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Assessment of morbidity and mortality factors affecting geriatric trauma patients: A comprehensive cross-sectional study in central India

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Abstract
India has geriatric population of about 76.6 million over the age of 60, constituting above 7.7% of total population. A cross-sectional study on 300 cases of geriatric and non-geriatric subjects was conducted at well-established Trauma, Orthopaedic and Neurosurgical services centre in Central India. Mechanisms of injury sustained by the participants showed that Falls which include both Ground level falls (GLF) and Fall from height (>2 metres) contributed to 55.4% cases in the geriatric population. The next most common cause of trauma was the road traffic accidents (RTA) amounting to 34.3% of the cases in the geriatric population. Data on the injuries sustained in terms Abbreviated injury Scale (AIS) and Injury severity score (ISS) showed that the head region was most consistently and maximally injured in both the study populations. Comorbidity profiles of geriatric and non-geriatric trauma populations showed significantly high hypertension, cerebrovascular disease, diabetes, diminished hearing and vision among the geriatric group. The maximum number of geriatric patients underwent Orthopaedic and spine surgeries (44.9%), Intercostal drain placements (34.6%), while the non-geriatric population had a higher number of Craniotomies (40%) and Intercostal drain placement (33.5%) surgeries respectively. The geriatric population had a significantly higher crude mortality rate of 39.3% compared to the non-geriatric population (26.3%). With reference to intervention procedures, the geriatric population had a lower percentage of operative intervention and a higher rate of conservative management as compared to the non-geriatric population.

Keywords: Trauma, geriatric patients, road traffic accidents, Injury severity score, mortality

Introduction

Worldwide people are living longer with increased life expectancy. In the world's population, the aged and older population of age 60 years and above is expected to cross over by 2.1 billion by 2050. According to the WHO, 80% of all older people will live in low- and middle-income countries by 2050 [1] According to the State of World Population 2019 report India's population in 2019 stood at 1.36 billion, and six percent of India's population was of the age 65 and above [2]. Patients older than 65 years account for 23% of all trauma admissions. Trauma represents the fifth leading cause of death in this population. In view of the high prevalence of multiple comorbidities, there is an increased rate of death or severe disability following trauma in aged population [3, 4, 5]. The risk of death after trauma is six fold high in older patients (65-80 years of age), compared to that of younger patients. Further, the socio--economic implications are more in geriatric trauma, therefore clinicians must strive for a standardized and evidence-based approach to the diagnosis and treatment of these patients.

Traditional trauma protocols have been established and proven in the treatment of younger accident victims. However, the older people with compromised physiological reserves and significant co-morbidities, require specialized strategies for treatment of trauma. The mechanism of injury and distribution of injuries will be different in a population with osteoporosis [6]. Older patients can sustain multiple injuries following low energy trauma and these injuries may have worse outcomes [7]. Patients with limited mental or physical capacity are more likely to be involved in accidents as their reflexes are slower to identify and respond to the dangerous situations. Medical emergencies such as myocardial infarction or stroke may precipitate in an accident, making it obligatory to treat these emergencies along with the patient's injuries.

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Mental and physical incapacity of these patients can make assessments more troublesome. Older patients may become confused and uncooperative during a minor physiological derangements, often compromising their investigation or treatment [8, 9].

Therefore, it is important to precisely document the pattern of injuries and clinical course of treatment for older patients with severe injuries. Recent reports of polytrauma in older adults are limited and the subject has previously been given only brief attention. This study aims to identify and characterize the geriatric population with polytrauma and compare them to non-geriatric trauma patients in terms of patterns of injury, severity of injuries, mortality and comorbidities exposed to various mechanisms of injury and trauma.

2. Material and methods
2.1 Study Setting
The study was conducted at a tertiary and well-established trauma care centre in Central India with Orthopaedic care, Trauma and Neurosurgical services. It is a well established hospital in these three specialties.

2.2 Study population
All geriatric and non-geriatric patients who had been admitted in the Trauma Care Centre through emergency medical services from June 2017- November 2019, who met the inclusion criteria were monitored in the trauma care centre until death/discharge in the wards were included in this study.

2.3 Inclusion criteria
Patients consenting to participate. Adult trauma patients from ages 18 – 64 years were admitted to the Surgical Casualty and Trauma Care Centre. Adult trauma patients from ages 65 – 89 years were admitted to the Surgical Casualty and Trauma Care Centre.

