	0.43	(0.36 - 0.56)
Facility Type							
Area	11	2,725	57	2.1	2.3	0.90	(0.81 - 1.01)
Provisional	3	203	2	1.0	1.1	0.93	(0.80 - 1.10)
Regional	26	12,172	481	4.0	4.3	0.93	(0.83 - 1.04)
Region							
Central NY	3	1,157	56	4.8	4.4	1.11	(0.99 - 1.27)
Hudson Valley	5	2,011	55	2.7	3.6	0.75	(0.67 - 0.86)
Nassau	4	2,266	90	4.0	3.7	1.07	(0.98 - 1.18)
New York City	17	4,658	138	3.0	2.6	1.12	(1.01 - 1.27)
Northeastern NY	3	1,290	54	4.2	5.5	0.76	(0.69 - 0.85)
Suffolk	5	2,042	80	3.9	5.1	0.77	(0.70 - 0.85)
Western NY/ Finger Lakes	3	1,676	67	4.0	4.7	0.84	(0.75 - 0.96)

Table 13

A risk ratio greater than one indicates a higher than expected mortality rate, a risk ratio less than one indicates a lower than expected mortality rate. The Hudson Valley region has the lowest risk ratio: 0.75, and the New York City region has the highest: 1.12.

Note: 40 trauma centers are included in the table; 3 trauma centers were excluded due to missing variables used for the risk-adjusted model.

Head Trauma Risk-Adjusted Mortality Ratios

	Facilities	Volume	Deaths	Observed Fatality Rate	Expected Fatality Rate	Risk Ratio	Confidence Interval
Designation							
Adult Trauma Center	26	12,071	797	6.6	6.2	1.07	(0.96 - 1.21)
Dual Designation	12	10,178	740	7.3	7.7	0.94	(0.85 - 1.06)
Pediatric Trauma Center	3	494	9	1.8	2.0	0.92	(0.75 - 1.20)
Facility Type							
Area	11	3,194	185	5.8	5.5	1.06	(0.95 - 1.21)
Provisional	3	272	12	4.4	3.3	1.34	(1.17 - 1.57)
Regional	27	19,277	1,349	7.0	7.0	1.00	(0.89 - 1.12)
Region							
Central NY	3	1,515	150	9.9	7.3	1.36	(1.21 - 1.55)
Hudson Valley	5	2,378	156	6.6	7.2	0.91	(0.82 - 1.03)
Nassau	4	3,896	253	6.5	6.0	1.08	(0.98 - 1.20)
New York City	18	8,232	488	5.9	5.6	1.05	(0.94 - 1.19)
Northeastern NY	3	2,110	170	8.1	9.1	0.88	(0.79 - 1.00)
Suffolk	5	2,410	139	5.8	7.3	0.78	(0.71 - 0.88)
Western NY/ Finger Lakes	3	2,202	190	8.6	8.6	1.00	(0.90 - 1.13)

Table 14

A risk ratio greater than one indicates a higher than expected mortality rate, a risk ratio less than one indicates a lower than expected mortality rate. The Suffolk region has the lowest risk ratio: 0.78, and the Central NY region has the highest: 1.36. Head trauma is defined here using the Abbreviated Injury Scale as having moderate or greater trauma to the head.

Note: 41 trauma centers are included in the table; 2 trauma centers were excluded due to missing variables used for the risk-adjusted model.

Appendix

Risk Adjustment Methodology

1. Introduction

This section describes the risk adjustment methodology developed by the New York State Trauma Registry. For the goal of the risk adjustment was to provide unbiased estimates of trauma fatality rates after controlling contributing risk factors. The risk adjustment model was developed using the New York Trauma Registry data submitted by the trauma centers across the state.

2. Trauma data

Trauma records submitted by the New York State certified trauma centers for patients. About 5% of the patients were excluded from the analysis due to the missing values of the variables used for risk adjustment model development.

