Long-term Survival of Adult Trauma Patients

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Context Inpatient trauma case fatality rates may provide an incomplete assessment for overall trauma care effectiveness. To date, there have been few large studies evaluating long-term mortality in trauma patients and identifying predictors that increase risk for death following hospital discharge.

Objectives To determine the long-term mortality of patients following trauma admission and to evaluate survivorship in relationship with discharge disposition.

Design, Setting, and Patients Retrospective cohort study of 124 421 injured adult patients during January 1995 to December 2008 using the Washington State Trauma Registry linked to death certificate data.

Main Outcome Measures Kaplan-Meier and Cox proportional hazards models were used to evaluate long-term mortality following hospital admission for trauma.

Results Of the 124 421 trauma patients, 7243 died before hospital discharge and 21 045 died following hospital discharge. Cumulative mortality at 3 years postinjury was 16% (95% confidence interval [CI], 15.8%-16.2%) compared with the expected population cumulative mortality of 5.9% (95% CI, 5.9%-5.9%). In-hospital mortality improved during the 14-year study period from 8% (n=362) to 4.9% (n=600), whereas long-term cumulative mortality increased from 4.7% (95% CI, 4.1%-5.4%) to 7.4% (95% CI, 6.8%-8.1%). After adjustments for confounders, patients who were older and those who were discharged to a skilled nursing facility had the highest risk of death. The adjusted hazard ratios (HRs) for death after discharge to a skilled nursing facility compared with that after discharge home were 1.41 (95% CI, 0.72-2.76) for patients aged 18 to 30 years, 1.92 (95% CI, 1.36-2.73) for patients aged 31 to 45 years, 2.02 (95% CI, 1.39-2.93) for patients aged 46 to 55 years, 1.93 (95% CI, 1.40-2.64) for patients aged 56 to 65 years, 1.49 (95% CI, 1.14-1.94) for patients aged 66 to 75 years, 1.54 (95% CI, 1.27-1.87) for patients aged 76 to 80 years, and 1.38 (95% CI, 1.09-1.74) for patients older than 80 years. Other significant predictors of mortality after discharge included maximum head injury score on Abbreviated Injury Score scale (HR, 1.20; 95% CI, 1.13-1.26), Injury Severity Score (HR, 0.98; 95% CI, 0.97-0.98), Functional Independence Measure (HR, 0.89; 95% CI, 0.88-0.91), mechanism of injury being a fall (HR, 1.43; 95% CI, 1.30-1.58), and having Medicare (HR, 1.28; 95% CI, 1.15-1.43) or other government insurance (HR, 1.65; 95% CI, 1.47-1.85).

Conclusions Among adults admitted for trauma in Washington State, 3-year cumulative mortality was 16% despite a decline in in-hospital deaths. Discharge to a skilled nursing facility at any age following trauma admission was associated with a higher risk of subsequent mortality.

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TRAUMA LEADS TO SIGNIFICANT morbidity and mortality.[1-5] In-hospital case fatality rates for initial hospitalization alone may not be an adequate method for determining success in trauma care because there is substantial mortality postdischarge.[1,3,6-8] Studies on surgical outcome have been primarily on in-hospital mortality and complications. However, little is known about long-term outcomes following trauma admission.[1,7,8] Previous studies have focused on outcomes of level 1 trauma centers. Results from these single center studies have shown that severely injured patients have a higher cumulative mortality in the years following admission.[7-9] However, a higher proportion of severely injured young patients are treated at level 1 trauma centers compared with nontrauma centers that treat a higher proportion of elderly patients.[10] Elderly patients have been found to have higher mortality after trauma as well as higher complication rates, specifically for pulmonary and infectious complications.[9,11-15] Age-related risk factors may be different for long-term mortality in the injured patient.