2.4 Exclusion criteria
Patients with penetrating traumatic injuries – gunshot and stab wounds. Patients below 18 years and above 90 years.

2.5 Sample size
The sample size is calculated as: Power (1-beta) %: 80%; Alpha error %: 5. Minimum sample required in each group n = 116 (Geriatric and Non-geriatric)

2.6 Estimated final sample size
300 cases each in both geriatric and non-geriatric population groups were enrolled in this study in accordance with the inclusion criteria.

2.7 Sampling Method
Study participants were drawn from all the patients who were admitted to the tertiary trauma centres of central India from June 2017 to November 2019. All adult trauma admissions from ages (18 –89 years) were subjected to the pre-determined inclusion criteria. Participants were then subsequently divided into two cohorts from all eligible adult trauma patients - the first consisting of a control group of all patients ages 18 to 64 years (non-geriatric patients) and the second consisting of all patients ages 65 to 89 years (geriatric patients).

The included study subjects were then examined in accordance with the various parameters included in the proforma below.

2.8 Variables collected for each group were
- Admission demographics.
- Vital signs and physiological parameters on admission.
- Mechanism of injury subdivided into falls (with a subgroup of ground level falls and falls from height (<2 meters), Road Traffic accidents, Assaults and others.
- Injury Severity Score (ISS)
- Abbreviated Injury Scale (AIS) for each body region.
- Comorbidities including Hypertension, Ischemic heart disease, Diabetes mellitus, Chronic obstructive pulmonary disease, Cerebrovascular disease, Chronic renal failure, diminution of vision and hearing were considered.
- Interventional procedures afforded to both the population groups in terms of surgical procedures or conservative management were also recorded.

The primary outcome was the type of injuries sustained and injuries were divided by ICD-9 code into the following categories:
- Traumatic brain injury (TBI)
- Skull fracture
- Facial fractures
- Abdominal injury
- Spine fractures
- Upper extremity fracture
- Thoracic injury
- Pelvic fracture
- Hip fracture
- Lower extremity fracture.

The secondary outcome includes mortality/discharge. Data were collected according to pre-determined proforma.

2.9 Research instruments
Pre-tested proforma was used to collect information bedside after clinical examination and by going through the patient charts. One research assistant accomplished by filling the admitting part of the questionnaire at casualty and confirmed by the author.

2.10 Data collection management and analysis
Data collection was done through a structured proforma as described above at the Emergency Department and in the ward. After admission, these patients were monitored until death/discharge and the relevant data was entered accordingly. This was done with assistance by pre-trained admitting staff and assisted by other doctors in the ward. The filled proforma were examined and the data was then systematically compiled in a master sheet using Microsoft Excel Program. All the variables and parameters were then subjected to statistical analysis.

2.11 Statistical Analysis
The data were analysed using PASW 18.0 Software; formerly known as SPSS 18.0 Software. The statistical analysis for comparative assessment will include, use of Student's t-test (for continuous scale data) and Pearson's ChiSquare test with Yates correction for categorical variables. Logistic regression analysis was also carried out to identify those factors independently affecting a certain outcome.

2.12 Ethical consideration
Permission to carry out the study was granted by MUHS research ethical committee. Additionally, informed consent was requested from the participants In line with consent, participants have explained the nature and purpose of the study.

3. Results

The results obtained from a comparative cross sectional study conducted on injury and trauma, mortality, morbidity in geriatric and non-geriatric patients admitted in a tertiary care trauma centre in central India is outlined below. The demographic profile of the participants in relation to the age distribution showed a male sex preponderance in both the population groups. Among non-geriatric patients, 62.7% and 52.6% were male patients, 37.3% and 47% were female patients respectively among geriatric and non-geriatric trauma patients. The geriatric population group showed a clear male preponderance with males making up 62.7% of the study group. The age distribution in the geriatric population group affected by injury and trauma ranged from 65-89 years. The maximum number of fatalities occurred in 65-69 age group while the 85-89 year remains the least affected. Mean age from this study cohort was 72 years. The age distribution in the non-geriatric study population ranged from 18 to 65 years. The age group of 18-27 years had the maximum number of fatality cases with the mean age in the non-geriatric cohort was found to be 39 years.

