



Injury patterns and outcomes in late middle age (55–65): The intersecting comorbidity with high-risk activity – A retrospective cohort study

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ABSTRACT

Background: Late middle age (LMA), is a watershed between youth and old age, with unique physical and social changes and declines in vitality, but a desire to remain active despite increasing comorbidity. While post-injury outcomes in the elderly are well studied, little is known regarding LMA patients. We analyzed the injured LMA population admitted to a rural, regional Level 1 Trauma Center relative to outcomes for both younger and older patients.

Materials and methods: Our registry was queried retrospectively for patients admitted 7/2008–12/2015; they were divided into three cohorts: 18–54, 55–65, and > 65 years. Demographics, injury details, comorbidities, and outcomes were compiled and compared using ANOVA and Chi-square; $p < 0.05$ was significant.

Results: During the study period, 10,543 were admitted; 1419 (14%) were LMA who experienced overall injury mechanisms, severities and patterns that mirrored the younger cohort. However comorbidity rates were high (56.4%) and comparable to the elderly. LMA patients had the highest rates of alcohol abuse, morbid obesity, and psychiatric illness ($p < 0.0001$) and suffered the poorest outcomes: highest complications and hospital charges, and longest ICU and hospital LOS. LMA mortality (4.1%) was 41% higher than younger patients (2.9%; $p < 0.02$) and similar to the older cohort (4.7%; $p = 0.32$).

Conclusions: The LMA population has similar mechanisms and injury patterns to younger patients, while exhibiting comorbidity rates similar to the elderly. High-energy injuries exact a greater toll in LMA with poorer outcomes and greater resource utilization. Targeted outreach for injury prevention, and future studies, are needed to address high-risk behavior, substance abuse, and societal contributors.

1. Background

Late middle age (55–65) represents the final watershed between youth and old age. In this stage of life, many individuals remain in the workforce, have achieved a certain degree of financial freedom, and strive to keep active despite beginning to develop comorbidities [1–3]. Yet, as their children have moved away, and they prepare to transition toward retirement, this group also experiences certain social and psychological stresses related to a real or perceived decrease in vitality [2–4]. Indeed by their late 60's, 32% Americans have at least one chronic disease and 22% have greater than three [5]. Further, substance abuse disorders, depression, and other psychiatric diseases are increasingly common amongst the middle-aged [2–4,6,7]. We postulated that these factors combine to create a “perfect storm” of relatively unfit patients engaging in high-risk activity. While the “elderly,” those patients aged > 65, are known to have poorer outcomes after traumatic injury [8], little is known regarding the specific epidemiology and

outcomes for those injured in late middle age (LMA). We sought to characterize the LMA injured population, treated at a rural Level 1 Trauma Center, and compare outcomes for this group to both younger and older patients in this setting.

2. Materials and methods

East Texas Medical Center (ETMC) is an American College of Surgeons Verified Level 1 Trauma Center, which leads a regionalized trauma system located in rural northeast Texas. ETMC admits approximately 1500 patients per year; nearly half are transferred from a stabilizing facility. After approval from the ETMC Institutional Review Board, the Trauma Center registry was queried to include all adult patients (aged ≥ 18 years) admitted from July 2008 through December 2015. Demographics, injury details, Injury Severity Score (ISS), comorbidities, and outcomes (complications, length of stay (LOS), mortality, hospital charges) were compiled in Excel spreadsheets

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Table 1
Demographics.

Demographics	< 55	55–65	> 65	p value
N (10543 Total)	5687 (54%)	1419 (14%)	3427 (32%)	
Age (Mean ± SD), yrs	52.9 ± 22.4			
Sex - % Male	73.8%	64.9%	40.3%	< 0.00001
Race				< 0.00001
Caucasian	71.0%	84.2%	92.8%	
Non-caucasian	29.0%	15.8%	7.2%	
Transfer	46.1%	45.5%	47.4%	0.37
Uninsured	31.3%	16.3%	3.9%	< 0.00001

(Microsoft, Redmond, WA). “Major Comorbidities” were any of the following: coronary artery disease, congestive heart failure, chronic obstructive pulmonary disease, diabetes mellitus, hypertension, morbid obesity, chronic renal failure, stroke history, cancer history, peripheral vascular disease, cirrhosis, dementia, or schizophrenia). Data were uploaded into Wizard for Mac (v1.8, Chicago, IL) for statistical analysis.

