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Octogenarian Motor Vehicle Collisions: Injury Patterns Matter

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ABSTRACT

Introduction. Motor vehicle collision (MVC) is the second most common mechanism of injury among octogenarians and is on the rise. These "oldest old" trauma patients have higher mortality rates than expected. This study examined potential factors influencing this increased mortality including comorbidities, medications, injury patterns, and hospital interventions.

Methods. A 10-year retrospective review was conducted of patients aged 80 and over who were injured in an MVC. Data collected included patient demographics, comorbidities, medication use prior to injury, collision details, injury severity and patterns, hospitalization details, outcomes, and discharge disposition.

Results. A total of 239 octogenarian patients were identified who were involved in an MVC. Overall mortality was 18.8%. An increased mortality was noted for specific injury patterns, patients injured in a rural setting, and those who were transfused, intubated, or admitted to the ICU. No correlation was found between mortality and medications or comorbidities.

Conclusions. The high mortality rate for octogenarian patients involved in an MVC was related to injury severity, type of injury, and in-hospital complications, and not due to comorbidities and prior medications. ***Kans J Med 2022;15:22-26***

INTRODUCTION

Similar to the rest of the developed world, the average age of the population in the U.S. continues to increase. The proportion of the U.S. population aged 65 and older in 1950 was only 8% compared to 16.5% of the population in 2019, and the proportion is projected to increase to 22% in 2050.[1] Simultaneously, the proportion of licensed drivers over the age of 65 continues to rise.[2] In 2019, 20.2% of all U.S. drivers were over the age of 65 and 3.7% of the population was over the age of 79.[3,4] While the octogenarian population is less likely to be licensed to drive, older drivers are keeping their licenses longer and driving more miles.[5,6]

In 2011, the number of injury-related emergency room visits per 100 persons per year was 18.3 for persons aged 75 years and older, the highest rate for any age group.[7] Falls remained the most common mechanism of injury for this population;[8] however, motor vehicle collisions (MVCs) represented the second most common mechanism of injury leading to trauma activation among octogenarians.[5,6,9] While older drivers only accounted for 9% of all individuals injured in MVCs in 2012, they accounted for over 17% of all traffic fatalities.[2] Individuals aged 80 years and older have the highest rate of fatal crash involvement in passenger vehicles per miles driven, and are ten times more likely to die than drivers aged 25-44.[10] Many studies have commented on these "oldest old" trauma patients and have hypothesized their outcomes are dismal due to medical comorbidities,[11-14] decreased physiologic reserve,[15,16] and increased susceptibility to injury,[17-19] particularly chest injuries[20] and polypharmacy.[21] Some authors suggested frailty or fragility as the major contributing factor to poor outcomes.[6,19,22]

According to 2019 Kansas collision statistics, drivers over the age of 79 accounted for 2.0% and 5.4% of all MVCs and fatal MVCs, respectively.[23] These individuals experience poor outcomes such as longer hospital stays,[11] discharge to long-term care facilities,[24] or mortality when compared to their younger counterparts. The families of these individuals can face difficulty in deciding how aggressive they should be in continuing care to keep their loved ones alive, and their decisions are made more difficult by a lack of sound evidence to guide their decisions.

The purpose of this study was to examine the distribution of injury patterns, advanced directives, and discharge disposition of drivers and passengers, aged 80 or older, who were involved in MVCs. Further, the study sought to determine if pre-existing comorbidities and polypharmacy were associated with higher mortality in these patients.

METHODS

The trauma database and electronic medical records at an American College of Surgeons verified level-1 trauma center were used to identify individuals 80 years of age and older who were involved in an MVC and were evaluated by the trauma team between November 1, 2000 and October 31, 2010. This study included all trauma patients aged 80 years and older and are hereafter referred to as octogenarians for the sake of simplicity. A retrospective chart review was conducted to abstract the following information: patient demographics; place of collision (urban vs. rural); motor vehicle collision information; whether the patient arrived intubated or was intubated on arrival; comorbid conditions as reported by patients or family members; medications upon admission as reported by the patient, family members, or local pharmacy; Injury Severity Score (ISS) and Abbreviated Injury Scale (AIS); Glasgow Coma Scale (GCS) score; Focused Assessment with Sonography for Trauma (FAST) findings; blood transfusion requirements; individual injuries and the need for operative or procedural management; information on comfort care, advanced directives, power of attorney, and living will; intensive care unit (ICU) or wards admission; ICU length of stay; ventilatory requirements and number of ventilator days; complications; hospital length of stay; discharge destination (i.e., home, rehabilitation, or skilled nursing facility); and mortality. Legal documentation regarding end-of-life wishes (i.e., advanced directives) was not recorded routinely for patients before 2008. This study was approved for implementation by the Institutional Review Board of Via Christi Hospitals Wichita, Inc.