Vital parameters such as mean systolic and diastolic blood pressure, mean pulse rate and the number of patients with a Glasgow Coma Score were recorded in both the study (Table 1). These parameters represent the baseline vital signs with which both the populations present to the trauma care centre. Further, these parameters signify the derangements in the physiology secondary to the traumatic event in both populations.

Table 1: Vital parameters in geriatric and non-geriatric population on admission

Admission Demographics	Geriatric Population	Non-geriatric Population	P- value
Mean Systolic Blood Pressure (mm Hg)	130 ± 23.3	117 ± 21.8	't' ratio = 6.895, $P<0.01$
Mean Diastolic Blood Pressure (mm Hg)	81.4 ± 10.4	75.8 ± 12.9	't' ratio = 5.622, $P<0.01$
Mean Pulse Rate (beats per minute)	90 ± 14.2	96 ± 16.8	't' ratio = 4.716, $P<0.01$
GCS $</= 8$ (%)	36%	35.3%	z=0.170, P=0.865 (NS)

The geriatric trauma population had a higher mean systolic blood pressure (130 mm Hg) compared to the non-geriatric counterparts who showed a mean of (117 mm Hg). Similarly, the mean diastolic blood pressure in the geriatric age group was relatively higher in the non-geriatric population. The mean pulse rate in the geriatric group was lower compared to the non-geriatric group with a mean of 90 ±14.2 and 96 ±16.8 bpm respectively. Glasgow Coma Scale (GCS) is a neurological scale that aims to give a reliable and objective method of recording the state of a person's consciousness for initial as well as subsequent assessment. A GCS of >/=8 is classified as severe brain injury. A shown in Table 1, 36% of patients showed GCS score <8 in both geriatric and non-geriatric patients. Mechanisms of injury sustained by the participants from both the cohorts i.e. geriatric and non-geriatric populations is presented in Table 2. It is evident that Falls which include both Ground level falls (GLF) and Fall from height (>2 metres) contributed to the largest number of cases in the geriatric population amounting to 55.4% cases out of all the cases.

The next most common cause for trauma in the geriatric population was Road traffic accidents amounting to 34.3% of the cases. The non-geriatric population showcased a different trend wherein, road traffic accidents contributed to the highest number of cases of 171 (57%). In contrast, the ground level falls had the least number of cases of 14 (4.7%) in this study population. Falls (ground level falls + falls from height)

contributed to 19.7% of all the causes in the non-geriatric population.

Table 2: Mechanisms of Injury in Geriatric and Non-geriatric Trauma Patients

Mechanism	Geriatric Population (n=300)	Non-geriatric Population (n=300)	P value
Ground level falls	48.7%	4.7%	$P<0.05$
Falls from Height	6.7%	15%	$P<0.05$
Road Traffic Accidents	34.3%	57%	$P<0.05$
Assaults	7.7%	15.3%	$P<0.05$
Others	2.6%	8%	$P<0.05$

Data on the injuries sustained by both the study cohorts in terms of the different body regions are presented in Table 3. These different body regions have an individual abbreviated injury score. The highest AIS scores 3 out of the total 6 regions are squared and summed to give to consolidated Injury severity score (ISS). Thus, both the geriatric and non-geriatric study populations had comparable Injury Severity Scores of greater than or equal to 16 which signifies a severe overall injury. The head region was most consistently and maximally injured in both the study populations. AIS >/=3 is defined as a severe injury to the head.

Table 3: Injury Severity Scores (ISS) and Abbreviated Injury Score (AIS) for each body region in Geriatric and Non-geriatric trauma patients

	Injury Score	Geriatric Population	Non-geriatric Population	P - value
ISS	ISS >/= 16	252	254	Z=0.22, P= 0.825 Not Significant
	ISS < 16	48	46	
Head AIS	Head AIS >/=3	213	193	Z=1.745, P=0.080 Not Significant
	Head AIS <3	87	107	
Face AIS	Face AIS >/=3	33	21	Z=1.7118, P=0.08726 Not Significant
	Face AIS <3	267	279	
Neck AIS	Neck AIS >/=3	4	15	Z= -2.5645, P=0.01046
	Neck AIS <3	296	285	
Thorax	Thorax >/=3	72	100	Z= 2.5278, P=0.0114
	Thorax <	228	200	
Abdomen	Abdomen >/=3	48	105	Z= -5.3389, P=0.00001
	Abdomen <	252	195	
Extremities	Extremities >/=3	135	114	Z= 1.74, P=0.08186 Not Significant
	Extremities <3	165	186	

External	External >/=3	18	13	Z= 0.9222, P=0.35758 Not Significant
	External <3	282	287	

The non-geriatric cohort had AIS >/= 3 of head injury. The next highest contributor to morbidity in the non-geriatric cohort was also severe extremity injury with Extremity AIS >/=3. The non-geriatric population was observed to have sustained a much higher proportion of severe thoracic (100 vs 72) and abdominal injuries (105 vs 48) as compared to the geriatric counterparts, both of which were statistically significant.