3. Selection of factors

The contributing fatality risk factors among trauma patients include the following categories:

- Patient demographic variables: age, gender, and comorbidities;
- Patient condition upon arrival: Glasgow coma score, and systolic blood pressure;
- Required pre-hospital and emergency room treatments: CPR, intubation, and ventilation;
- Severity of injury and Mechanism of injury.

4. Risk adjustment model

We chose to use logistic regression to model trauma patient fatality risk with trauma death as the dependent variable and the potential risks factors (listed in 3, Selection of factors) as the independent variables. All the final risk adjustment model variables are highly significant with greater than 95% confidence.

5. Calculation of the risk-adjusted fatality rate and confidence intervals

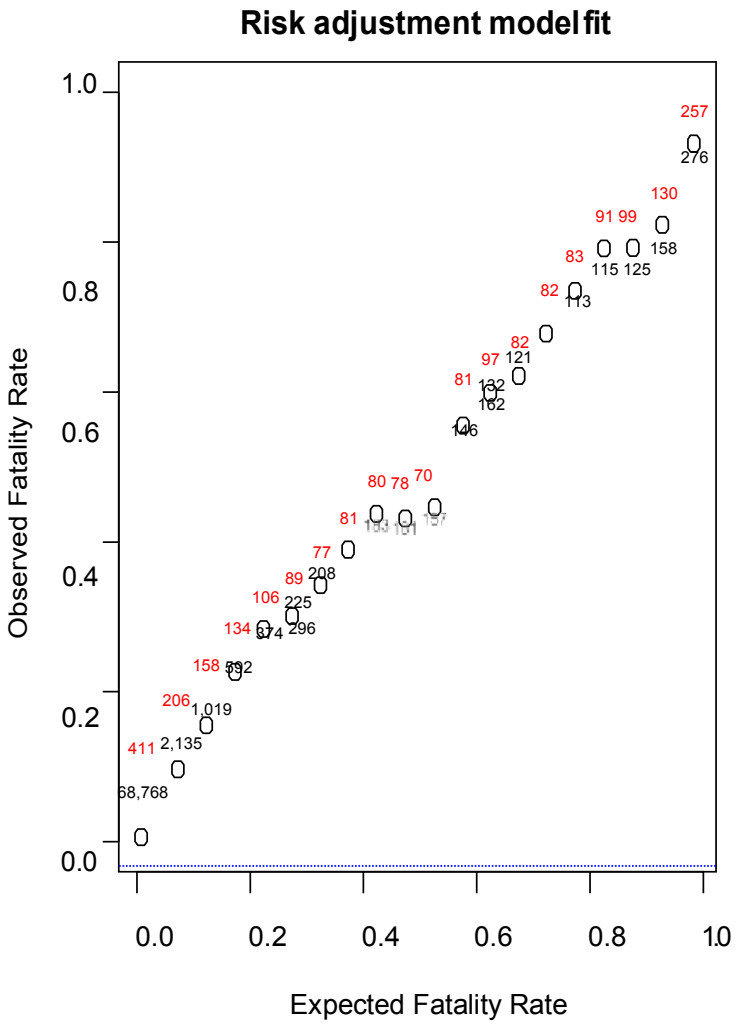
- Expected fatality rate: calculated using the developed risk-adjusted model Adjusting for the differences among groups..
- Observed fatality rate: calculated using the number of patient deaths observed in the group divided by the number of patients in the group.
- Risk ratio: calculated using the observed fatality rate divided by the expected fatality rate. If the ratio is larger than one, the group has a higher fatality rate than expected on the basis of its patient mix.
- Confidence intervals: The 95% confidence intervals for the risk ratios were calculated using the standard error of the observed fatality rate[1]. A confidence interval is above the statewide rate indicating a statistically significantly higher than expected fatality rate after adjusting for risk.