Data initially were summarized and stratified by survival status at discharge. Comparisons of continuous and categorical data were conducted using one-way analysis of variance and Chi-square analysis, respectively. All statistical tests were two-sided, and analyses were considered significant when the resultant p value was less than or equal to 0.05. All analyses were conducted using SPSS release 19.0 (IBM® Corp., Armonk, New York).

RESULTS

A total of 239 subjects met inclusion criteria. Of these, 45 (18.8%) died of their injuries, while 194 (81.2%) survived to discharge. An initial comparison was made between those patients who died and who survived to discharge. Patients who died were older (85.7 ± 3.4 vs. 84.2 ± 3.3 years, p = 0.005), more severely injured as shown by increased ISS (22.3 ± 15.4 vs. 9.2 ± 8.1, p < 0.001), had decreased GCS (10.8 ± 5.3 vs. 14.3 ± 2.4, p < 0.001), and were more often injured in a rural setting (64.4% vs. 47.7%, p = 0.043) than those who survived. As expected, the mortality rate was higher in those who were more severely injured (ISS > 15, mortality = 39.2%) when compared to those less severely injured (ISS = 1 to 15, mortality = 9.7%, p < 0.001).

The remaining analyses were conducted comparing mortality rate for each variable studied. Patient sex, location within the vehicle (driver vs. passenger), and vehicle ejection were not associated with increased mortality (data not shown). Mortality rate was significantly higher in those patients who were intubated in the field (64.7% vs. 15.3%) or upon arrival (69.6% vs. 13.4%), had a positive FAST examination (53.8% vs. 15.2%), or required a transfusion (40.8% vs. 13.2%; Table 1; p < 0.001).

Table 1. Comparison of mortality rates based upon presence or absence of parameter.

Parameter	Yes		No		p Value
	Number/ total	Mortality rate (%)	Number/ total	Mortality rate (%)	
Arrived intubated	11/17	64.7	34/222	15.3	< 0.001
Intubated on arrival	16/23	69.6	29/216	13.4	< 0.001
Positive FAST* examination	7/13	53.8	32/211	15.2	< 0.001
Required transfusion	20/49	40.8	25/190	13.2	< 0.001

*Focused Assessment with Sonography for Trauma

Comparisons were made for the most common comorbidities and medications voluntarily offered by patients or their family members upon admission to the hospital or updated throughout their hospitalization. Comorbid conditions evaluated included: Alzheimer's disease, cerebrovascular accident, coronary artery disease, congestive heart failure, atrial fibrillation, myocardial infarction, stenting, chronic obstructive pulmonary disease, chronic renal failure, diabetes mellitus, and hypertension. Medications evaluated included: anti-hypertensives, aspirin, beta-blockers, warfarin, diuretics, inhalers, insulin, lipid-lowering agents, oral anti-hyperglycemics, and clopidogrel. No medications or comorbid conditions were associated significantly with mortality rate (data not shown).

The mortality rates for major and minor head injuries are reported in Table 2. Surprisingly, the only major head injuries significantly associated with an increase in mortality were intraparenchymal hematoma (33.3% vs. 15.0%) and skull fracture (75.0% vs. 15.7%). This unexpected finding may have been due in part to the low number of subjects in this study that suffered major head injuries, thereby limiting statistical power. Simple concussion (29.6% vs. 11.9%, p < 0.002) and loss of consciousness (26.9% vs. 12.6%, p < 0.014) also were shown to be associated with a significant increase in mortality. Cervical (31.9% vs. 13.4%, p = 0.003) and thoracic (38.9% vs. 15.3%, p = 0.011) spine injuries, spinal injuries treated with a cervical collar (31.0% vs. 15.1%, p = 0.033), and those requiring spinal surgery (62.5% vs. 15.9%, p = 0.005) were associated with statistically significant increases in mortality (Table 3).