Comorbidity profiles of geriatric and non-geriatric trauma populations are presented in Table 4. The geriatric study group had a significantly higher number of a wide range of comorbidities with many patients having more than 1 comorbidity simultaneously. Hypertension was the most common comorbidity noted amongst both the study groups although, the geriatric study group had more than twice the number of cases with hypertension compared to the non-geriatric population i.e. 50% and 24% respectively. Cerebrovascular disease was noted amongst 25% and 17% of the geriatric and non-geriatric trauma populations respectively with the geriatric cohort showing a higher incidence. 27% of the geriatric study population was diabetic as compared to 24% of the non-geriatric population who also had diabetes mellitus. The diminished vision was noted in 30% of the geriatric trauma patients as opposed to just 13% of the non-geriatric patients having the same complaints. The diminished hearing was also primarily noted in the geriatric population with up to 28% of them having the above comorbidity as opposed to just 6% of the non-geriatric population having diminished vision.

Table 4: Comorbidities in Non-geriatric and Geriatric Trauma Patients

Comorbidity	Geriatric Population (%)	Non-geriatric Population (%)	P value
Hypertension	151 (50%)	73 (24%)	Z=6.583, $p<0.0001$
Ischaemic Heart Disease	40 (13%)	28 (9%)	Z=1.5454, p=0.12114Not Significant
Cerebrovascular disease	75 (25%)	52 (17%)	Z=2.2986, $p<0.02144$
Chronic obstructive Pulmonary Disorder	18 (6%)	28 (9%)	Z=-1.5344, p=0.12602Not Significant
Diabetes Mellitus	81 (27%)	72 (24%)	Z=0.843, p=0.4009 Not Significant
Chronic Renal Failure	22 (7%)	21 (7%)	Z=0.1583, p=0.87288 Not Significant
Diminished Vision	89 (30%)	40 (13%)	Z=4.8693, $p<0.00001$
Diminished Hearing	83 (28%)	19 (6%)	Z=6.9557, $p<0.00001$

Various injury patterns noted in both the study populations have been stratified by the various mechanisms of injury is presented in Table 5. Falls contributed to the highest number of cases (55%) in the geriatric population followed by RTA (34%) as the next major cause for trauma. Amongst the falls, Ground level fall has been the highest casualty at 87% as compared to fall from height (> 2 metres) contributing 13% towards the total number of falls.

Table 5: Injury Patterns for Geriatric and Non-geriatric Trauma Patients Stratified by Mechanism of Injury

Mechanism of Injury	Injury	Geriatric	Non-geriatric	P- Value
Falls G=166 NG=59	Head	128 (77%)	35 (59%)	Z=8.5, $p<0.00001$
	Face	19 (11%)	2 (3%)	Z=3.8, $p<0.00016$
	Neck	0 (0%)	5 (8%)	Z=-2.2, $p<0.02$
	Thorax	28 (17%)	27 (46%)	Z=-0.1,p=0.88Not Significant
	Abdomen	15 (9%)	27 (46%)	Z=--1.9, $p<0.05$Not Significant
	Extremity	107 (64%)	33 (56%)	Z= 7.1, $p<0.00001$
	External	33 (20%)	6 (10%)	Z= 4.5, $p<0.00001$
Ground level Falls G=145 NG=14	Head	116 (80%)	6 (43%)	Z= 11.2, $p<0.00001$
	Face	18 (12%)	0 (0%)	Z= 4.3, $p<0.00001$
	Neck	0 (0%)	1 (7%)	Z=-1.0, p=0.3 Not Significant
	Thorax	15 (10%)	0 (0%)	Z= 3.9, $p<0.00008$
	Abdomen	2 (1%)	0 (0%)	Z= 1.4, p=0.1556 Not Significant
	Extremity	32 (22%)	12 (85%)	Z= 3.1, $p<0.001$
	External	32 (22%)	4 (29%)	Z= 4.8, $p<0.00001$
RTA G =103 NG=171	Head	74 (72%)	124 (73%)	Z= -4.3, $p<0.00001$
	Face	21 (20%)	29 (17%)	Z= -1.2, p=0.238Not Significant
	Neck	4 (4%)	11 (6%)	Z= -1.8, p=0.06724 Not Significant
	Thorax	36 (35%)	53 (31%)	Z= -1.9, p=0.05118Not Significant
	Abdomen	25 (24%)	52 (30%)	Z= -3.3, $p<0.00096$
	Extremity	49 (48%)	82 (48%)	Z= -3.3, $p<0.001$
	External	10 (10%)	34 (20%)	Z= -3.8, $p<0.0001$
Assault G=23 NG=45	Head	13 (57%)	32 (71%)	Z= -2.9, $p<0.00$
	Face	5 (22%)	9 (20%)	Z= -1.1, $p<0.28014$ Not Significant
	Neck	0 (0%)	0 (0%)	NA
	Thorax	7 (30%)	17 (38%)	Z= -2.0, $p<0.3752$
	Abdomen	6 (26%)	14 (31%)	Z= -1.8, p=0.06876 Not Significant
	Extremity	8 (35%)	24 (53%)	Z= -2.9, $p<0.003$
	External	2 (9%)	6 (13%)	Z= -1.4, p=0.15 Not Significant

