Long-term Survival of Elderly Trauma Patients

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**Objective:** To evaluate the long-term survival and factors that influence survival among a cohort of elderly trauma patients compared with an uninjured cohort.

**Design:** A retrospective cohort analysis.

**Data Sources:** Health Care Finance Administration, Baltimore, Md, Medicare data.

**Subjects:** A cohort of elderly patients (n=9424) hospitalized for injury in 1987 was identified using Medicare hospital discharge abstract data. An uninjured comparison group (n=37787) was identified from Medicare eligibility files. For injured patients, an Injury Severity Score was generated from the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9CM) codes. For both cohorts, preexisting illness was assessed by ICD-9CM codes from Health Care Finance Administration outpatient and inpatient data files for 1986 and 1987.

**Main Outcome Measures:** Relative risk for mortality within 5 years subsequent to injury, adjusted for age, sex, and preexisting illness, using Cox proportional hazard regression.

**Results:** The injured cohort had a significantly reduced 5-year survival when compared with the uninjured group (relative risk [RR] = 1.71; 95% confidence interval, 1.66-1.77). The lower survival persisted even among patients who survived at least 3 years after injury. Coexisting disease, age, and Injury Severity Score were strong predictors of survival.

**Conclusions:** The adverse effect of trauma on survival in elderly patients is not isolated to the immediate postinjury period, but lasts years after the trauma episode. Further study is required to identify the reasons for this persistent effect of trauma on subsequent survival.

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**Geriatric Trauma** is a common problem in the United States. More than 800,000 elderly patients are hospitalized annually with injuries, and in 1991 more than 26,000 geriatric patients died as a direct result of trauma. The economic impact of trauma care is enormous; geriatric patients account for almost one third of all trauma-related expenses.

The magnitude of this problem is expected to increase. Representing 12.5% of the population, the 30 million Americans aged 65 years and older will increase to 52 million by the year 2020. While the incidence of injury is lower in the elderly population than in any other age group, older patients are more likely to die or have prolonged hospitalization as a result of their injuries. The elderly in-hospital case-fatality rate is 15% to 30% compared with a 4% to 8% case-fatality rate for younger trauma patients. Elderly persons account for a disproportionate number of deaths due to injury.

Most research of injury outcomes in elderly patients has addressed short-term measures only, including in-hospital mortality, days in the intensive care unit, and functional status at discharge and at 1 year. Research into the long-term survival of injured elderly patients has been limited to small, uncontrolled, retrospective cohorts, mostly from selected patient populations admitted to trauma centers. While some researchers have suggested there is little or no long-term decrease in the survival of elderly patients once they are discharged from the hospital, others suggest that the detrimental effects of injury last for years. To our knowledge, there have been no population-based studies of long-term survival among geriatric trauma patients compared with an uninjured cohort, and the research to date has not been of adequate size or scope to answer this controversy.
DATA SOURCE

The data for this study were obtained from public-use Medicare files acquired from the Health Care Financing Administration (HCFA), Baltimore, Md. Individuals in the Medicare tracking system are followed up by a unique file identifier. The cohort at risk of injury consisted of all Medicare-eligible residents in the state of Washington at least 66 years of age in 1986. Members of the cohort injured during the 1987 calendar year were identified from the expanded, modified Medicare Provider Analysis and Review (MEDPAR) hospital discharge data. These data contain records of all Medicare beneficiaries using hospital inpatient services and are uniformly collected for all Medicare beneficiaries discharged from acute-care hospitals. Data include patient demographics, type of admission, length of hospital stay, discharge status, and diagnoses and procedure codes using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9CM).

DETERMINATION OF EXPOSURE

The injured cohort of the study population was defined by a principal hospital discharge diagnosis for trauma (ICD-9CM codes 800-959) in 1987, excluding the following ICD-9CM diagnoses: late effects (ICD-9CM codes 905-909); foreign bodies (ICD-9CM codes 930-939); and complications (ICD-9CM code 958). To avoid double counting of interhospital transfers, only the first hospital admission for trauma in 1987 was included in the analysis.

Uninjured members of the cohort were identified from the population at risk and not hospitalized for a trauma-related injury during 1987 when cross-referenced to the MEDPAR data. Four uninjured persons were frequency matched for sex and age (within 5-year strata) for each injured member of the cohort.

DETERMINATION OF INJURY SEVERITY

The Injury Severity Score (ISS), for each person in the exposed group was determined using a computer mapping program (ICD-MAP). While the ICD-MAP conversion process does not provide an exact correspondence with the ISS calculated directly from the medical record, validation studies have shown that the ICD-MAP does provide good information on relative injury severity. To improve reliability of the ISS as a determinant of injury severity, interval grouping (scores of 1-8, 9-16, 16-24, 25-40, 41-49, and 50-66) was used.