Table 2. Comparison of mortality rates based upon cranial injuries.

Head injury	With specified injury		Without specified injury		p Value
	Number/ total	Mortality rate (%)	Number/ total	Mortality rate (%)	
Major head injury	10/40	23.3	30/191	15.7	0.235
Intraparenchymal hematoma	6/18	33.3	32/214	15.0	0.043
Subarachnoid hemorrhage	3/14	21.4	35/218	16.1	0.707
Subdural hematoma	4/21	19.0	34/211	16.1	0.757
Skull fracture	3/4	75.0	36/229	15.7	0.016
Minor head injury	19/68	27.9	20/165	12.1	0.004
Concussion	16/54	29.6	21/177	11.9	0.002
Loss of consciousness	14/52	26.9	22/174	12.6	0.014
Facial fracture	4/11	36.4	35/222	15.8	0.092

Table 3. Comparison of mortality rates based upon spinal injuries.

Spinal injury/ treatment	With specified injury		Without specified injury		p Value
	Number/ total	Mortality rate (%)	Number/ total	Mortality rate (%)	
Spine injury	16/60	26.7	24/174	13.8	0.022
Cervical	15/47	31.9	25/187	13.4	0.003
Thoracic	7/18	38.9	33/216	15.3	0.011
Lumbar	2/10	20.0	38/224	17.0	0.682
Cervical collar	9/29	31.0	31/205	15.1	0.033
Required surgery of the spine	5/8	62.5	36/227	15.9	0.005
Spinal cord injury	2/4	50.0	38/230	16.5	0.136
Spinal cord paralysis	1/2	50.0	39/232	16.8	0.313

All thoracic injuries recorded were associated with a significantly increased mortality rate (p < 0.001, Table 4). Patients with bilateral rib fractures, cardiac injuries, sternal fractures, and patients presenting with a pneumothorax all had mortality rates greater than 50% compared to their counterparts without these injuries (< 16%).

Table 4. Comparison of mortality rates based upon thoracic injuries.

Thoracic injury	With specified injury		Without specified injury		p Value
	Number/ total	Mortality rate (%)	Number/ total	Mortality rate (%)	
Thoracic injury	23/55	41.8	19/181	10.5	< 0.001
Thoracic requiring surgery	9/18	50.0	33/218	15.1	< 0.001
Rib fracture	20/51	39.2	22/185	11.9	< 0.001
Bilateral rib fractures	6/7	85.7	36/229	15.7	< 0.001
Pulmonary	15/32	46.9	27/204	13.2	< 0.001
Pneumothorax	14/27	51.9	28/209	13.4	< 0.001
Sternal fracture	10/18	55.6	32/218	14.7	< 0.001
Cardiac	6/10	60.0	35/225	15.6	0.002

The mortality rates associated with different fractures are displayed in Table 5. Upper extremity, femur, pelvic, and pubic rami fractures were associated with statistically significant increases in mortality. A trend was found towards increased mortality in those patients suffering lower extremity and acetabular fractures.

Table 5. Comparison of mortality rates based upon fractures.

Extremity or pelvic fracture	With specified fracture		Without specified fracture		p Value
	Number/ total	Mortality rate (%)	Number/ total	Mortality rate (%)	
Upper extremity	13/44	29.5	27/190	14.2	0.015
Lower extremity	13/49	26.5	28/186	15.1	0.060
Femur	9/18	50.0	32/217	14.7	< 0.001
Pelvic	6/13	46.2	37/224	16.5	0.007
Pubic rami	3/5	60.0	40/232	17.2	0.043
Hip	3/9	33.3	40/228	17.5	0.211
Acetabular	3/6	50.0	40/231	17.3	0.075

Table 6 displays the mortality rates for patients with or without abdominal injuries. The presence of an abdominal injury was associated with an increased mortality rate (50.0% vs. 15.8%, p = 0.001); however, the only specific abdominal injury associated with an increase in mortality was a hollow viscus injury (75.0% vs. 16.5%, p = 0.018). Patients requiring abdominal surgery also had significantly increased mortality rates when compared to those patients not requiring abdominal surgery (50.0% vs. 16.4%, p = 0.007).