For this single-center retrospective cohort study, patients were separated into three age group cohorts: younger (18–54), late middle aged (LMA) (55–65), and elderly (> 65 years) and compared. ANOVA was used for continuous variables and Chi-square was used for categorical variables; $p < 0.05$ was significant. *Post hoc* testing, with Bonferroni correction, was used to further scrutinize significant differences between individual age groups.

3. Results

During the 7.5-year study period, 10,543 adult patients were admitted to ETMC after traumatic injury. Of these, 1419 (13.5%) were LMA. For the study population, mean age and demographics, by group, are summarized in [Table 1](#).

3.1. Injury data

Mechanisms of injury and major injuries sustained are presented in [Table 2](#). LMA patients had the highest rate of motorcycle crashes and the highest rate of “falls greater than ground level” compared to the other groups. The LMA cohort also had similar rates for all-terrain vehicle (ATV) crashes and “other” non-fall blunt trauma (i.e. animal-related, tractor/machinery, boating/recreational) to the younger group, which were much higher than observed in older patients. Overall, the combined rate for injuries due to these higher risk activities was

Table 2
Injury Data.

	< 55	55–65	> 65	p value
Mechanism of Injury				
Motor Vehicle Crash	33.9%	20.3%	11.9%	< 0.00001
Motorcycle Crash	7.0%	9.8%	1.0%	< 0.00001
ATV/other blunt	23.5%	20.2%	7.1%	< 0.00001
Fall from Height	4.4%	7.7%	3.0%	< 0.00001
Ground level fall	11.3%	33.9%	74.8%	< 0.00001
Penetrating Trauma	13.4%	5.7%	2.0%	< 0.00001
Assault	6.5%	2.4%	0.2%	< 0.00001
Injury Patterns				
ISS (mean ± SD)	11 ± 9	11 ± 8	10 ± 6	< 0.00001
Traumatic Brain Injury	19.0%	20.5%	23.5%	< 0.005
Spine Fracture	20.1%	21.6%	15.7%	< 0.00001
Rib Fracture(s)	17.1%	23.0%	11.6%	< 0.00001
Hemo/pneumothorax	19.1%	16.8%	8.0%	< 0.00001
Abdominal Organ/Viscus	12.7%	8.2%	4.0%	< 0.00001
Open Extremity Fracture	12.5%	10.4%	5.1%	< 0.00001
Pelvic Fracture	9.3%	8.5%	7.0%	< 0.002
Spinal Cord Injury	2.8%	3.9%	2.0%	< 0.0005

Italics: statistically similar between groups in *post hoc* testing.

Table 3
Comorbidities.

	< 55	55–65	> 65	p value
Substance Abuse				
Alcohol	9.6%	11.6%	3.5%	< 0.00001
Tobacco	29.9%	24.9%	9.7%	< 0.00001
Illicit Drugs	6.4%	3.3%	2.1%	< 0.00001
Substance Abuse (any)	36.1%	31.3%	12.9%	< 0.00001
Comorbidities				
Hypertension	13.0%	41.8%	57.4%	< 0.00001
Diabetes Mellitus	5.2%	20.3%	22.0%	< 0.00001
COPD	2.4%	8.6%	11.7%	< 0.00001
Psychiatric Illness	5.0%	7.8%	5.8%	< 0.0003
Morbid Obesity	4.9%	8.7%	4.5%	< 0.00001
Comorbid status	23.9%	56.4%	72.2%	< 0.00001

Italics: statistically similar between groups in *post hoc* testing.

greatest amongst LMA patients accounting for 35.7% of injuries, compared to 32.9% for younger patient injuries, and only 10.3% for elderly patients ($p < 0.00001$). Rates for penetrating injury and assaults fell in between the other two groups.