Currently, to our knowledge, there have been few studies evaluating long-term mortality in a large trauma system. To determine the overall mortality attributable to injury, further research is needed to evaluate trauma outcomes throughout the entire health care system beyond the initial hospitalization. Information on the short- and long-term causes of death following discharge for injury could potentially identify gaps in care amenable to improve-

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Table 1. Characteristics of Washington State Trauma Patients 1995-2008

	No. (%) of Trauma Patients (N = 124 421)[a]
Sex	
Male	72 918 (58.6)
Female	51 503 (41.4)
Age, mean (SD), y	53.2 (23)
18-30	26 772 (21.52)
31-45	26 654 (21.42)
46-55	16 826 (13.52)
56-65	12 211 (9.81)
66-75	11 503 (9.25)
76-80	17 872 (14.36)
>80	12 583 (10.11)
Injury severity score, mean (SD)	10.8 (10)
0-9	77 610 (62.4)
10-15	22 807 (18.3)
16-24	11 166 (9.0)
≥25	12 035 (9.7)
Disposition	
Home (no assistance)	65 074 (52.3)
Home (with assistance)	7158 (5.8)
Skilled nursing facility	30 515 (24.5)
Rehabilitation facility	7403 (6.0)
Other[b]	13 318 (10.7)
Insurance status[c]	
Commercial	44 851 (45.7)
Government	19 420 (19.8)
Medicare	21 264 (21.7)
None	12 600 (12.8)
Level 1 or 2 trauma center	75 687 (60.83)
Functional independence measure, mean (SD)	10.7 (1.7)
Mechanism of injury	
Blunt	48 352 (38.9)
Penetrating	12 723 (10.2)
Fall	58 377 (46.9)
Other	3335 (2.7)
Abbreviated Injury Score >3 for head injury	14 219 (11.4)
Systolic blood pressure <90 mm Hg in the emergency department	11 602 (9.32)

[a] Unless otherwise indicated. Percentages may not equal 100% due to rounding.
[b] Includes jail, psychiatric hospital transfer, transfer to acute care facility, or ventilation weaning facility.
[c] Adjusted for age older than 64 years.

ment, and allow for counseling of patients and their families about prognosis following traumatic injuries.[15] The purpose of this study was to describe the long-term mortality of Washington State trauma patients and to identify risk factors for death following hospital discharge.

METHODS

We performed a retrospective cohort study of injured patients (N=124 421) who were treated at one of Washington State's 78 trauma hospitals. All data were obtained from the Washington State Trauma Registry from January 1995 to December 2008 and included those aged 18 years or older admitted to a state-designated trauma hospital. The Washington State Department of Health designates 5 levels of acute care trauma hospitals in the state of Washington, and we included patients hospitalized at any one of these. Institutional review board approval was obtained from the Washington State Department of Health as well as the University of Washington.

Patients included in the trauma registry were enrolled based on classification as a trauma patient with trauma team activation or discharge according to *International Classification of Diseases, Ninth Revision, Clinical Modification* codes 800 through 949. Washington State had a well-organized and mature statewide trauma system (established in 1990) during the study period. State registry inclusion criteria include all patients for whom a full or modified trauma resuscitation team was activated, all trauma patients dead on arrival, transferred between facilities by emergency medical services, flown from the scene, pediatric trauma patients (aged 0-14 years), and all injured adults admitted with a length of stay longer than 48 hours. Trauma registry inclusion criteria for eligible study patients did not substantially change during the study period. The Washington State Department of Health does not require that isolated hip fractures or femoral neck fractures in patients older than age 65 years be reported.

Specific exclusions for our study included patients with the primary injury being burns, patients with significant burns described as greater than 20% of the body surface area (n=3605), age younger than 18 years (n=36 907), patients transferred from outside of Washington State (n=25 977), error in coding for age (n=124), discharge date after December 31, 2008 (n=134), or other missing data (n=31).

Deaths among trauma patients were ascertained by linking the Washington State Trauma registry cohort with Washington State death certificates using *Link Plus*, a probabilistic record linkage software program developed at the US Centers for Disease Control and Prevention. After linkage, personal identifiers were used to remove duplicated links. Mortality follow-up ended on December 31, 2008.

The burden of trauma includes the mortality of both inpatients and those who die following discharge. There were thus 2 main analyses: (1) an analysis of survivorship after admission in all patients in relationship with characteristics ascertained on admission with a focus on age; and (2) a comparison of survival after discharge in relationship with disposition among those who were discharged alive. We used the Kaplan-Meier method to estimate survival from admission for injury stratified by age group and disposition. The log-rank test was used to test the statistical significance of observed differences in survivorship between the exposure groups. A logistic regression was performed to identify patients on admission who have a significantly high chance of death in the year following injury. The main statistical approach for the second analysis was a Cox proportional hazards model to estimate the relative risk of mortality following discharge from the hospital.