COMORBIDITY

The presence of preexisting conditions was determined for both the exposed and nonexposed cohorts using inpatient and outpatient data sources. Inpatient data was obtained from the 1987 MEDPAR hospital data set. To more completely identify comorbid conditions, outpatient data were obtained from the Standard Analytical Outpatient File for the year 1986. A comorbidity index (developed by Charlson et al) was used to account for the effects of multiple preexisting conditions on survival. As their results showed, this weighted index accounts for the seriousness and number of the preexisting conditions and has been previously validated in studies of mortality. Thus the effect of co-morbid illness on mortality can be accounted for in the analysis. The comorbid index used for this analysis is available from us on request. Statistically adjusting for the comorbid conditions in the Cox proportional hazards analysis is a way of controlling for the fact that the elderly patients with injuries had an increased prevalence of comorbid conditions at the time of injury.

MEASUREMENT OF OUTCOME

The long-term outcome measure of interest was the 5-year survival of the injured cohort compared with the uninjured cohort. Dead injured and uninjured patients were identified using the Medicare Mortality Information System, which identifies the death of a beneficiary through a uniform reporting system. The Medicare mortality data are cross-checked with Social Security system records to assure accuracy in reporting date of death. The system identifies all known deaths irrespective of location of death or residence of the beneficiary at time of death.

DATA MANAGEMENT AND ANALYSIS

Four separate data sets for the years 1986 through 1992 were linked for this study: MEDPAR hospital discharge data on injuries and comorbid conditions; Standard Analytical Outpatient File for comorbid conditions; Medicare eligibility file for selection of the cohort; and the Medicare Mortality Information System file for outcome. These files were linked using the patient’s unique file identifier. For the injured group, the distribution of injury severity, length of hospital stay, and date of discharge were determined. Cumulative incidence of hospitalization for trauma during 1987 was calculated using the Medicare enrollee data for the state of Washington.

Using the Cox proportional hazards regression, survivalship was compared for the injured and uninjured cohorts, adjusted for age, sex, race, and the comprehensive index of comorbidity. To investigate the long-term survival of the injured cohort, the survival analysis was repeated with various start times (1 month, 6 months, 1 year, and 3 years after injury). These secondary analyses of survival were performed to examine the long-term effects of injury among those who survived the more immediate effects of trauma.

This study was approved by the University of Washington Human Subjects Investigation Review Board, Seattle, and the Office of Data Release, Statistics, and Data Management of the Department of Health and Human Services, HCFA. All data used in this study were obtained from the public-use files provided by the Department of Health and Human Services, HCFA.

To address these questions, we performed a population-based retrospective cohort analysis comparing the survival of elderly persons who required hospitalization for injury during 1987 in the state of Washington with the survival of an uninjured cohort of comparable age. Using available data, we were able to statistically adjust for comorbid conditions within this population. Hence, we were able to isolate and study the long-term detrimental effects of injury among elderly persons.
patients (3.4%) with an ISS of between 16 and 40, and only 5 (0.1%) with an ISS of greater than 40.

SURVIVAL

There were 382 deaths during the index hospitalization for trauma, resulting in a hospital case-fatality rate of 4.1%. The hospital case-fatality rate varied markedly with injury severity. More than half (55.9%) of those with an ISS of 25 or greater died in the hospital, compared with 13.4% for those with an ISS between 16 and 24, 4.0% for those with an ISS between 9 and 15, and only 2.8% of those with an ISS less than 9.

The risk for death in the injured compared with the uninjured cohort increased with age, injury severity, and the presence of preexisting comorbid conditions (Table 2). Persons between 72 and 76 years old were almost 50% more likely to die compared with those between 65 and 71 years old, while persons older than 97 years were almost 10 times more likely to die. Preexisting illness was strongly related to survival as well. Persons with a Charlson index rating of 1 to 3 were almost twice as likely to die within 5 years, while those with the most preexisting illness (Charlson index 10-13) were more than 8-fold more likely to die than those without preexisting illness. Men were about 44% more likely to die compared with women in the same 5-year age strata.

The overall 5-year risk for death among the injured cohort relative to the uninjured cohort was 1.7 (95% confidence interval [CI], 1.7-1.8; adjusted for age, sex, race, and comorbid conditions). The difference in death rate
for the injured cohort compared with the uninjured cohort was greatest in the initial period after injury (Figure 1).

Survival was related to injury severity. The 5-year risk for death was greatest among those with more severe injury. Patients with an ISS greater than 25 were almost 6-fold more likely to die than the uninjured cohort. While risk for early death increased with the degree of injury severity, this effect was not constant during the entire 5-year period. Persons in the 3 less severe ISS categories continued to have a lower survival throughout the follow-up period. However, persons in the most severely injured groups had some plateauing of their survival curves after the immediate posttrauma period, a finding particularly seen in those patients with an ISS greater than 25 (Figure 2).

