Predictors of Postacute Mortality Following Traumatic Brain Injury in a Seriously Injured Population

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Background: **Traumatic brain injury (TBI) is a primary cause of injury mortality in developed countries but less is known about the impact of TBI on postacute mortality in large study populations. This study investigates the rate and predictors of postacute mortality (1–9 years after the initial injury) of severely injured persons with TBI in the Province of Ontario from April 1, 1993 to March 31, 1995.**

Method: **Cases were identified (n = 2,721) from the Ontario Trauma Registry Comprehensive Data Set based on lead trauma hospitals in the province which also provided data on predictors. Severely injured patients (n = 557) who had lower extremity injuries during the sample time period formed a control population.**

Results: **Poisson regression modeling showed that having a TBI was a significant predictor of premature death controlling for age and injury severity. Age, the number of comorbidities, injury severity, mechanism of injury, and discharge destination were significant predictors in the multivariate analyses for the TBI population.**

Conclusions: **This research quantifies the elevated risk of premature death in the postacute period for seriously injured adults with TBI and identifies factors most associated with highest mortality rates in this population.**

Key Words: **Brain injury, Mortality, Trauma.**

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Persons with traumatic brain injury (TBI) are at an increased risk for a premature death. TBI is a primary cause of mortality in Canada, especially among young men, where published estimates of head injury associated death are 21 per 100,000.[1] TBI also accounts for one-third of injury deaths in the United States.[2] This constitutes a major health problem.[1–4] Further, while a significant proportion of head injury deaths occur a short time after the injury, a person with TBI who recovers during this acute period may still have a substantially reduced life expectancy and poor outcome.[5–7] This, however, has not been studied in large trauma populations.

Decreased life expectancy in the postacute period after TBI has been documented in populations of war veterans and also in persons discharged from rehabilitation hospitals and single tertiary care centers.[8–18] Recently, this has been shown in two population-based studies.[19,20] In terms of predictors of postacute mortality, age at time of injury and time since injury have been shown to be important.[8,11,12,14,19] Variables relating to injury severity—Injury Severity Scores (ISS), location of lesion, posttraumatic amnesia—that have been useful predictors of acute mortality appear to be poor predictors during the postacute period. Among the strongest predictors of postacute mortality are preexisting comorbid conditions such as psychosocial and psychiatric problems[5,8,11] and epilepsy.[9,15–18] Poor scores on functional measures[5,8,11,13,15] (mobility, eating, or grooming, for instance) have also been found to be significant predictors of premature death. Poor mobility at discharge, for instance, has been shown to more than double standard mortality ratios.[14]

There is evidence that the causes of death in persons with TBI who survive beyond the acute phase may be different from those in the general population.[8,13–15] This has been demonstrated even in cases when no differences were found in mortality rates. The causes of death in persons with TBI include cardiorespiratory disease, circulatory diseases, and chronic coma sequelae. Interestingly, there have been suggestions of a link between walking and cause of death as many of the fatalities of TBI patients may be due to a more sedentary lifestyle.[8] For example, Shavelle et al.[15] found that estimates of mortality from cardiovascular or respiratory diseases varied inversely with mobility (attaining much higher values in those with greater levels of restriction).

These studies have provided important information. Studies of war veterans and selected rehabilitation samples, however, may not be generalizable to those injured in the general population. Current population based studies have had a limited follow-up period (1 year)[19] or limited power to

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detect significant differences as a result of few deaths in the postacute period.[20] In addition, there is a need for more studies on larger populations with longer follow-up periods.

Few studies have included control populations in the study of postacute mortality. The one study that has used such an injury control group to compare mortality rates was a study of Korean and WWII veterans. Corkin et al.[9] found no differences between brain injured and peripheral nerve injured controls in their study, which would corroborate more recent suggestions. However, this result must be interpreted with some caution because there is no mention of how well matched the two groups were in their level of mobility, or whether this variable was taken into consideration at all. The sample size used in this study (n = 190) was also among the lowest of previous studies.

The present study investigated the rate of postacute mortality—that is, mortality 1 year or more after the initial injury—in a large population of severely injured persons. This study used a population-based registry that included all cases of severe TBIs from all major trauma centers in the Province of Ontario, Canada with a 9-year follow-up period. Standardized mortality rates (SMRs) were examined for a number of predictors of mortality including discharge status that has not been considered in previous research. An identification of higher risk profiles can provide the basis for more effective postdischarge care to improve outcomes.