We adjusted for maximum head Abbreviated Injury Score, Injury Severity Score, the Glasgow Coma Scale, and Functional Independence Measure mobility score at the time of discharge, mechanism of injury, length of stay in the hospital, intensive care length of stay, need for tracheotomy, level of trauma center, Charlson comorbidity index (based on preexisting comorbidities), and insurance status. The use of survival analysis methods for both analyses accounted for varying amounts of follow-up time for patients admitted in different calendar years and censored at the completion of the study. Two-sided tests of significance were used when appropriate and results were considered significant with a *P* value of less than .05.

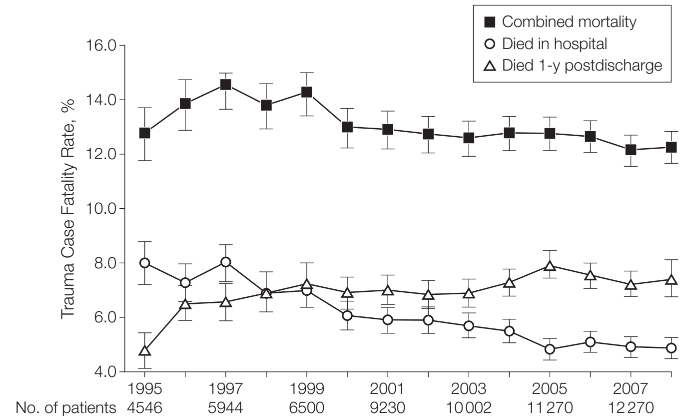
We determined that the Functional Independence Measure mobility score was a strong predictor of mortality following discharge; however, this was missing in 14% of our study population. Therefore, we used multiple imputation to account for missing data using the method of chained equations.[16,17] Variables in the imputation model included components of the Functional Independence Measure mobility score (locomotion and feeding ability at discharge), components of the Glasgow Coma Scale score at discharge, Injury Severity Score, mechanism of injury (blunt or penetrating), disposition, sex, age, and mortality. All statistical analyses were performed using Stata software version 11.0 (StataCorp, College Station, Texas). The time variable for the secondary analysis was person-days of observation, defined as the interval between day of discharge and date of death or December 31, 2008.

To compare the outcomes from our trauma population with the general Washington State population, we used age- and sex-specific mortality rates for Washington State for the years 1999 through 2006, obtained from the US Centers for Disease Control and Prevention's Wonder progam,[18] to calculate the probability of death over a 3-year period and adjusted by age and sex. We then applied these probabilities to the age and sex distribution of the trauma population to obtain expected cumulative mortality in this cohort for the same age and sex distribution.

RESULTS

The mean (SD) age of our trauma population was 53.2 (23.0) years and 59% were male. The mean (SD) Injury Severity Score was 10.9 (10) (TABLE 1). When the data were broken into smaller study periods, there were no significant differences in our patient population by age, sex, Injury Severity Score, disposition, trauma center level that the patient was discharged from, Functional Independence Measure mobility score at discharge, or mechanism of injury from the beginning of the study period to the end. Of the 124 421 adult patients coded in the trauma registry during the study period, 7243 died (5.8%) during their index trauma hospitalization. The proportion of patients who died while in the hospital declined each year of our study from 8% (95% confidence interval [CI], 7.2%-8.8%) in 1995 to approximately 4.9% (95% CI, 4.5%-5.2%) in 2008. Of those who survived to discharge, 21 045 individuals died prior to the censoring date of December 31, 2008.

Figure 1. Trauma Case Fatality Rate for Inpatients and 1-Year Postdischarge



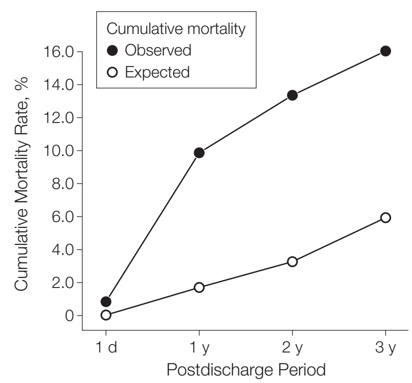
Error bars indicate 95% confidence intervals.