Others G=8 NG=24	Head	2 (25%)	6 (25%)	Z= -1.4237, p=0.15 Not Significant
	Face	0 (0%)	0 (0%)	NA
	Neck	0 (0%)	0 (0%)	NA
	Thorax	5 (21%)	12 (50%)	Z= -1.7, p=0.085 Not Significant
	Abdomen	6 (25%)	19 (79%)	Z= -2.6, *p<0.00782*
	Extremity	3 (13%)	8 (33%)	Z= -1.5, p=0.12 Not Significant
	External	1 (4%)	4 (17%)	Z= -1.3, p=0.17 Not Significant

The head and extremities were most often injured in the geriatric population sustaining falls with 77% and 64% of them showing the above the two injuries respectively. The next major mechanism responsible for trauma in the geriatric age group is Road traffic accidents (RTA) with 34% of the population having sustained RTA. The head, extremities and thorax were once again most often injured at 72%, 48% and 35% respectively. In the non-geriatric population, RTA was the major cause of trauma responsible for 57% of the casualties with the head, extremities, thorax and abdominal injuries accounting for the injury patterns in the descending order.

Table 6. Illustrates a comparison between the geriatric and non-geriatric trauma populations who underwent operative interventions and conservative management.

It is evident that the geriatric population had a lower percentage of patients who underwent an operative intervention as compared to the non-geriatric population (45.3% vs 56.7%). Similarly, the geriatric population group had a higher rate of conservatively managed patients as compared to the non-geriatric population (54.7% vs 43.3%). Both the findings were statistically significant.

Table 6: Comparison between the geriatric and non-geriatric populations in terms of operative interventions vs non-operative interventions (Conservative management).

Intervention	Geriatric Population (n=300)	Non-geriatric Population (n=300)	P-value
Operative Intervention (%)	136 (45.3%)	170 (56.7%)	Z=-2.7, *p<0.005*
Conservative Management (%)	164 (54.7%)	130 (43.3%)	Z= 2.7, *p<0.005*

The different operative interventions underwent by the geriatric and non-geriatric trauma populations is presented in Table 7. The geriatric population had the maximum number of patients who underwent Orthopaedic and spine surgeries (44.9%) followed by Intercostal drain placements (34.6%), Craniotomies (22.8%) and Laparotomies (14%) in the decreasing order. The non-geriatric population had the maximum number of Craniotomies (40%) followed by Intercostal drain placements (33.5%), laparotomies (23%) and orthopedic and spinal surgeries (15.9%) in the descending order. It can be deduced that the geriatric population, even though had a high number of head injuries underwent a significantly fewer number of craniotomies compared to the non-geriatric population while a significantly higher number of orthopedic and spinal surgeries were performed in the geriatric age group as compared to the non-geriatric population. The non-geriatric population had a higher number of craniotomies performed as compared to the geriatric age group.

Table 7: Comparison of the different operative interventions underwent by the geriatric and non-geriatric trauma populations.