Table 6. Comparison of mortality rates based upon presence or absence of abdominal injuries.

Abdominal injury/ surgery	With specified injury		Without specified injury		p Value
	Number/ total	Mortality rate (%)	Number/ total	Mortality rate (%)	
Abdominal	7/14	50.0	35/222	15.8	0.001
Hollow viscus	3/4	75.0	38/231	16.5	0.018
Kidney	1/1	100.0	40/234	17.1	0.174
Liver	1/3	33.3	40/232	17.2	0.439
Spleen	3/7	42.9	38/228	16.7	0.104
Required abdominal surgery	5/10	50.0	37/226	16.4	0.007

The only in-hospital complications associated with a significantly higher mortality rate were myocardial infarction (66.7% vs. 17.6%, p = 0.012) and line infections (100% vs. 18.1%, p = 0.035; Table 7). Patients with pneumonia or acute respiratory distress syndrome had mortality rates over 35%, but these rates did not reach statistical significance when compared to uncomplicated cases.

Table 7. Comparison of mortality rates based upon presence or absence of complications.

Complication	With specified complication		Without specified complication		p Value
	Number/ total	Mortality rate (%)	Number/ total	Mortality rate (%)	
In-hospital myocardial infarction	4/6	66.7	41/233	17.6	0.012
Line infection	2/2	100.0	43/237	18.1	0.035
Pneumonia	6/17	35.3	39/222	17.6	0.072
Acute respiratory distress syndrome	3/6	50.0	42/233	18.0	0.082
MRSA infection	1/1	100.0	41/228	18.0	0.183
Urinary tract infection	3/20	15.0	42/219	19.2	0.774
Deep vein thrombosis	0/2	0.0	45/237	19.0	1.000
Delayed diagnosis	1/6	16.7	25/150	16.7	1.000

With regard to patient hospitalization, those patients admitted to the ICU and those requiring mechanical ventilation had significantly higher mortality rates than those not admitted to the ICU or ventilated (Table 8). As expected, mortality was higher in patients with advanced directives who proceeded to comfort care measures. Of note, only 117 of 239 (49.0%) of the cohort had advanced directives. Approximately one-third of the patients were discharged to home (34.7%, n = 83) with an additional 5% (n = 12) being discharged to home with home health. Forty-four patients (18.4%) died in the hospital and one additional patient was sent to hospice (0.4%) where they later died, resulting in an overall mortality rate of 18.8%. Nearly one-half of the patients (41.5%) required some form of extended care post-discharge, which included skilled nursing unit care (n = 59, 24.7%), rehabilitation (n = 20, 8.4%), nursing home (n = 14, 5.9%), assisted living (n = 5, 2.1%), or a mental health facility (n = 1, 0.4%).

Table 8. Comparison of mortality rates based upon hospitalization and advanced directives.

Parameter	Yes		No		p Value
	Number/ total	Mortality rate (%)	Number/ total	Mortality rate (%)	
Intensive care unit admission	34/109	31.2	11/130	8.5	< 0.001
Mechanical ventilation (Y)	29/49	59.2	16/190	8.4	< 0.001
Tracheostomy	12/86	14.0	33/153	21.6	0.148
Advanced directives	19/56	33.9	11/61	18.0	0.003
Comfort care	26/26	100.0	19/213	8.9	< 0.001

DISCUSSION

A population of octogenarian MVC victims was evaluated to identify factors associated with increased mortality. Older, more severely injured patients, and patients injured in a rural setting had a significantly higher mortality rate. Higher mortality rates were noted among patients who arrived intubated or were intubated shortly after arrival to the hospital. The finding of increased mortality in those requiring transfusion was in accord with that of Zhao et al.[25] Whether a patient was the driver or passenger did not affect mortality rate significantly.

