Impact of Geriatric Trauma Co-Management on 1-Year Mortality in Older Adults with Multiple Rib Fractures

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ABSTRACT

BACKGROUND: Rib fractures in older adults are associated with higher morbidity and mortality. Geriatric trauma co-management programs have looked at in-hospital mortality but not long-term outcomes.

METHODS: A retrospective study of multiple rib fracture patients 65 years and older (n=357), admitted from September 2012 to November 2014 comparing Geriatric trauma co-management (GTC) vs Usual Care by trauma surgery (UC). The primary outcome was 1-year mortality.

RESULTS: 38.9% (139) were cared for by GTC. Compared to the UC, GTC patients were older (81.6±8.6 years vs 79±8.5) and had more comorbidities (Charlson 2.8±1.6 vs 2.2±1.6). GTC patients had 46% less chance of dying in 1-year compared to UC (HR 0.54, 95% CI [0.33-0.86]).

CONCLUSIONS: GTC showed a significant reduction in 1-year mortality even though patients were overall older and more comorbid. This shows multidisciplinary teams are crucial to patient outcomes and should continue to be further explored.

KEYWORDS: ribs fracture; multiple trauma; geriatric assessments; frail older adults

INTRODUCTION

The United States (US) population continues to age rapidly and live longer than ever before. The population over 65 years grew by over a third during the past decade,[1] with older adults making up 17.7% of Rhode Island's population.[2] Eighty million adults will be over 65 by 2040 and they will account for one in five adults by 2050.[3] Advanced age predisposes to increased medical complexity. Most commonly, cardiovascular disease, impaired stress response, multi-morbidity, frailty, poor physiologic reserve and geriatric syndromes like falls, gait imbalance, osteoporosis, sarcopenia, polypharmacy, cognitive deficits.[4,5,6] With increased life expectancy and availability of healthcare services, we expect a significant increase in the number of patients admitted for trauma. Blunt force chest trauma makes up 10–15% of trauma admissions.[7] Rib fractures account for 10% of trauma patients, with older adults having an incidence as high as 60 per 100,000 person years.[4,8] In comparison, the US has a hip fracture incidence rate of 195/100,000 person years with other countries ranging from 2–574/100,000.[9] The two most common causes of rib fractures are falls and motor vehicle accidents (MVA).[10, 11] Osteoporosis, common in older adults predisposes to fractures in low impact, less severe and lower velocity trauma in comparison to younger patients.[12]

Multiple rib fractures in older adults result in increased morbidity and mortality.[4] Complications like pneumonia or respiratory failure, which are rare in younger populations, are common in older adults.[5,13,14,15] These can lead to doubling of mortality from around 10% to 20% in the older adults.[5,8] Furthermore, older adults have increased risk for poor outcomes like prolonged hospitalization, intensive care unit (ICU) stays, long-term disability and inability to return to baseline.[8,16,17,18] In addition, for each subsequent rib fractured, mortality increases by 19% and pneumonia risk by 27%.[4,8,19]

Current trauma guidelines recommend patients 65 years and older with two or more rib fractures get directly admitted to a unit with ICU level staffing.[17] In our institution, these patients get initial management in the Trauma Intensive Care Unit (TICU). The Usual Care (UC) typically involves the critical care trauma surgery team providing pain management and respiratory rehabilitation. The TICU team manages hemodynamic instability, intervenes surgically: for example, chest tube insertion or in rare cases rib stabilization. They coordinate care with other surgical specialties like orthopedic surgery, neurosurgery or interventional radiology on a case-by-case manner. They follow these patients closely until they are stable enough to be transferred to the regular surgical floor.

Medical literature shows that geriatric surgical co-management results in better outcomes in surgical patients[20] and in those with hip fracture.[21] Geriatric trauma co-management (GTC) was developed at our institution to provide an additional layer of care to adults 65 years and older with multiple rib fractures. A dedicated geriatrician helped manage acute medical issues, chronic comorbidities, and geriatric syndromes while the TICU team addressed the critical care needs and surgical management of these vulnerable adults.

We hypothesized that patients 65 years and older with multiple rib fractures, admitted to TICU, with GTC will have a lower 1-year mortality in comparison to the UC.

METHODS

Study design and setting

This was a retrospective cohort study conducted in Rhode Island at the state's only academic, tertiary care, level 1 trauma center. Trauma patients 65 years and older with two or more rib fractures from September 1, 2012 to November 30, 2014 were included in this study. Patients were initially managed in an 11-bed closed TICU, followed by transfer to intermediate level of care or a regular surgical floor per trauma protocol. This study was approved with waived consent by the institutional review board of Lifespan, Inc./ Rhode Island Hospital (RIH).