Table 2. Survival for Washington State Patients Discharged Alive After Hospitalization for Trauma

	Proportion of Patients	Cumulative Mortality Postdischarge, % (95% CI) At 1 y	At 3 y
Disposition			
Home (no assistance)	52.7	1.7 (1.6-1.8)	4.0 (3.9-4.2)
Home (with assistance)	5.8	8.3 (7.6-9.0)	15.9 (15.0-16.8)
Skilled nursing facility	24.7	18.7 (18.3-19.2)	34.0 (33.4-34.5)
Rehabilitation facility	6.0	5.5 (5.0-6.1)	12.0 (11.4-13.0)

Abbreviation: CI, confidence interval.

Figure 2. Observed vs Expected Cumulative Mortality for the Washington State Adult Trauma Population (n=117 178)



The 95% confidence intervals for observed and expected cumulative mortality are 0.85%-0.95% and 0%, respectively, for 1-day postdischarge; 9.6%-10.0% and 1.626%-1.634% for 1-year postdischarge; 13.0%-13.4% and 3.244%-3.256% for 2-years postdischarge; and 15.8%-16.2% and 5.932%-5.948% for 3-years postdischarge.

The proportion of all patients admitted for trauma that died within 1 year following discharge was 7.2% (95% CI, 7.0%-7.3%).

The 117 178 patients discharged alive constituted the cohort for the analyses of risk factors for long-term postdischarge mortality. The median length of hospital stay was 4 days with a mean (SD) of 6 (11) days. In our study, 24.7% were discharged to a skilled nursing facility. Of those older than age 65 years, 54% were discharged to a skilled nursing facility.

Table 3. Mortality for Patients Discharged Home Without Assistance Compared With Other Patients

	No. of Patients (N = 124 421)	No. of Deaths	HR (95% CI)	
			Unadjusted	Adjusted
Age group 18-30 y[a]				
Home (no assistance)	20 174	172	1 [Reference]	1 [Reference]
Home (with assistance)	817	12	1.62 (0.90-2.92)	1.15 (0.35-3.78)
Skilled nursing facility	1119	47	4.18 (3.00-5.81)	1.41 (0.72-2.76)
Rehabilitation facility	1570	28	1.21 (0.75-1.95)	0.54 (0.25-1.14)
Other[b]	2719	7	2.29 (1.51-3.53)	1.60 (0.69-3.72)
Age group 31-45 y[c]				
Home (no assistance)	19 222	600	1 [Reference]	1 [Reference]
Home (with assistance)	1081	49	1.44 (1.07-1.92)	1.97 (1.18-3.29)
Skilled nursing facility	1999	189	2.70 (2.29-3.19)	1.92 (1.36-2.73)
Rehabilitation facility	1363	86	1.84 (1.47-2.31)	1.01 (0.70-1.44)
Other[b]	2690	86	1.80 (1.43-2.26)	1.27 (0.81-1.98)
Age group 46-55 y[d]				
Home (no assistance)	11 015	596	1 [Reference]	1 [Reference]
Home (with assistance)	1024	82	1.53 (1.22-1.93)	1.83 (1.08-3.10)
Skilled nursing facility	2055	300	2.75 (2.40-3.18)	2.02 (1.39-2.93)
Rehabilitation facility	1006	104	1.75 (1.42-2.16)	1.02 (0.72-1.46)
Other[b]	1620	102	2.25 (1.83-2.77)	1.78 (1.16-2.73)
Age group 56-65 y[d]				
Home (no assistance)	6646	560	1 [Reference]	1 [Reference]
Home (with assistance)	1015	135	1.63 (1.35-1.97)	1.66 (1.04-2.66)
Skilled nursing facility	2543	605	3.19 (2.84-3.58)	1.93 (1.40-2.64)
Rehabilitation facility	794	114	1.69 (1.38-2.06)	0.96 (0.68-1.36)
Other[b]	1162	137	2.81 (2.31-3.40)	2.17 (1.42-3.32)
Age group 66-75 y[e]				
Home (no assistance)	3902	713	1 [Reference]	1 [Reference]
Home (with assistance)	1044	277	1.54 (1.34-1.76)	1.75 (1.21-2.52)
Skilled nursing facility	4357	1679	2.51 (2.30-2.74)	1.49 (1.14-1.94)
Rehabilitation facility	898	229	1.45 (1.25-1.69)	0.88 (0.64-1.22)
Other[b]	1258	192	1.71 (1.45-2.02)	1.90 (1.26-2.86)
Age group 76-80 y[e]				
Home (no assistance)	2963	927	1 [Reference]	1 [Reference]
Home (with assistance)	1375	532	1.33 (1.20-1.48)	1.12 (0.83-1.51)
Skilled nursing facility	10 012	4986	1.85 (1.73-1.98)	1.54 (1.27-1.87)
Rehabilitation facility	1218	490	1.35 (1.22-1.50)	1.18 (0.91-1.52)
Other[b]	2253	402	1.34 (1.18-1.52)	1.43 (1.05-1.95)
Age group >80 y[e]				
Home (no assistance)	1152	505	1 [Reference]	1 [Reference]
Home (with assistance)	802	420	1.12 (0.83-1.50)	1.12 (0.82-1.54)
Skilled nursing facility	8430	5036	1.54 (1.27-1.62)	1.38 (1.09-1.74)
Rehabilitation facility	554	256	1.18 (0.91-1.17)	1.03 (0.72-1.47)
Other[b]	1616	292	1.43 (1.05-1.12)	1.08 (0.76-1.55)