The TBI population was compared with a large population of persons who experienced low-extremity trauma during the same period. This comparison would analyze whether mortality rates and factors that predict mortality are related to effects of TBI per se, or whether they are related to complications that may be common to other types of severe trauma.

PATIENTS AND METHODS

Subjects

The study used a retrospective cohort design. Eligible participants who had a TBI between April 1, 1993 and March 31, 1995 were identified in the Ontario Trauma Registry (OTR). All participants were 15 years of age or older at the time of injury, and all had ISS over 12 with the following DRG International Classification of Diseases—9th Rev. (ICD-9) codes for head injury: 800, 801, 803-804, and 850-854. These cases were compared with another cohort of patients identified by the OTR during the same time period as having a lower extremity injury with no head injury involvement (ICD codes: 820-829, 835-838, 843-845, 890-897, 904, 916-917, 924, 928, 945, 956). The reason why lower extremity injuries were chosen as a comparator for head injuries was because there was less chance of overlap, that is, less chance of having subjects who had injuries at both sites. By having an additional trauma reference group in addition to the general population, we can assess the relative contribution of the TBI in relation to another trauma injury group.

Data Sources

The data for the project was built by linking the OTR and the Registered Persons Data Base (RPDB). The OTR was developed to provide comprehensive, accurate, and timely population-based information about injury in the Province of Ontario. The database itself identifies, describes, and quantifies traumatic injury and death including risk factors and type of injury. It was also designed to provide a scientific basis to facilitate injury prevention programs, to evaluate preventive measures and legislative changes, and to aid in decisions regarding resource allocation.[21]

The OTR consists of two levels of detail: the Minimum and Comprehensive Data Sets (MDS and CDS). The MDS includes information on all patients admitted to acute care hospitals in the province as a result of injury. This data set provides population-based estimates of people province-wide for all levels of injury severity. The CDS is a subset of the MDS containing records for injuries with an ISS greater than 12. It contains much more information including provincial health card numbers that can be used to link data from death registries. In addition, it provides more detailed information on severe injuries and fatalities from the 12 specialized lead trauma hospitals located throughout the province.

The RPDB from provincial health insurance records was used to confirm death in persons with TBI and with a lower extremity injury. The RPDB is a database containing basic demographic data on all residents of Ontario with a health card number. Included in the RPDB is the date of death if the person is deceased. Mortality data from OTR was inappropriate because it contains information on deaths before hospital admission as well as deaths occurring during hospitalization. Thus, this data set does not capture postacute death. It was therefore necessary to rely on the RPDB for the outcome measure in this study.

Data Collection

Data from the RPDB was merged with the OTR using provincial health insurance card numbers, an identifier that was common to both datasets. This was performed by the staff at the Institute for Clinical Evaluative Sciences who are one of the provincial entities that can conduct this merge using a confidential identifier. Personal identifiers were removed once the merge was completed.

Variables

Baseline information about study participants was obtained from the OTR. Study variables were classified as preinjury, injury, or postinjury categories. Preinjury sociodemographic variables included age at time of injury (stratified into 5-year intervals for SMR analysis), gender, and rural versus urban dwelling (based on postal code). The number of comorbidities at time of injury, including the presence of mental health diagnoses was also categorized as preinjury. These were identified through discharge abstract codes.

Variables at time of injury included the mechanism of injury (motor vehicle and other transportation crashes, falls, and "other") which was derived from E-codes. The ISS was also used, based on the highest Abbreviated Injury Scale (AIS) score[22] during acute stay in hospital. The ISS[23] is an index of overall severity useful for persons sustaining multiple injuries. In cases where no AIS score was available, an AIS score was assigned using the Glasgow Coma Scale (GCS) score based on expert review: GCS values less than 8, from 8 to 12, and 13 or greater were assigned MaxAIS values of 4, 3, and 2, respectively. GCS scores were not, however, used as a variable because it was incomplete across the registry.