For injury severity and types of injuries sustained (injury pattern), analysis demonstrated differences between age groupings for all injuries compared. *Post hoc* testing between individual groups revealed that for injury severity and rates for most injuries tested, the young cohort and the LMA group were statistically similar. Specifically the incidence of traumatic brain injury (TBI), hemo/pneumothorax, pelvic fracture, spine fracture, spinal cord injury, and open extremity fracture were all statistically similar between the young and LMA groups. Further, LMA patients actually had the highest rate of rib fractures, spine fractures, and spinal cord injuries amongst the study population. Patterns for the elderly group were overall very different and seemed to reflect the lower energy mechanisms.

3.2. Comorbidities

Substance abuse and comorbidity rates are presented in [Table 3](#). Alcohol abuse was actually highest amongst the LMA group. Tobacco abuse also remained common into LMA while illicit drug abuse was not. Overall, rate of substance abuse amongst LMA patients was high, approaching that of the younger cohort and was 2.4 times greater than in the elderly group. In contrast, compared to the younger patient cohort, LMA patients had much higher rates of hypertension, COPD, diabetes, and obesity. Diabetes rates were statistically similar to the older cohort ($p = 0.19$). Morbid obesity was highest amongst the LMA group. As expected, overall “comorbid status” for LMA patients fell between the other two cohorts but more closely approached the elderly cohort.

3.3. Outcomes

Outcomes are presented in [Table 4](#). Infectious, non-infectious, and

Table 4
Outcomes.

	< 55	55–65	> 65	p value
Complications				
Infectious	7.0%	8.7%	6.7%	< 0.05
Major (non-infectious)	7.0%	9.6%	7.7%	< 0.003
Total	9.1%	11.8%	10.1%	< 0.003
Length of Stay				
ICU (mean ± SD), d	5.9 ± 8.5	6.9 ± 8.9	6.1 ± 7.1	< 0.005
Hospital (mean ± SD)	7.1 ± 9.6	7.7 ± 8.9	6.4 ± 5.7	< 0.00001
Charges (mean)	\$126,900	\$168,300	\$113,300	< 0.02
Mortality	2.9%	4.1%	4.7%	< 0.00002

Italics: statistically similar between groups in *post hoc* testing.

overall complication rates, hospital and intensive care unit (ICU) length of stay (LOS), and hospital charges were all highest for the LMA cohort. Mortality for LMA patients fell between the other groups but was statistically similar to the elderly group.

4. Discussion

To our knowledge, the present study is the first to examine “late middle age” as a unique trauma population. Herein we describe the epidemiology and outcomes of traumatic injuries in late middle-aged patients treated in a rural Level 1 Trauma Center as part of a regionalized trauma system. We determined that LMA patients had the highest rates for motorcycle crashes and falls from a height, while also having high rates of injury due to recreational activities (i.e. ATVs, equestrian, boating). At the same time, these patients had the highest rates for alcohol abuse and obesity amongst the study population, and had similar rates of diabetes mellitus to the older cohort; more than half had at least one major comorbidity. Finally, the types of injuries sustained by LMA patients closely mirrored those of the younger cohort – reflecting higher energy blunt mechanisms; for the LMA group, these injuries lead to the overall longest ICU and total hospital length of stay, the highest hospital charges, and the highest rates of complications.

Our results appear consistent with social and scientific research documenting the evolution of the health and behavior of the “Baby Boom” generation - those born between 1945 and 1964 - who are now late middle-aged adults. In 2013 the Centers for Disease Control (CDC) reported that mortality from “Unintentional Injury” is now the third leading cause of death (after cancer and heart disease) for those aged 55–64 due to a 33% increase in injury mortality from 2003 to 2013 [9].

Similar to an adolescent, who at times identifies both as a child and as an adult, those in late middle age find themselves in transition between the vigor of their youth and the inevitable decline of their old age. A population enters middle age with a wide spectrum of comorbidity, vitality, and wellness [2,9]. Some are quite vigorous while others are highly dependent [2,10]. According to the CDC nearly 20% of LMA adults are diabetic, more than 40% are obese, and greater than 50% have hypertension – with all of these comorbidities trending higher than in the previous decade [9].