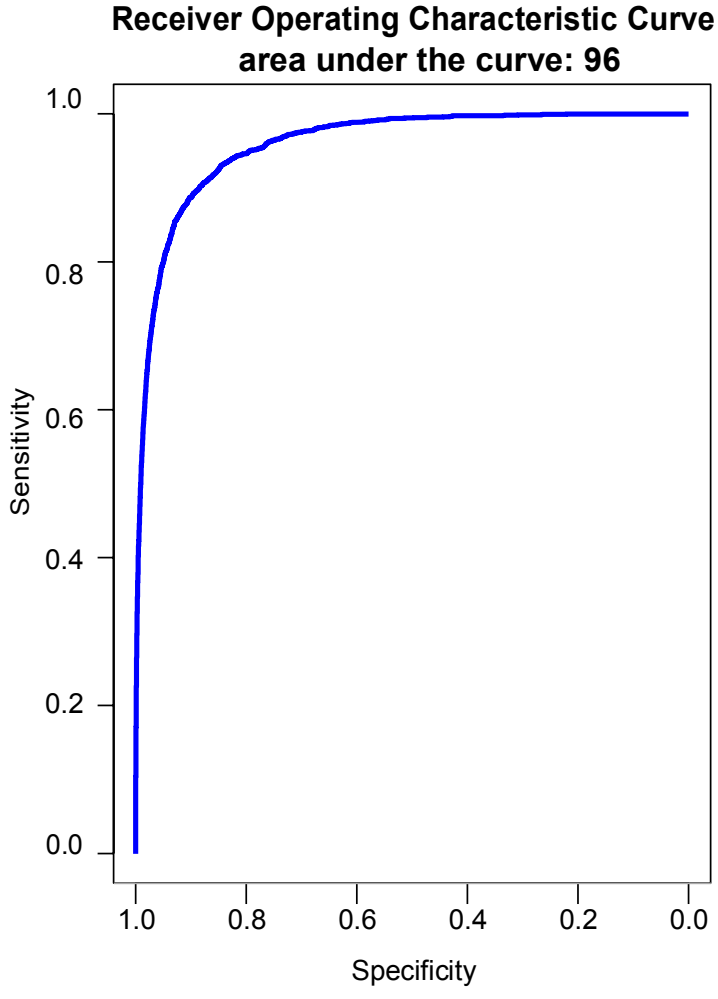
Risk adjustment model variables summary statistics

Independent variable	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-0.396	0.271	-1.464	0.143
Demographics				
Age* 0-30	0.625	0.217	2.883	0.004
Age* 30-60	3.024	0.194	15.607	0.000
Age* 60-80	3.055	0.517	5.913	0.000
Age* +80	3.879	0.340	11.398	0.000
Male	0.205	0.060	3.405	0.001
Residential Institution	0.250	0.107	2.342	0.019
Comorbidity				
Bleeding disorder	0.258	0.058	4.412	0.000
Advanced directive	1.443	0.080	18.003	0.000
Disseminated cancer	0.946	0.175	5.406	0.000
Prior renal failure	0.605	0.107	5.667	0.000
Patient condition on arrival				
Prehospital cardiac arrest	1.964	0.508	3.866	0.000
Systolic Blood Pressure* 0-50	-8.544	0.314	-27.171	0.000
Systolic Blood Pressure* +50	-0.884	0.230	-3.845	0.000
Glasgow Comma Score Motor	-0.387	0.017	-23.188	0.000
Required treatment				
CPR administered in field or ED	0.525	0.076	6.879	0.000
Ventilator required	2.338	0.070	33.199	0.000
Intubation occurred in the ED	0.190	0.078	2.436	0.015
Injury Severity				
Injury Severity Score	0.047	0.003	14.848	0.000
Severe head or neck trauma	1.036	0.089	11.587	0.000
Severe chest trauma	0.456	0.209	2.187	0.029
Mechanism of Injury				
Self-Inflicted	0.744	0.188	3.949	0.000
firearm	1.043	0.143	7.300	0.000

Table 15

* A model with combination of linear and polynomial function was used here to account for non-linearity.