For analyses examining mortality in TBI cases only the AIS score for the head and neck was used to provide a measure of TBI severity. An AIS score of <3 was considered mild, 3 was considered moderate, and >3 was considered severe. This coding system has been used by other investigators.[19] For the purpose of our analyses, we examined AIS scores by each level and then in the multivariate examined severe injuries versus moderate or severe since we anticipated small numbers of mild cases leading to unstable estimates. The presence of comorbid mental health problems, including any substance abuse present after the injury, was derived from the ICD codes. Psychiatric comorbidity was also examined independently and derived from ICD codes (ICD 290-319) as it is considered a major comorbidity in this population and associated with earlier death.

Postinjury variables included whether injured persons were sent home or to some other location after discharge (other hospital, nursing home, etc.), and whether the visit to hospital for the injury was due to a previous crash that required admission to a trauma center.

Other potential variables that were available in the database such as the GCS, and the Ranchos Los Amigos Score were considered for the analyses. However, they were not

Table 1 Poisson Univariate Regression for Predictor Variables for Postacute Mortality, TBI, and Low-Extremity Injury Groups Combined

Variable	Category	n	Observed	Expected	SMR	χ^2	*df*	p Value
Injury type	TBI	2,721	524	180.54	2.90	3.95	1	0.046
	Lower extremity	557	67	29.63	2.26			
Preinjury variables								
Age (yrs)	15–19	356	15	1.74	8.62	70.75	15	<0.0001
	20–24	407	*	*	*			
	25–29	378	13	2.75	4.73			
	30–34	327	18	3.17	5.68			
	35–39	319	25	4.46	5.61			
	40–44	251	29	5.2	5.58			
	45–49	212	27	6.78	3.98			
	50–54	174	26	8.9	2.92			
	55–59	168	32	13.74	2.33			
	60–64	142	58	17.54	3.31			
	65–69	146	69	24.22	2.85			
	70–74	136	62	33.5	1.85			
	75–79	107	79	31.3	2.52			
	80–84	94	81	30.24	2.68			
	85–89	43	36	19.18	1.88			
	90+	17	*	*	*			
Gender	Female	973	180	66.12	2.72	0.28	1	0.598
	Male	2,305	411	144.05	2.85			
Postal code	Rural	861	143	49.43	2.89	0.13	1	0.715
	Urban	2,300	434	115.42	3.76			
Comorbidities	0	2,602	392	155.17	2.53	28.19	2	<0.0001
	1	463	108	36.35	2.97			
	2 or more	213	91	18.64	4.88			
Psychiatric comorbidity	Yes	277	62	13.45	4.61	13.98	1	0.0002
	No	3,001	529	196.72	2.69			
Injury variables								
Mechanism of injury	Falls	763	308	98.53	3.13	12.54	2	0.002
	MVC/related	2156	232	97.27	2.39			
	Other	359	51	14.37	3.55			
Postinjury variables								
Discharge Status	Home (with support)	1,783	207	103.20	2.01	47.67	1	<0.0001
	Other	1,495	384	106.00	3.62			
Readmission	Yes	276	31	11.17	2.78	0.01	1	0.936
	No	3,002	560	199.00	2.81			

* Suppressed because of small cell size.

used in the modeling because of a large number of missing observations.

Mortality

Postacute death was defined as death 1 year or more after discharge. The RPDB provided the date of death. The length of follow-up was until December 31, 2002 providing up to 9 years of follow-up.

Analysis

Descriptive analyses were first employed to characterize the study sample and to generate frequencies of causes of death of deceased participants. Using a Poisson regression, we estimated the SMR and compared them to observed SMRs from published death rates to examine which (univariate) baseline variables affected the SMR.

Poisson regression analysis was also used to model risk of death compared with the expected number of deaths during the time of exposure. This was performed by using standard methods to calculate the probability of death for the time of exposure to death from the published death rate. The time of exposure to death was analyzed to be the interval beginning when the study participant was discharged from hospital care to the time of death. If the person did not die, time of exposure ended at the end of the data collection year. The GENMOD procedure in SAS (Version 8.02) was used to carry out two sets of analyses: one including both TBI cases and a comparison group and one just with TBI cases that included more specific TBI injury measures. The rationale for comparing cases and controls was to test for the effect of the TBI versus another trauma population controlling for factors related to postacute mortality. For the multivariate analyses,

Table 2 Univariate Regression Analyses for Predictor Variables of Postacute Mortality, TBI Group Only