Due to changing roles in family, at work, and in society, the transition to late middle age is often also accompanied by a host of social and psychological stresses [2–4,11], which can lead to depression [4], substance abuse [7,12–14], and risk taking behaviors [15,16]. These elements combine in the LMA population leading to unique risk factors for potential injury and for poor post-injury outcomes. Interestingly, from 1985 to 2010 the *average* age of motorcycle riders in the US increased from 28 years [17] to 49 years [18] and not surprisingly, as motorcyclists have aged, outcomes have declined [15,19]. In a study by Con et al., [20] middle age individuals (age 45–65) represented more than half of all falls from ladders and suffered significantly greater injuries than the younger cohort. At the same time, there is considerable evidence that alcohol and drug use amongst older people is high and increasing [6,7,14,21–23] including binge drinking and mixing alcohol with prescription sedative-hypnotic drugs [13]. For the middle-aged, an increase in the number of falls observed may be more related to substance abuse than to frailty as seen in the elderly (> 65 years) [6,12].

In late middle age, a combination of cultural and physical factors combine increasing the risk and the severity of injury, and resulting in worse injury outcomes compared to other age groups. While our data document the phenomenon in a rural setting, the literature suggests a more national trend. The etiology is unclear but, in part, an element of widespread cultural resistance to the very real limitations of aging appears to exist amongst middle-aged Americans. Perhaps related to the “Baby Boomer” psychology of testing boundaries and cultural norms, the current LMA generation seems to be rejecting the “social clock” [18] of advancing age and continues to engage in activities requiring a degree physical strength, stamina, or coordination that may no longer

be present due to age, comorbidities, or medications. High substance abuse rates are also contributory and likely reflect both this generation's culture and a degree of individual escapism used to combat the depression, loneliness or boredom associated with advancing age [13,14].

As these trends will likely continue, and the population will further age, trauma centers should anticipate treating a growing number of older patients for injuries sustained in higher energy mechanisms. Unfortunately, because of the myriad limitations encountered in caring for geriatric trauma patients [8], centers will likely also experience overall poorer outcomes as elderly trauma volumes rise. There are, however, opportunities for intervention. Targeted outreach, aimed at limiting high-risk behavior, may be helpful - especially if championed by primary care physicians counseling patients with various comorbidities, on certain medications, or with substance abuse problems. Also, more specific interventions may be needed: more comprehensive testing for those seeking or renewing motorcycle operator licensure; public campaigns that raise awareness of medication side effects, the dangers of ladder use by the elderly, and other specific age-related injury risks. Ultimately, the adult children of “Baby Boom” parents might be the best targets for efforts to increase awareness and bring intervention to the family level where it will likely be most effective.

4.1. Limitations

This study's greatest limitation is its retrospective nature and its reliance on registry data. During data collection entry errors, misinterpretation of clinical facts by coders, and coding errors can occur. Further, as a single institutional experience in a non-urban setting, the current data may have limited applicability to larger centers in more culturally diverse areas.

5. Conclusions

High-risk behavior is prevalent in late middle-aged injured patients with rates and injury patterns similar to younger patients. Concurrently, the LMA population suffers from high alcohol and substance abuse rates and comorbidity rates approaching those of the elderly. This combination of factors is associated with higher rates of severe injury and more prolonged, complicated, and expensive hospitalizations. Targeted outreach may be indicated for injury prevention and to identify societal contributors. Future studies are required to validate our findings in non-rural settings and to prospectively evaluate the impact of outreach programs on patient outcomes in this complicated demographic.

Ethical approval

The East Texas Medical Center Institutional Review Board (IRB) approved Class 4 – Exemption Status for the current project as a retrospective review of previously collected administrative data.

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Author contributions

Gale – study design, data collection, data analysis, writing; Peters - study design, data collection, critical revision; Murry - study design, critical revision, Crystal - data analysis, critical revision; Dombrowskiy – data analysis, critical revision.

Conflicts of interest

Authors have no conflicts of Interest.

Guarantor

I, Stephen Gale, MD FACS – the corresponding author, am the guarantor of this research. I accept full responsibility for the work, had access to the data, and controlled the decision to publish.

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