When the analysis was limited to patients who survived various amounts of time after injury, the injured cohort continued to demonstrate worse survival than the uninjured cohort. The relative risk for death (adjusted for age, sex, race, and comorbid conditions) among those who survived 30 days after injury was 1.6 (95% CI, 1.5-1.6), while among those who survived 6 months, 1 year, or 3 years, the relative risk (RR) for death was 1.4 (95% CI, 1.4-1.5), 1.4 (95% CI, 1.4-1.5), and 1.4 (95% CI, 1.3-1.4), respectively.

**COMMENT**

This is the largest study to date that examines the long-term outcome of an injured geriatric population. It demonstrates that elderly patients have a markedly increased risk for death following injury and that, even among those who survive for extended periods after injury, the risk for death remains high compared with the noninjured elderly population.

Our results differ from previous reports studying the outcomes of elderly victims of trauma, which have been restricted to the experience of a few trauma centers and limited by the duration of follow-up. The large sample size in our study enabled detection of effects that may have been too small to detect in previous studies. In one small study limited to elderly patients after burn injury, Manktelow and colleagues14 found comparable life expectancy among patients who survived beyond 1 year relative to uninjured persons. In another study of 63 survivors of blunt trauma older than age 65 years followed up to 38 months after hospital discharge, DeMaria et al15 found that 89% of patients returned home after injury, and thus concluded that aggressive support of the elderly trauma patient was justified. However, their study did not control for comorbid status, and was limited to selected patients within a single trauma center. A strong point for this study was our ability to control for the fact that elderly patients with injuries were more likely to have comorbid illness, such as liver or renal disease. The results demonstrate that, above and beyond the increased mortality associated with comorbid illness, injury is associated with decreased long-term survival among elderly patients.

Injured elderly patients not only had a higher hospital and short-term mortality compared with the uninjured cohort but, once discharged from the hospital, also had a persistently increased mortality rate. Unlike other studies that examined the outcomes of elderly trauma patients,6,7 we found that the adverse effect of trauma on survival remained for an extended period after injury. The reason for this persistent negative effect on survival is unknown. It may be that, once injured, elderly patients never regain their level of preinjury health. Whether it is a direct loss of function secondary to injury, a complication of injury, or a depletion of body energy stores is unknown.

Our study differs from others because our data are derived from a wide population base, and thus represent the experience of community hospitals and trauma centers. Most other studies have been case series from trauma centers, where study subjects are likely to have a higher level of acute illness and associated mortality. As evidence of the difference between our study and those from trauma centers, the case-fatality rate of 4.1% shown in this study is strikingly lower than the 15% previously reported from our center and the case-fatality rates reported by others.

The finding in this study that preexisting illness adversely affects the long-term survival is in contrast to other studies, including one from our own institution. However, those studies included relatively few patients, were limited to trauma centers, and did not have set criteria for the identification of preexisting comorbid illness. As in other studies3,4 our study found older age to be the best
single predictor of an adverse outcome, and that sex also predicts survival.

This study has limitations. We accounted for the effects of concurrent and preexisting disease on mortality by using HCFA administrative databases to identify and statistically adjust for these conditions. A weighted index, developed by Charlson et al. and validated for use with administrative databases, was used to account for the number and seriousness of preexisting illnesses. The utility of this index can be seen by the marked association with risk for death as the comorbidity index increases (Table 2).

We also performed an additional analysis adjusting for age, sex, race, and preexisting illness in an unweighted form. This regression model, to adjust for the presence of preexisting illness in the injured and uninjured cohort, showed no appreciable difference from the analysis that solely used the weighted index. It is possible that neither model completely captured all differences in preexisting illness among the cohorts and that the poorer survival after injury is in part caused by these differences.

Although the results of this study are provocative, the findings must be qualified. The study of trauma depends on the reliability of the ISS as a useful and accurate method for quantifying injury severity. Copes and others have demonstrated that the placement of ISS values into cohort intervals groups improves the validity of the ISS as a predictor of mortality. The data used in the analysis were not collected specifically for this study. Health care providers are required to report the information used in our analysis to Medicare to receive reimbursement. Medicare data files have been used to determine incidence and risk factors for disease, mortality rates, quality of care, and treatment outcomes. The limitations of Medicare data for epidemiologic research have been described by others. Data from HCFA do not include patient identifiers and cannot be validated against medical records or other data sources such as trauma registries. Additionally, the data may be biased by the method of coding. Hospital discharge abstracts, the basis of HCFA data, are not uniformly collected by hospitals and may differ in the number, ordering, or criteria for coding of comorbid conditions. Nevertheless, many of these limitations have been minimized in this study by the careful linking of data from multiple files, cross-checking of results, and using the same data sources for the injured and uninjured cohorts.

This study demonstrates that the effect of trauma is not isolated to the immediate postinjury period but adversely affects the long-term survival of injured elderly persons. Apart from the particular medical and surgical problems associated with care of elderly patients, the adverse effects of injury on the long-term survival of the elderly trauma patient are striking. Efforts to improve outcomes of trauma in elderly patients may need to focus on their long-term care and rehabilitation in addition to care in the immediate postinjury period.

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