Patient selection

Eligible patients were placed in the GTC program at the discretion of the primary TICU team. Patients were seen with and without other injuries such as sternal fracture, retroperitoneal hematoma, or long bone fractures. We excluded patients who were not initially admitted to the TICU from the emergency department or had emergent surgery prior to arrival to TICU. Patients whose information could not be confirmed deceased with our electronic medical record and Social Security Death Index (SSDI) were excluded from analysis.

Intervention

GTC at our institution is an interdisciplinary team that started in September 2012. Patients under GTC receive an initial comprehensive geriatric assessment and daily follow-up until the day of discharge Comprehensive geriatric assessment includes prevention and management of geriatric syndromes and medical comorbidities. In addition, regular communications were maintained with the patient's health care proxy, nurses, physical therapist, occupational therapist, case manager, and social worker. The geriatrician attended daily TICU rounds and conducted informal educational sessions with the TICU team members as well as formal didactics for surgical residents. These sessions focused on core geriatric topics such as delirium, falls, cognition assessment, or polypharmacy.

Data collection

Data was collected from the Lifespan electronic medical record (Epic, Veona, WI). Baseline demographic information included age, gender, race, Charlson Comorbidity Index (CCI) and at-risk medications. We measured injury mechanism, number of injuries, Injury Severity Score (ISS), Abbreviated Injury Scale (AIS) [both scoring systems for injury severity], advanced directives and whether patients were community dwelling.

Primary outcome

The primary outcome was 1-year mortality. We defined it as patients who died during the index admission and within a year of their initial discharge. This was irrespective of the location of death, or whether they were discharged to hospice during index hospitalization. For patients whose information could not be obtained in the institute's medical record, we checked the Social Security Death Index. This was done to confirm whether they were alive within one year of their initial discharge from the hospital or not.

Secondary outcome

The secondary outcomes were 30-day readmission from index admission; admission within 1 year of index admission; and number of ED visits during the year following index admission. The number of ED visits that did not result in an admission were recorded and indications for the first three ED visits after initial discharge were recorded (not shown). The causes for the ED visits were split into categories after data collection (infection, surgical issues, cardiac issues, falls, and nervous system issues). All admissions that occurred less than or equal to 30 days after the initial discharge were considered a readmission. All post-discharge admissions were recorded until a year after the initial discharge, and the first three dates and causes were recorded. The causes for admission were then split into the same categories as previously mentioned above.

STATISTICAL ANALYSIS

Statistical analysis was done using the software program SAS© software version 9.4. Univariate analysis was done to evaluate demographic and clinical variables, using t-Student, Fisher exact test and Chi-Square tests. The Kaplan-Meier and multivariate Cox-proportional hazard model was used for calculation of survival over time at 95% confidence level. The Kaplan-Meier curves were compared with the Wilcoxon and the log-rank tests of significance. The patients were followed until they died (are considered a case) or are censored, otherwise. The multivariate model with indicators of study group was conducted to compare 1-year mortality, among all patients. This was adjusted for age, gender, race and number of comorbidities. Comorbidities included: cancer, heart failure, diabetes, hypertension, respiratory disease. We looked at admission location, home or skilled nursing facility (SNF), 30-day readmissions, surgical revision, number of ED visits, and number of readmissions within one year after discharge.

The multivariate model to compare 1-year mortality among patients that were 65–70 years an older was adjusted by age, gender, respiratory comorbidity, 30-day readmission, and number of ED visits, number readmissions within 1 year after discharge. For patients that were 85 years and older the multivariable model included all of the above and, in addition, admission from SNF, 30-day readmission, and surgical revision and ISS score.

RESULTS

395 patients with two or more rib fractures were admitted to RIH during this 26-month period (**Table 1**). Of them, 131 were under GTC and 218 under usual care (UC) with 35 excluded due to unknown morality status and three excluded as they were identified as duplicate patients (**Figure 1**). The GTC on average were older (81.6±8.6 years vs 79±8.5; p<0.005), more likely to have hypertension, live in assisted living facility with higher comorbidities (Charlson 2.8±1.6 vs 2.2±1.6; p<0.001). The GTC group had a higher ISS (13.4±7.4 vs 12.4±6.6; p=0.188) and a higher percentage residing in a skilled nursing facility (SNF) (4.3% vs 3.2%; p=0.558) but they were not significant. The AIS Score (Chest 2.8±0.5 vs 2.8±0.6; p=0.884) and number of trauma diagnoses (3.2±2.3 vs 3.7±2.8; p=0.086) did not differ. The UC group had more patients admitted from home (93.6% vs 86.3%; p=0.021).