Variable	Category	N	Observed	Expected	SMR	χ^2	*df*	*p* Value
Preinjury variables								
Age (yrs)	15–19	297	12	1.45	8.28	62.47	15	<0.0001
	20–24	337	*	*	*			
	25–29	304	11	2.23	4.93			
	30–34	254	15	2.49	6.02			
	35–39	259	21	3.62	5.80			
	40–44	212	27	4.33	6.24			
	45–49	169	22	5.24	4.20			
	50–54	143	20	7.4	2.70			
	55–59	142	29	11.61	2.50			
	60–64	126	52	15.67	3.32			
	65–69	127	60	20.98	2.86			
	70–74	114	51	27.68	1.84			
	75–79	94	75	26.14	2.87			
	80–84	89	77	28.82	2.67			
	85–89	39	*	*	*			
	90+	15	*	*	*			
Gender	Female	790	160	56.3	2.84	0.747	1	0.100
	Male	1,931	364	124.24	2.93			
Postal code	Rural	687	115	38.28	3.00	0.15	1	0.696
	Urban	1,947	398	138.00	2.88			
Comorbidities	0	2,167	355	135.47	2.62	23.62	2	<0.0001
	1	373	94	30.22	3.11			
	2 or more	181	75	14.83	5.06			
Psychiatric comorbidity	Yes	220	47	11.08	4.24	6.43	1	0.011
	No	2,501	477	169.00	2.82			
Injury variables								
Maximum head AIS	1	103	22	7.02	3.13	16.26	6	0.001
	2	934	123	53.84	2.28			
	3	764	101	38.57	2.62			
	4	517	143	41.75	3.43			
	5	402	135	39.34	3.43			
Mechanism of injury	Falls	667	283	93.07	3.04	5.22	2	0.074
	MVC	1,742	196	75.19	2.61			
	Other	302	45	12.27	3.67			
Postinjury variables								
Discharge status	Other	1,238	341	91.06	3.74	45.65	1	<0.0001
	Home (with Support)	1,483	183	89.47	2.05			
Readmission	Yes	218	25	9.15	2.73			0.753
	No	2,305	499	171.39	2.91	0.1	1	

* Suppressed because of small cell size.

comparisons to a referent category are made for each variable. This parametric model is used instead of the Cox proportional hazard model since the Cox model assumes a proportional hazard function and in effect estimates an underlying baseline hazard with fairly sparse data compared with this parametric model which uses the entire population of Ontario to estimate the baseline hazard function given age and gender.

RESULTS

A total of 3,278 cases meeting criteria for injuries were found in the CDS during a 2-year period. TBI cases totaled 2,721, and the lower extremity cases totaled 557. The TBI group, typical of this population, was predominantly men (71%), as was the case for the lower extremity group (67%). Persons with TBI made up a lower percentage of injuries sustained under the age of 40 (53% vs. 60%), but a higher percentage over the age of 70 (13% vs. 8%). In the TBI group, 25% of injuries were due to falls and 64% to motor vehicle crashes (MVCs). In the lower extremity group, 17% were due to falls and 73% to MVCs.

Univariate Comparisons for Injury Groups Combined

Effects of variables of the TBI and lower extremity injury groups combined are shown in Table 1. The two sites of injury are combined in this analysis to provide basic descriptive data. A comparison of SMRs showed that mortality was significantly higher in the TBI group (2.90 vs. 2.26, $p = 0.046$). The only preinjury demographic variable that significantly affected mortality rates was age (SMR ranges from 2.09 to 8.62, $p < 0.0001$), with persons less than 50 years of age generally having the higher than expected mortality rates. There were no differences in the SMR for gender (women = 2.72, men = 2.85), or whether they lived in a rural or urban setting (2.89 vs. 3.76). The presence of a comorbidity also was related to increased mortality, and there was an especially sharp increase with multiple comorbidities (none = 2.53, one = 2.97, more than one = 4.88; $p < 0.0001$). The presence of a psychiatric condition alone almost doubled mortality rates (2.69 vs. 4.61), where the SMR was similar to when there were multiple comorbidities.