Operative Intervention	Geriatric Population (%) (n = 136/300)	Non-geriatric Population (%) (n=170/300)	P-value
Craniotomy	31 (22.8%)	68 (40%)	Z= -4.0, *p<0.00001*
Laparotomy	19 (14.0%)	39 (23.0%)	Z= -2.7, *p<0.00578*
Orthopaedic and Spine Surgeries	61 (44.9%)	27 (15.9%)	Z= 3.9, *p<0.00008*
Intercostal Drain Placements	47 (34.6%)	57 (33.5%)	Z= -1.0, p=0.28 Not Significant
Others	0 (0%)	3 (1.8%)	Z= -1.7, p=0.08 Not Significant

The geriatric population had a significantly higher crude mortality rate at 39.3% as compared to the non-geriatric population (Table 8). Falls especially ground level falls were responsible for the maximum number of mortalities (58.5%) among all mechanisms of injury followed by RTA (33.1%) in the geriatric trauma population. Road traffic accidents were the cause of the maximum number of mortalities (64.6%) amongst the non-geriatric population in the present study.

Table 8: Mortality according to the Mechanism of Injury in Geriatric and Non-geriatric populations.

Mortality rate	Geriatric Population (n= 118)	Non-geriatric Population (n = 79)	P-value
Crude Mortality (%)	39.3%	26.3%	Z= 3.39 *P<0.01*
Ground level fall + Fall from Height	75	15	Z= 6.8, *p<0.00001*
Ground level Falls	58.5%	2.5%	Z= 10.1, *p<0.00001*
Falls from Height	5.1%	16.5%	Z= -4.1, *p<0.00001*
RTA	33.1%	64.6%	Z= -7.6, *p<0.00001*
Assault	1.7%	6.3%	Z= -2.9, *p<0.0035*
Others	1.6%	10.1%	Z= -2.9, *p<0.0035*

Factors that are independently associated with mortality for the entire population i.e. geriatric and non-geriatric populations is presented with statistical significance in Table 9. These factors have been identified on logistic regression analysis. Odds ratios are used to compare the relative odds of the occurrence of the outcome of interest (e.g. disease or disorder), given exposure to the variable of interest (e.g. health characteristic, aspect of medical history). The odds ratio can also be used to determine whether exposure is a risk factor for a particular outcome and to compare the magnitude of various risk factors for that outcome.

Table 9: Factors Associated with Mortality for the Entire Population Identified on Logistic Regression.

Risk Factor	Odds Ratio	95% Confidence interval	P value
Admission Physiology			
GCS </=8	1.0295	0.7371 to 1.4379	P= 0.864
Mechanism			
Ground level Falls	11.7424	6.6153 to 20.8432	*P<0.0001*
Road Traffic Accidents	0.3944	0.2835 to 0.5488	*P<0.0001*
Injury Severity			
Head AIS >/=3	1.3573	0.9627 to 1.9137	P= 0.0813
Thorax >/=3	0.6316	0.4417 to 0.9030	P=0.00118
Abdomen >/=3	0.3537	0.2397 to 0.5221	*P<0.0001*
Extremities >/=3	1.3349	0.9638 to 1.8489	P= 0.0822
Comorbidities			
Hypertension	3.1513	2.262 to 4.4609	*P<0.0001*
Cerebrovascular disease	1.5897	1.0688 to 2.3647	P= 0.0221
Diabetes mellitus	1.1712	0.8109 to 1.6917	P= 0.3994
Diminished Vision	2.7417	1.8105 to 4.1518	*P<0.0001*
Diminished Hearing	5.6568	3.3329 to 9.6010	*P<0.0001*

Odds ration=1 Exposure does not affect odds outcome.
Odds ratio >1 Exposure associated with higher odds outcome.
Odds ratio <1 Exposure associated with lower odds outcome.

It is clearly evident that Ground level falls (OR - 11.742 and CI - 6.6153 to 20.8432) are independently associated with mortality for the entire population and in the geriatric population ground level falls are significantly high compared to the non-geriatric group. Head (OR - 1.357 and CI - 0.9627 to 1.9137) and extremity injuries (OR - 1.3349 and CI - 0.9638 to 1.8489) are common in both population groups secondary to a traumatic event and thus, also independently are associated with mortality. Amongst, the comorbidities, it is clear that hypertension (OR - 3.1513 and CI - 2.262 to 4.4609), diminished vision (OR - 2.7417 and CI - 1.8105 to 4.1518) and diminished hearing (OR - 5.6568 and CI - 3.3329 to 9.6010) are other major contributors for mortality.