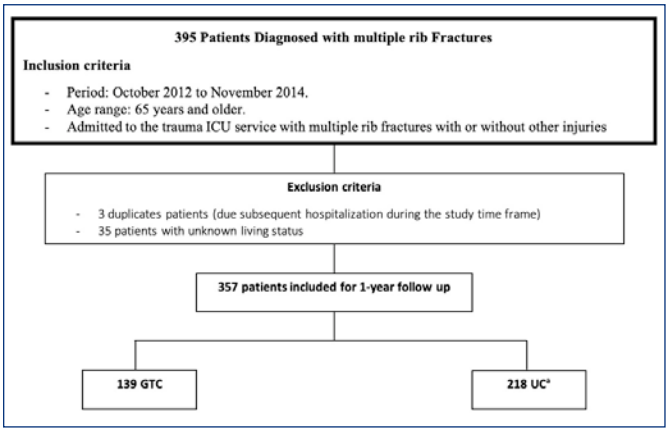
The primary outcome was 1-year mortality rate or discharge to hospice following the initial discharge (**Table 2**). When adjusted, there was a decrease in mortality by 46%; adjusted HR 0.54 [95% CI 0.33–0.86, p=0.011] in the GTC group compared to the UC. When stratified by age GTC had a reduction in hazard of mortality for ages 65–70 of 89% HR

Table 1. Baseline Characteristics of Analytical Study Sample

Patient Characteristics	Study group			
	GTC (n=139)	Usual Care[a] (n=218)	Full sample (n=357)	P-value
Age, mean (SD)	81.6 (8.6)	79.0 (8.5)	80.0 (8.6)	0.0053
Male, no. (%)	62 (44.6)	106 (48.6)	168 (47.1)	0.4581
White, no. (%)	129 (93.5)	202 (92.7)	331 (93.0)	0.7686
Injury mechanism, no. (%), Fall	106 (76.3)	148 (67.9)	254 (71.2)	0.0888
ISS Score, mean (SD)	13.4 (7.4)	12.4 (6.6)	13.0 (7.1)	0.1857
AIS Scores[b], mean (SD), Chest	2.8 (0.5)	2.8 (0.6)	2.8 (0.6)	0.8836
No. of Trauma Dx, mean (SD)	3.2 (2.3)	3.7 (2.8)	3.5 (2.6)	0.0860
No. of comorbidities, mean (SD)	2.8 (1.6)	2.2 (1.6)	2.4 (1.6)	0.0002
Admission Location				
Home, no. (%)	20 (86.3)	204 (93.6)	324 (90.8)	0.0212
ALF, no (%)	13 (9.4)	7 (3.2)	20 (5.2)	0.0139
SNF/Acute Rehab, no. (%)	6 (4.3)	7 (3.2)	13 (3.4)	0.5866

[a] care provided by the trauma team
[b] AIS scores Head, Face/Neck, Abdomen/Pelvis, Extremities, External all p>0.05
Abbreviations: AIS - Abbreviated injury scale ; ALF - Assisted living facility; CHF - Congestive heart failure ; Dx - diagnosis ; DNR/DNI - Do not resuscitate/Do not intubate; GTC - geriatric trauma co-management program; ISS - Injury Severity Score; SD - standard deviation; ALF - Assisted Living Facility; SNF - Skilled nursing facility.

Figure 1. Flow chart



[a]Care provided by the trauma team.
Abbreviations: GTC - geriatric trauma co-management program; UTI - Urinary tract infection; ICU - Intensive care Unit.

Table 2. 1-year mortality (patients who expired or were discharged to hospice) up to 1-year after post-discharge

	No. (%)	Unadjusted		Adjusted	
		HR (95% CI)	P-value	HR (95% CI)	P-value
Overall					
Usual care[a]	59 (29.5)	1 [Reference]		1 [Reference]	
GTC	34 (27.9)	0.60 (0.39–0.92)	0.0197	0.54 (0.33–0.86)	0.0105[a]
Age 65–70 years old					
Usual care[a]	10 (25.6)	1 [Reference]		1 [Reference]	
GTC	3 (15.8)	0.43 (0.12–1.59)	0.2033	0.11 (0.02–0.64)	0.0147[b]
Age more than 85 years old					
Usual care[a]	19 (34.6)	1 [Reference]		1 [Reference]	
GTC	12 (29.3)	0.56 (0.26–1.19)	0.1293	0.34 (0.13–0.91)	0.0317[d]