There were a number of injury-related variables that significantly affected mortality rates. Higher ISS scores were

Table 3 Final Poisson Multivariate Model of TBI Cases and Controls Combined

Variable	RR	Lower CI	Upper CI	χ^2	*df*	*p* Value
Intercept	3.5601	1.9336	6.5548			
Case						
Control	1.0000	1.0000	1.0000	7.4400	1.0000	0.0064
TBI	1.6651	1.1543	2.4020			
Age (yrs)						
15–19	1.0000	1.0000	1.0000	110.6800	15.0000	<0.0001
20–24	0.2395	0.0870	0.6593			
25–29	0.4856	0.2308	1.0219			
30–34	0.6219	0.3131	1.2353			
35–39	0.5705	0.3002	1.0842			
40–44	0.5467	0.2924	1.0221			
45–49	0.3877	0.2058	0.7304			
50–54	0.2742	0.1448	0.5193			
55–59	0.2053	0.1107	0.3807			
60–64	0.2998	0.1688	0.5321			
65–69	0.2496	0.1420	0.4389			
70–74	0.1574	0.0887	0.2794			
75–79	0.1995	0.1137	0.3500			
80–84	0.2003	0.1137	0.3529			
85–89	0.1269	0.0682	0.2361			
90+	0.1847	0.0894	0.3816			
No. comorbidities						
0	1.0000	1.0000	1.0000	37.7200	2.0000	<0.0001
1	1.3144	1.0450	1.6533			
≥2	2.2883	1.7563	2.9811			
Psychiatric disorder						
No	1.0000	1.0000	1.0000	3.1400	1.0000	0.0762
Yes	1.7695	0.9416	3.3251			
Mechanism of injury						
Falls	2.6161	1.5457	4.4278	13.5300	2.0000	0.0012
MVCs	1.0000	1.0000	1.0000			
Other	1.0945	0.4385	2.7319			
Discharge status						
Home (with support)	1.0000	1.0000	1.0000			
Other	1.8957	1.5950	2.2529	52.7300	1.0000	<0.0001

significantly associated with postacute mortality ($p < 0.05$). Persons who were injured by MVCs had a lower rate of mortality compared with those who were injured from falls or other types of injuries (2.39, 3.13, and 3.55 respectively; $p = 0.0019$). For the postinjury variables, there was only a significant increase in mortality in cases for injured persons discharged to places other than their homes (2.01 vs. 3.62; $p < 0.0001$), presumably to some postacute rehabilitation or long-term care facility. There were no differences in cases where the hospital visit was a readmission (2.78 vs. 2.81).

Univariate Comparisons for the TBI Group Only

Factors affecting mortality in the TBI group alone (Table 2) were very similar to those in the combined analysis: There were significant differences in mortality for different age groups. Again, there was generally higher mortality for those under the age of 50 compared with the expected death rates. However, there were no differences in the other preinjury variables of gender (women = 2.84, men = 2.93), or urban or rural setting (3.00 vs. 2.88).

For the injury-related variables, there was an increase in mortality if there was one or more comorbidities identified at the time of injury (none = 2.62, one = 3.11, more than one = 5.06, $p < 0.0001$). Also the presence of psychiatric disorder increased risk of death (2.82 vs. 4.24, $p = 0.0112$). Unlike the combined analysis, there were only marginal differences in the mechanism of injury (MVCs = 2.61, falls = 3.04, other = 3.67, $p = 0.074$). Higher ISS scores coded as a continuous variable (not in Table) were also associated with postacute mortality ($p < 0.05$). One variable that was examined only for the TBI group was the highest MaxAIS for the head and neck area. There were significant differences in SMR at different AIS levels ($p = 0.001$) with highest mortality rates among the most severely injured.

Finally, there were significantly higher SMRs for persons with TBI who were discharged to a location other than their homes (2.05 vs. 3.74, $p < 0.0001$). However, those who were readmitted to hospital after discharge did not have a higher mortality than those who were not readmitted (2.73 vs. 2.91).

Modeling Using Poisson Regression

Using forward stepwise regression, there were two final models for the analysis; one for cases and controls combined and one for TBI cases only that included variables significant at the 0.05 level. In the first model for cases and controls (Table 3), the variables that contributed were type of case, age, mechanism of injury, number of comorbidities, presence of a psychiatric disorder, and discharge status. The overall increase risk of mortality for cases and controls combined was 2.95. There was an increased risk of mortality for: cases versus controls, being discharged somewhere other than home with support, the mechanism of injury being a fall or other crash compared with a motor vehicle crash, and having the presence of a psychiatric condition. There is a trend toward an increased mortality rate for the younger age categories and for the greater number of preinjury comorbid conditions. In the second model for TBI cases only (Table 4), there is an overall increase in mortality rate by 4.28 when the variables age, number of comorbid conditions, discharge status, mechanism of injury, and maximum head injury AIS score are entered. The mechanism of injury with the highest increase in mortality is other injuries, followed by falls and then motor vehicle or transportation-related injuries. There is also a trend toward increased mortality rates for the younger age groups, for the greater number of preinjury comorbid conditions and for the higher maximum AIS for the head injury. The ISS score was not retained in the final model. As in the model for cases and controls, the mortality rate increases if one is discharged somewhere other than home.