4. Discussion
A comprehensive comparative cross-sectional study on mortality and morbidity and the factors affecting the trauma in geriatric and non-geriatric patients was conducted in a tertiary care and trauma centre in central India. An in-depth evaluation of comorbidities, mechanism of injury, injury pattern and preventive interventions in 300 geriatric population and non-geriatric trauma patients each were undertaken in this study after meeting the pre-decided inclusion criteria. These subjects were then evaluated according to the various parameters and the results obtained were subsequently analyzed.

Demographic details of both the cohorts were collected and analysed. In our study, there was a significant male preponderance (62.7%) in the geriatric whereas the non-geriatric population showed a marginal increase in the males over the females. In the geriatric trauma population, there was a clear male predilection in every age distribution group. A retrospective analysis of the Trauma Audit and Research Network (TARN) database, an ongoing national study of trauma epidemiology in the United Kingdom reported a significantly greater proportion of female patients (42%) in the geriatric group. This could be attributed to the demographic differences between the two regions and populations [10]. The geriatric age range as decided by the inclusion criteria in this study was found to be between 65-89 years and 18-27 years among the non-geriatric group. The mean age amongst this cohort was 72 and 39 years respectively and a similar mean age group of 75 years was reported [10]. Adults between the ages of 18-30 years in this study were found to be more prone to traumatic injuries due to

their risk behaviour which is common in young adults.

The overall experience of an elderly person who sustains a trauma injury can be different from that of a younger patient with trauma, hence a special consideration should be given to proper triage and treatment of the geriatric patient. Vital signs and physical examination can be deceptive in these patients, who may exhibit examination characteristics very different from those of younger patients. Although the ATLS protocol should be followed for geriatric patients just as it is for younger patients, there are some differences in the normal physiology of elderly patients that will make their evaluation and treatment more challenging. Elderly patients also subjectively report less pain for the same severity of injury than do their younger counterparts [11].

Certain vital parameters such as mean systolic blood pressure, mean pulse rate and GCS were recorded on admission in both the study populations, The geriatric population showed a much higher systolic blood pressure on admission at a mean of 130 mm of Hg across all the cases as compared to the non-geriatric age group which had a mean of 117 mm of Hg (Table 4). These observations suggest that the geriatric cardiovascular physiology who have higher baseline blood pressures and ejection fractions, lower left ventricular end-diastolic volumes, stroke volumes, and cardiac outputs compared to younger populations [12]. These findings in our study are in accordance with the findings of earlier reports where the geriatric trauma population also showed a higher mean systolic blood pressure, lower mean pulse rates as compared to the non-geriatric counterparts despite having a higher mean systolic blood pressure across all mechanisms of injury [13].

The physiology of aging affects different organs in the geriatric person especially on the cardiovascular system and significantly impact the care of the geriatric trauma patients. The geriatric patients have systolic and diastolic dysfunction and a blunted response to adrenergic stimulation that may limit vasoconstriction and result in tachycardia response [14, 15, 16, 17] which is magnified by the chronic use of beta-blocking agents in this population. These physiologic changes lead to cardiovascular comorbidities such as hypertension (50% vs 24%), ischaemic heart disease (13% vs 9%) and cerebrovascular disease (25% vs 17%) in geriatric and non-geriatric groups respectively.

Glasgow Coma Scale (GCS) scoring is difficult in the geriatric

patients, who may have pre-existing cognitive deficits, hearing impairment, or other factors that can confound these examinations [18]. The clinical neurologic examination has also been shown to be unreliable in detecting significant hemorrhage in patients with minor head trauma [19]. Thus, a low threshold of reliability in ancillary studies has to be emphasized on the geriatric patient with trauma. In our study, the geriatric population had comparable rates of GCS </= 8 with the non-geriatric population with head injuries being the most common injury pattern across the various mechanisms causing injury. Despite this, the geriatric population showed a higher crude mortality rate compared to their non-geriatric counterparts which underline that there are certain other factors responsible for this. The GCS is, therefore, an unreliable clinical tool, use of computed tomography (CT) has become the essential means of identifying increased intracranial pressure in acute traumatic brain injury [20].