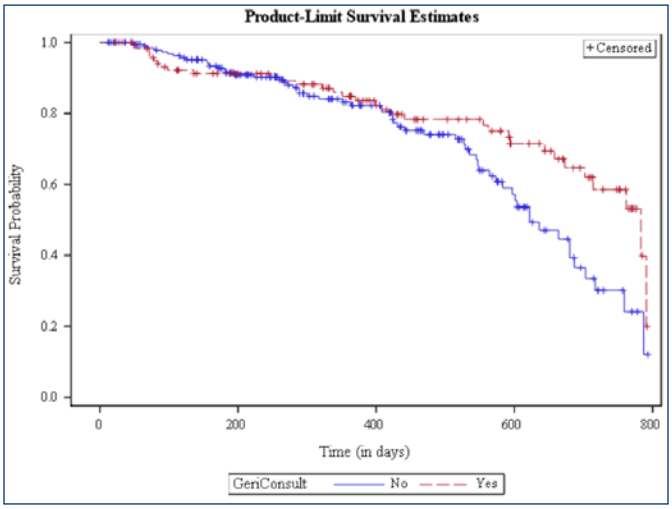
[a] Care provided by the trauma team.
[b] Results from Cox proportional hazard model with indicators of study group.
[a] controls for age, gender, race, number of comorbidities, comorbidities (cancer, CHF, diabetes, hypertension, respiratory), admitted from home or SNF, 30-day readmission, and surgical revision, number of ED visits, number readmissions within 1 year after discharge; [b] controls for age, gender, respiratory comorbidity, 30-day readmission, and number of ED visits, number readmissions within 1 year after discharge; [d] controls for age, gender, number of comorbidities, respiratory comorbidity, admitted from SNF, 30-day readmission, and surgical revision, number of ED visits, number readmissions within 1 year after discharge, ISS score
Abbreviations: CI - Confidence interval; ED - emergency department; GTC - geriatric trauma co-management program; HR - Hazard ratio; ISS - Injury Severity Score; SNF - Skilled nursing facility.

0.11 [95% CI 0.02-0.64, p=0.015] and age 85 years or older of 66% HR 0.34 [95% CI 0.13-0.91, p=0.032]. There were no difference in mortality rates in age groups 71 to 75 (23.5% [GTC] vs 22.9% [UC], p-value=1.000) and 76 to 80 (29.4% [GTC] vs 25.0% [UC], p-value=0.7458).

Figure 2 shows the Kaplan-Meier Survival curve with one-year survival with GTC significantly higher compared to UC (p=0.026), and shows that as time progresses the benefits of the GTC are even more advantageous on mortality with greater separation of the two groups.

There were no significant differences between the two groups for the secondary outcomes of 30-day readmission, admission within 1 year and number of ED visits during the year following index admission (**Table 3**). Sub analysis excluding patients that died in either group shows the same finding with higher mortality for the GTC group (5.7%) when compared with the UC (0.7%), p-value=0.0324. There was a non-significant increase in the GTC group for readmission and being seen in the emergency departments. **Table 4** shows the primary diagnosis of first three admissions within 1-year follow-up with p>0.05 between both groups for each diagnosis and admission (not shown).

Figure 2. Ribs fracture patients Kaplan-Meier survival curves, 1-year follow-up after discharge, for Geriatric Fracture Program patients compared to usual care.



Day 1 represents the first day after discharge for the first patient(s) enrolled in this study. The patients are followed until they die within a 1-year period follow-up (are considered a case) or are censored, otherwise. The Log-Rank test p-value was 0.0257. Abbreviations: ° – censured participants; GTC - geriatric trauma co-management program; UC - care provided by trauma team.

Month 1 represents the first month after one-year admission for the first patient(s) enrolled in this study. The patients are followed until they die (are considered a case) or are censored, otherwise. The Wilcoxon and the Log-Rank test p-values were 0.0049 and 0.0038, respectively.

Abbreviations: + - censured participants; GFP - geriatric fracture program.

Table 3. ED visits and readmissions within 1-year follow-up.