Table 4 Final Multivariate Model for TBI Cases Only

Variable	RR	Lower CI	Upper CI	χ^2	*df*	*p* Value
Intercept	4.90	2.74	8.76			
Age (yrs)						
15–19	1.00	1.00	1.00	62.47	15	<0.0001
20–24	0.25	0.08	0.79			
25–29	0.55	0.24	1.24			
30–34	0.70	0.33	1.50			
35–39	0.61	0.30	1.25			
40–44	0.66	0.33	1.31			
45–49	0.43	0.21	0.86			
50–54	0.28	0.14	0.57			
55–59	0.23	0.12	0.46			
60–64	0.33	0.17	0.62			
65–69	0.26	0.14	0.49			
70–74	0.17	0.09	0.32			
75–79	0.25	0.13	0.46			
80–84	0.22	0.12	0.41			
85–89	0.14	0.07	0.27			
90+	0.22	0.10	0.49			
No. comorbidities						
0	1.00	1.00	1.00	28.51	2	<0.0001
1	1.27	1.01	1.60			
≥2	2.08	1.61	2.68			
Max AIS						
1, 2 or 3	1.00	1.00	1.00	11.26	1	.0008
4 or 5	1.37	1.14	1.64			
Mechanism of injury						
MVCs	1.00	1.00	1.00	14.38	2	<0.0001
Falls	1.33	1.09	1.64			
Other	1.36	0.98	1.91			
Discharge status						
Home	1.00	1.00	1.00	51.05	1	<0.0001
Other	1.87	1.56	2.24			

DISCUSSION

This study investigated mortality in a large population of severely injured persons in the province of Ontario, Canada and as far as we know, it presents the first Canadian data on this topic. We recognize that our data were not totally population-based as cases were derived from lead trauma hospitals. In addition, potentially important variables such as the GCS were

not complete and therefore not included in the analyses to avoid missing data. However, this severity indicator has not been as useful for predicting long-term outcomes. We also were limited to the variables routinely collected by the trauma registry, which did not include more detailed functional measures. Nevertheless, we found that the results of this more population-based study corroborate a number of previous studies. In addition, our data shows that having a TBI puts one at greater risk for death than in a control population of severely injured adults.

In agreement with some previous work, age at injury was very significant, where mortality rate was much higher than expected in the youngest persons with TBI. The SMR decreases with age because although there is a higher raw death rate among the older age groups, the ratio of the raw death rate to the expected death rate actually decreases for the older age groups. This result has been found in some other studies.[5,14] Our findings also corroborated a more consistent finding that the presence of a comorbid condition, as well as the particular presence of a psychiatric disorder, was associated with a marked increase in mortality rates.[5,8,11–13,15–19]

The AIS measure of head injury severity was a powerful predictor of mortality, in agreement with Selassie et al.[19] This result contrasts with other measures of injury severity used in previous research[5,11] which have not been strong predictors possibly because rehabilitation samples span less of a range in terms of TBI severity. Mechanism of injury was also predictive of postdischarge mortality with those in motor vehicle crashes with better outcomes. Persons who benefit from automobile insurance can access more private funded care in Ontario apart from publicly available services.[24] It is not clear whether this is a factor or that persons in motor vehicle crashes are younger. Other reports have shown the effect of insurance status.[19] Our report also highlights discharge destination as a independent predictor of postacute mortality controlling for relevant demographic and injury factors. This is a variable that needs to be investigated further as it could very well be a measure of severity of injury or be an indicator of fewer social resources to assist with home-based care. Our study benefited from a lengthy follow-up period and future research is planned on longer lengths of follow-up.

Our study findings show that serious injuries and more specifically brain injuries can lead to premature death well into the postacute period. These results profile persons most at risk that could potentially benefit from more resources when discharged from trauma hospitals.

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