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Inclusion Criteria: ICD Codes

- Starting January 1, 2014, the New York Trauma Registry inclusion criteria was expanded to include a broader range of trauma injuries. The ICD-9 codes include: 800 - 813, 817 - 824, 827 - 829, 836, 839, 850 - 854, 860 - 887, 890 - 897, 900 - 904, 925 - 929, 950 - 959.

- **Exceptions:**
  - Sometimes a patient will have a typical trauma diagnosis code but given the cause or severity of injury they should be excluded from the trauma registry.
  - If a case present one of following E codes: E837.3, E850-869.9, E870-879.9, E890-899, E900-904.9, E906.0, E906.3, E910-915, E923.0 .1 .2 .8 .9, E924.0 .1 .2 .8 .9, E925.1 .8 .9, E926.1, E929.0-.9, E930-949, E950.0-.7, E954, E958.1, E959, E968.3, E968.7, E969, E977, E980.0-.9, E981-982, E983.0-.9, E984, E989, E999.0-.1, the registrar should review the case carefully and determine if the case should be excluded (non-reportable).
  - Cases with a principal diagnosis of V57 are excluded unless they are trauma deaths in the Emergency Department.

- **Note:** Every trauma case that is "eligible" for reporting/submitting to the NYSTR according to the inclusion criteria (ICD codes) should be reviewed by the registrar of a trauma center. If the registrar determines that a case should be excluded (non-reportable), the reviewer will complete an exclusion report containing the non-reportable cases and submit them quarterly to the NYSTR.

- **Starting October 1, 2015,** several trauma centers started using ICD-10 codes for their trauma cases that accounted for 12% of total reported trauma cases in 2014-2015. Trauma cases containing ICD-10 codes were mapped to ICD-9 codes.

- **Expanded criteria:** The inclusion criteria have expanded from including moderate to severe trauma, to additionally including lower severity trauma as well. These criteria more closely align with the National Trauma Data Bank.

References

[1] Hosmer D. and Lemeshow S. Confidence Interval Estimates of an Index of Quality Performance Based on Logistic Regression Models. Statistics in Medicine, Volume 14, 2161-2172(1995).

[2] Baker, O'Neill, Haddon, and Long. The Injury Severity Score: A Method for Describing Patients with Multiple Injuries and Evaluating Emergency Care. Journal of Trauma, Volume 14 No. 3, March 1974.

[3] Surveillance, Epidemiology, and End Results (SEER) Program Populations (1969-2013) (www.seer.cancer.gov/popdata), National Cancer Institute, DCCPS, Surveillance Research Program, Surveillance Systems Branch, released January 2015.

[4] Tables 21 and 22, Committee on Trauma, American College of Surgeons. NTDB Annual Report2014. Chicago, IL. https://www.facs.org/quality%20programs/trauma/ntdb/docpub

[5] R Core Team (2014). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

[6] Original S code by Richard A. Becker and Allan R. Wilks. R version by Ray Brownrigg. Enhancements by Thomas P Minka <tpminka@media.mit.edu> (2014). maps: Draw Geographical Maps. R package version 2.3-9. http://CRAN.R-project.org

[7] Friedrich Leisch. Sweave: Dynamic generation of statistical reports using literate data analysis. In Wolfgang Härdle and Bernd Rönz, editors, Compstat 2002 - Proceedings in Computational Statistics, pages 575-580. Physica Verlag, Heidelberg, 2002. ISBN 3-7908-1517-9.

[8] Yihui Xie (2014) knitr: A Comprehensive Tool for Reproducible Research in R. In Victoria Stodden, Friedrich Leisch and Roger D. Peng, editors, Implementing Reproducible Computational Research. Chapman and Hall/CRC. ISBN 978-1466561595