Abbreviations: CI, confidence interval; HR, hazard ratio.
[a] Adjusted for maximum score for head injury on Abbreviated Injury Score scale, Functional Independence Measure at discharge, and length of stay.
[b] Includes transfer to another facility (including a ventilator weaning facility) or other hospital, jail, or psychiatric facility.
[c] Adjusted for maximum score for head injury on Abbreviated Injury Score scale, Functional Independence Measure at discharge, and Injury Severity Score on admission.
[d] Adjusted for everything in footnote "c" plus mechanism of injury, insurance status, and Charlson comorbidity index score.
[e] Adjusted for everything in footnote "c" plus insurance status and Charlson comorbidity index score.

Risk of Death Following Admission for Trauma by Age

A total of 21 045 patients died during the study period following admission from the hospital for their injury. Inpatient mortality for adult trauma patients improved from 1995 to 2008. This included improvements both in case fatality ratios for those who died in the emergency department and those who died in-hospital after admission for trauma. However, the postdischarge case fatality rates increased (FIGURE 1). Using Kaplan-Meier analysis for the trauma registry population of 124 421, cumulative mortality following injury was 9.8% (95% CI, 9.6%-10.0%) at 1 year and 16% (95% CI, 15.8%-16.2%) at 3 years. Age strongly predicted risk of death during the follow-up period and time to death following injury. In addition, patients who had a systolic blood pressure of less than 90 mm Hg in the emergency department, those with a Glasgow Coma Scale score of less than 9, male sex, and a mechanism of fall or blunt injury had the highest risk of death in the subsequent 1 year (44%).

Risk Factors for Death Following Discharge After an Admission for Trauma

Among patients discharged from the hospital alive, more than half were discharged home without assistance and nearly one-quarter of patients were discharged to a skilled nursing facility (TABLE 2). The cumulative mortality during the 3-year period following discharge for injury was higher for the trauma population than expected in the general population of the same age and sex distribution (FIGURE 2). Overall, cumulative mortality was significantly lower for those patients discharged home with or without assistance and patients discharged to rehabilitation facilities than for patients discharged to a skilled nursing facility, who had a 34% (95% CI, 33.4%-34.5%) cumulative mortality by 3 years postdischarge. The other category included a diverse group of patients including those discharged to jail, transferred to another acute care facility (including ventilator weaning facilities), and psychiatric hospital transfers.

Multivariate analyses using Cox proportional hazard models (adjusted also for maximum head injury score on the Abbreviated Injury Score scale and Functional Independence Measure mobility score) showed that patients who were discharged to a skilled nursing facility had the highest risk of death at all ages (TABLE 3). Other significant predictors of mortality after discharge included maximum score for head injury on Abbreviated Injury Score scale, Functional Independence Measure, mechanism of injury being a fall, and having Medicare or other government insurance (TABLE 4).