Outcomes	Study group			
	GTC (n=139)	Usual care[a] (n=218)	Full sample (n=357)	P-value
Number of ED visits, mean (SD)	0.9 (1.9)	0.7 (2.5)	0.8 (2.3)	0.2972
At least 1 ED visit, no. (%)	48 (34.5)	58 (26.6)	106 (29.7)	0.1100
30-day ED visit, no. (%)	16 (11.5)	17 (7.8)	33 (9.2)	0.2376
Number of readmissions, mean (SD)	0.6 (1.4)	0.4 (0.9)	0.5 (1.1)	0.1510
At least 1 readmission, no. (%)	38 (27.3)	52 (23.9)	90 (25.2)	0.4597
30-day readmissions, no. (%)	15 (10.8)	13 (6.0)	28 (7.4)	0.0980
Revision required for prior surgery, no. (%)	2 (1.5)	2 (1.0)	4 (1.2)	0.6489

[a] Care provided by the trauma team
[b] within the first 3 ED visits/admission
Abbreviations: GTC - geriatric trauma co-management program; ARF - Acute renal failure; PNA - Pneumonia; UTI - Urinary tract infection; ICU - Intensive care Unit; SD - standard deviation; SNF - Skilled nursing facility.

Table 4. Diagnosis for first 3 admissions within 1-year follow-up.

Diagnosis[a]
Heart failure
Pneumonia
UTI
Stroke
Sepsis
Infected Joint-Wound Infection
Prosthetic malfunction
Empyema
Pneumothorax
Hemothorax
Pleural effusion

[a] All diagnosis studied for first 3 admission within 1-year follow-up for GTC vs Usual Care p>0.05

DISCUSSION

Older patients with multiple rib fractures have mortality rates 2–5 times higher than younger adults despite equivalent ISS.[5, 22] Our results show that for patients with similar levels of rib-fracture severity, involvement of a geriatrician lowers mortality at one year, including those greater than 85 years of age. The involvement of a geriatrician can potentially prevent and address commonly encountered geriatric issues, including acute delirium, cognitive impairment and

or dementia with or without behavioral changes, urinary retention, falls, osteoporosis and medication management. Although literature in geriatric rib fracture co-management is limited, there is strong evidence of benefit with hip fracture patients[23, 24] and Acute Care for Elderly units.[22]

A previous study from our academic level-1 trauma center looked at in-hospital mortality for GTC and found a 40% reduction in-hospital mortality, or 9 fewer deaths.[4] This work revealed that overall in-hospital mortality can be reduced by as much as 22% in a geriatrician led co-management model of care. Recent literature has shown benefits of implementation of geriatric principles in trauma centers, though not specific to the co-managed model.[25,26]

Our analysis found a significant reduction in harm of 46% for one-year mortality or hospice referral post-discharge for older trauma patients with rib fractures followed by a geriatric trauma co-management group. In our small sample size this was more pronounced when stratified by age, especially for patients 65–70. Of note, the GTC patients were older, had more comorbidity and were less likely to be from the community. One would expect the GTC patients with worse pre-existing risk factors to have a higher mortality and hospice referral, but the inverse was seen. Sub-analysis by age was unable to identify specific trends in mortality. Our cohorts did not show any difference in trauma mechanism or severity between the two cohorts and we cannot assert how this plays a role in mortality.

We report long-term outcomes of older trauma patients with multiple rib fractures under GTC. This work adds to the literature on interventions to improve outcomes in the older population and potentially sets a foundation upon which other studies can be built. Our analysis demonstrates harm reduction in mortality and hospice referral up to one year out for all patients 65 and older, even in the more pre-morbid, frail patients.

Limitations

Our analysis was not without its limitations. The retrospective design creates potential bias as we cannot ascertain cause and effect but only associations.[4] Next, only 375 patients were able to be accounted for, thus limiting the power and generalizability of our conclusions. Also, as GTC was at the discretion of the trauma team, selection bias was most likely introduced when more frail patients were admitted. Furthermore, RIH is the only level-1 Trauma center/TICU in RI serving patients from all over the metropolitan area, regardless of the care system patient's normally use. This single center result cannot be generalized to other population demographics which likely differ from this state. We used the Lifespan chart system, the largest in RI, but were unable to access follow-up information from non-Lifespan hospitals and out-of-state residents, possibly missing key follow-up information. Additionally, we looked at post-hospital complications and did not control for prevalence of acute hospital complications such as delirium or ICU days that have a clear impact on mortality. We also did not look at patient's advance directives, family involvement regarding goals of care, or hospice.

CONCLUSION

Future studies that are larger and randomized controlled trials are needed to further understand the impact of geriatric co-management in older patients with multiple rib fractures and establish cause and effect. As the geriatric population continues to grow, further research is also needed to explore the effect of collaboration of a geriatrician with surgical subspecialties and the impact on patient outcomes. In our analysis, GTC intervention lowered 1-year mortality significantly. We need further studies while expanding access to the GTC model of care.

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Disclaimer

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