These findings suggested higher mortality rates among octogenarians involved in MVCs when compared to the available literature on geriatric trauma patients.[6,13,14] Most trauma research focusing on a geriatric population use an age of 65 years as the lower inclusion.[8,9,12,14,15,20] These studies commented on the elderly population having increased mortality rates, but few studies focused exclusively on octogenarian patients. This population had a mortality rate of 18.8%, which is significantly higher than the 5 to 12% published mortality rate for geriatric patients 65 years of age or older.[9,12] Older patients had a decreased ability to tolerate thoracic injuries, and subsequently had a higher mortality.[13,14,22] This fact was likely to be true for most injuries as an increased mortality was demonstrated for head, spine, thoracic, and abdominal injuries.

Previously published studies disagreed on the role comorbidities and medications play in affecting mortality. Many studies suggested an increased mortality,[12,22] some referred to increased morbidity and prolonged hospitalization,[11,24] while others refuted comorbidities or medications as a cause of increased mortality in this population.[8,12,24] Among octogenarians involved in MVCs, no specific comorbidities were shown to correlate with increased mortality. Similarly, mortality was not found to increase in association with the use of any medications, including anticoagulants and antiplatelet therapies. One possible explanation for our finding was that individual comorbid conditions and medications were evaluated rather than the combined effect of multiple comorbidities or medications. For example, Bartolomeo et al.[21] found that anticoagulant or antiplatelet therapy, when evaluated individually, had little or no increased impact on the odds of older patients (older than 74 years) being admitted for traumatic injuries. However, the authors found increased odds for admission in patients taking antiplatelet therapy and anticoagulants in combination. Another possible explanation was that while a patient's list of prescribed medications may be readily available, obtaining information on an individual patient's compliance with these medications is difficult at best.

Despite their comorbidities and the medications a patient has been taking, the decrease in physiologic reserve has been suggested as a factor in the higher mortality rate observed.[15,16] Given that this population had a relatively high mortality rate of 9.7% in those patients with an ISS of 15 or less, any detrimental effect from comorbidity may have been overshadowed by the effect of frailty. However, this quantification was not done via direct measurement of physiologic reserve or calculation of a frailty index as this was a retrospective review and these data were not available.

This study was limited by the fact that it was retrospective. It also was limited by the fact that major injuries were observed in a limited number of the subjects. Further, while some information about living situation prior to injury can be obtained through chart review, it was possible that a percentage of the population required assistance with activities of daily living prior to the MVC that was not available through chart review. However, it was likely that the percentage of patients who required assistance with activities of daily living pre-injury was significantly less than the 41.4% of patients needing such assistance on discharge. As we could not determine with a high degree of confidence the patient's pre-injury level of functioning or requirements for daily assistance, discharge destination did not provide an objective measurement of patient return to previous functioning. But discharge destination has been suggested as a proxy measure when that is all that is available.[26]

Advanced Trauma Life Support (ATLS) continues to teach that the geriatric trauma population can return to their previous level of functioning with appropriate management.[16] This assumption was based on an accepted geriatric population of all individuals aged 65 and older. Based upon the findings of this study, this may not hold true for octogenarian trauma patients involved in MVCs. Only 34.7% of patients returned home upon discharge from the hospital, with an additional 5% returning with home health. The remainder of the patients (41.5%) required additional assistance with activities of daily living following discharge (i.e., skilled nursing unit, long-term acute care hospital, rehabilitation hospital, nursing home). When the geriatric population is defined as ages 65 and older, most of these patients may be returning to their previous level of functioning, as stated by ATLS. However, the majority of patients aged 80 and older likely either succumb to their injuries or require additional assistance upon dismissal from the hospital after presenting as a trauma activation following MVC.

A minority of the patients in this study was known to have legal documents stating their wishes for end-of-life care. However, this information was not recorded until 2008, as trauma surgeons were not trained specifically to ask for patient requests for end of life care prior to 2008. Considering these findings concerning the relationship of medical history and medications upon mortality, it may be of more significant benefit to obtain a "do not resuscitate" status and end-of-life wishes during our AMPLE history. AMPLE (Allergies, Medications, Past medical history, Last meal or other intake, and Events leading to presentation) often is useful as a means of remembering key elements of the history.

CONCLUSIONS

Octogenarian trauma patients injured as a result of MVCs are being seen with increasing frequency. These patients have an increased mortality that is not explained by underlying comorbid conditions or medications, but is related to injury pattern, setting, and hospital interventions. These factors can be predictive of mortality and discharge disposition and may prove valuable in discussing desires for level of care and interventions with patients and family.

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