Table 4. Mortality for the Adult Washington State Trauma Population Following Discharge Alive for Injury

	HR (95% CI)	
	Unadjusted	Adjusted
Age, y	1.95 (1.94-1.97)	1.69 (1.64-1.74)
Disposition		
Home (no assistance)	1 [Reference]	1 [Reference]
Home (with assistance)	3.78 (3.56-4.01)	1.43 (1.22-1.69)
Skilled nursing facility	8.92 (8.61-9.24)	1.57 (1.41-1.76)
Rehabilitation facility	2.88 (2.70-3.06)	1.04 (0.91-1.19)
Other[a]	3.22 (3.01-3.44)	1.61 (1.37-1.89)
Maximum score for head injury on Abbreviated Injury Score scale	1.34 (1.21-1.39)	1.20 (1.13-1.26)
Functional Independence Measure at discharge	0.76 (0.76-0.77)	0.89 (0.88-0.91)
Length of stay, d	1.00 (1.00-1.00)	1.00 (1.00-1.00)
Charlson comorbidity index	1.92 (1.86-1.99)	1.07 (0.98-1.16)
Mechanism of injury		
Blunt	1 [Reference]	1 [Reference]
Penetrating	0.62 (0.56-0.68)	1.15 (0.9-1.47)
Fall	5.86 (5.65-6.09)	1.43 (1.30-1.58)
Other	0.82 (0.70-0.95)	0.90 (0.65-1.25)
Injury Severity Score	0.99 (0.99-0.99)	0.98 (0.97-0.98)
Insurance status[b]		
Commercial	1 [Reference]	1 [Reference]
Government	1.06 (0.99-1.12)	1.65 (1.47-1.85)
Medicare	6.79 (6.51-7.07)	1.28 (1.15-1.43)
None	0.46 (0.42-0.52)	1.03 (0.84-1.27)

Abbreviations: CI, confidence interval; HR, hazard ratio.
[a] Includes jail, psychiatric hospital transfer, transfer to acute care facility, or ventilation weaning facility.
[b] Adjusted for age older than 64 years.

COMMENT

In this retrospective cohort study of adult trauma patients from all Washington State designated trauma centers, we found significant excess mortality following discharge for trauma in our population with 16% of all discharged injured patients dying in the 3 years following injury and 9.9% in the first year. The observed cumulative mortality for our trauma population was sharply higher than that expected for the general Washington State population at 1, 2, and 3 years when age and sex were controlled. Maximum head injury score on the Abbreviated Injury Score scale, Functional Independence Measure score, length of stay, Injury Severity Score, Charlson comorbidity index score, and mechanism of injury were all important predictors for long-term mortality. In addition to indicators at discharge (such as Functional Independence Measure mobility score and disposition), we were also able to identify predictors on admission for death in the year following injury. These include advanced age, male sex, hypotension in the emergency department, and Glasgow Coma Scale score of less than 9 with injury sustained from blunt trauma or fall. This information can help guide clinician and family decision making for the adult trauma patient. These results suggest that in an adult trauma patient, acute injury is not just a brief physiological setback to a healthy life, but rather signals significant long-term mortality in a large number of patients.

One of the limitations of this study may be under- or overestimation of the true number of deaths because of potential errors in linking algorithms between the trauma registry and death certificates. We used methods similar to Mullins et al[1] who hypothesized they would be more likely to underestimate mortality in their population because death certificates are from Washington State only. A potential pitfall of this method will be patients admitted to a Washington State hospital who lived in or migrated to other states and may have been missed in linking death certificate data. We attempted to minimize this by excluding trauma patients initially transferred from surrounding states because they are likely to return home or to a skilled nursing facility in their home state.

Another limitation is that information on underlying cause of death is limited. Trauma may not have been the sole reason for subsequent death and existing comorbidities may contribute to the high cumulative mortality of the trauma population. However, due to the substantial difference between the expected and observed mortality rates for our trauma population, we conclude that trauma itself may be an indicator of higher long-term mortality or marker of patient decline.

Inpatient mortality rates declined each year to 4.9% for trauma at all age groups in 2008. This may be due to maturation of the trauma system in Washington State. Our previous studies have shown that inclusive trauma systems (such as the one in Washington State) reduce in-hospital mortality over time.[19-22] However, there are no long-term outcome measures in these studies. In our current study, while inpatient mortality decreased over the study period, there was no decrease in postdischarge mortality and, in fact, postdischarge cumulative mortality increased over time in this inclusive trauma system. Short-term examination of mortality may not be sufficient in trauma patients because we have shown that long-term mortality of trauma patients is far higher than expected.

Previous studies have evaluated long-term mortality in trauma using the experience of level 1 trauma centers.[7-9] However, the demographic characteristics of patients treated at level 1 trauma centers differ from those of patients treated at lower-level trauma centers. Our study included the entire trauma population for the state including those treated at Harborview Medical Center, the sole level 1 trauma center in Washington State. The inclusion of all patients is important in assessing long-term outcomes from trauma patients, especially in the elderly who tend to be hospitalized at local and not regional centers.

Discharge to a skilled nursing facility was associated with a higher risk of death following discharge in all age groups compared with those discharged home without assistance. This hazard ratio was greatest for the age group of 31- to 80-year-olds. Discharge to a skilled nursing facility was one of the most important independent predictors of long-term mortality in our study. While we adjusted for functional status at discharge, head injury severity, injury severity at admission, mechanism of injury, Charlson comorbidity index score, and length of stay, we were limited by the retrospective nature of the study. There are significant differences between patients discharged to a skilled nursing facility and those discharged to an inpatient rehabilitation facility. In addition, different hospitals within the state also have different criteria for skilled nursing facility or rehabilitation admission. There was a higher proportion of older trauma patients that were discharged to a skilled nursing facility than the 11% reported by Legner et al[23] for Washington State patients older than age 65 years and hospitalized for abdominopelvic operation. Moreover, some patients may have had their acute injury while they were residents of a skilled nursing facility, and therefore, were more likely to return to the same facilities. Our database did not identify the preinjury location of patients.

Despite the above limitations, our results indicate that skilled nursing facility discharge status may at least be a marker for significantly higher risk of subsequent mortality and may be the focus for future research and intervention, especially in the age group of 31- to 80-year-olds. There are significant differences in physical therapy and occupational therapy for patients in rehabilitation programs compared with patients at skilled nursing facilities, even when comparing similar demographic characteristics and medical complexity.[24] Other studies have also demonstrated an increased risk of mortality following skilled nursing facility discharge. After adjusting for surgical patient demographics and surgical and hospital characteristics, the odds of death at 1 year for patients older than age 65 years undergoing abdominopelvic operations was 3.5 times higher for those discharged to a skilled nursing facility compared with those discharged home.[23] Another study examining the long-term outcome of intensive care unit survivors demonstrated that discharge to skilled care facilities was associated with a higher mortality at 6 months compared with controls.[25] Despite increases in federal regulations intended to improve skilled nursing facility care, there has been insufficient impact on quality or public reputation.[26] Further investigation is needed to determine if more health clinician oversight, funding, or rehabilitation therapy is needed to improve the care of the patients at skilled nursing facilities following discharge for injury. Establishing a quality assurance data requirement to compare outcomes of skilled nursing facility patients across the country and establishing best practice guidelines may make improvements in long-term care facilities. Future research in surgical patients should focus on outcomes longer than the standard reporting of 30-day mortality because we may be seeing a downwind shift in mortality from improvements in the acute care period. Interventions should be aimed at improving the care of the injured patient following discharge from the hospital and narrow the gap in outcomes for those patients discharged to skilled nursing facilities.

Author Contributions: Dr Davidson had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Davidson, Hamlat, Koepsell, Jurkovich, Arbabi.
Acquisition of data: Davidson, Hamlat, Arbabi.
Analysis and interpretation of data: Davidson, Hamlat, Rivara, Koepsell, Jurkovich, Arbabi.
Drafting of the manuscript: Davidson, Hamlat, Jurkovich, Arbabi.
Critical revision of the manuscript for important intellectual content: Davidson, Rivara, Koepsell, Jurkovich, Arbabi.
Statistical analysis: Davidson, Koepsell, Arbabi.
Administrative, technical, or material support: Hamlat, Rivara, Jurkovich, Arbabi.
Study supervision: Rivara, Koepsell, Jurkovich, Arbabi.
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