Several factors place the geriatric population at risk for traumatic events, and subsequent delayed recovery from trauma. Conditions that predispose patients to incur trauma are seen in higher prevalence in the elderly population. Weakness or chronic illnesses can lead to an increased rate of falls or other accidents in these patients. Loss of visual acuity, balance and gait instability, slowed reaction times, and cognitive impairments are the important disabilities that are responsible for an increased occurrence of traumatic events in the elderly. Often these issues are not recognized before the trauma, but the cognitive dysfunction can be seen in about 35% of geriatric visitor to the emergency department after trauma [21]. Trauma is considered as a risk factor in elderly patients who have sustained trauma in the past are more likely to have a future traumatic event [21]. Owing to the constellation of problems seen in the elderly, prevention of geriatric trauma should be addressed by clinicians in management of geriatric patients.

Falls account for nearly 75% of all traumas in the geriatric population, with motor vehicle accidents accounting for the remaining 25% of injuries. Penetrating trauma and other mechanisms constitute 4% of total trauma in the geriatric population [22]. Among the elderly patients, nearly 90% experienced simple falls, such as falls from standing. Despite being simple mechanisms, the multiple comorbidities in the elderly population, along with the need for rehabilitation, make falls a significant medical and economic event in the life of these patients. Falls associated with blunt cerebral injury and long bone fractures lead to the greatest morbidity and mortality [23]. Ground level fall with head injuries result in 80% injuries and extremity injuries constitute 22% of other injuries. With these head injury patterns, it evident that mortality rate was higher in geriatric patients after falls compared to the non-geriatric counterparts (25% vs 5%). Although ground level falls are a low-energy mechanism and may seem innocuous, mortality was higher in geriatric patients (23% vs 0%). However, in the non-geriatric population, the most common injury was RTA (57%), with head injury at 72% followed by extremity injuries at 48% respectively. Our findings are similar and comparable to ground level falls, mortality among older, aged patients reported elsewhere [24, 25]. In our study, mortality due to RTA in the geriatric group was relatively low of about 33% compared to 64.5% in the non-geriatric age group.

In our study we have noted that 35% of the injuries that occurred secondary to RTA were thoracic injuries in the geriatric group. It has been well established that elderly patients with rib fractures are at increased risk for adverse outcomes including pneumonia, prolonged ICU stay, ventilator days, and increased mortality [26, 28]. About 25% of all elderly victims of motor vehicle accidents sustain chest trauma with chest and rib fractures, which can complicate pre-existing cardiopulmonary disease and lead to pneumonia or respiratory failure resulting in high morbidity and mortality [29, 30]. RTAs resulting in high energy and velocity injuries contribute to varied and severe injuries in the elderly who have already compromised physiology are incompetent to deal with trauma.

Traumatic brain injury (TBI) is quite common in geriatric patients after both falls and RTA, thus the trauma surgeon must realize the potential lethal combination of TBI and older age. Geriatric trauma patients should receive liberal CT scan because there will be brain atrophy in elder patients that causes stretching of bridging veins and an increased risk of subdural hematoma [31]. Hence, clinical decision-making tools commonly used to evaluate younger trauma patients should not be applied to older trauma patients [31]. Further, the general neurological examination will be unreliable in elderly patients and may miss significant TBI.

Injury Severity Score (ISS) is an important method for describing patients with multiple injuries and evaluating emergency care. For a trauma centre intending to perform an effective review of their service, as well as for the scientific study of trauma, it is important to have an accurate benchmark of mortality risk. This benchmark serves as a predictor of mortality or "expected" outcome for any patient presenting with certain injuries. Trauma and Injury Severity Score (TRISS) utilizes the patient's age, type of injury, Revised Trauma Score (RTS), and the Injury Severity Score to estimate the probability of survival. It considers the patient's physiological injury, a physiological response and anatomic injury [32]. The ISS supplies the anatomic index for TRISS, and has been a standard tool for three decades. A major trauma (polytrauma) is defined as the Injury Severity Score is greater than 15 [33, 34]. In our study, both the geriatric and non-geriatric populations had comparable ISS>/=16 suggesting severe trauma (252 vs 254). The geriatric trauma population had a higher crude mortality rate (39.3% vs 26.3%) compared to the non-geriatric population even though both of them had similar ISS rates of 16 thus suggesting that there are certain factors which are intrinsic to the geriatric group responsible for the higher mortality rate.

Co-morbidities are present in both the geriatric and non-geriatric populations but the relatively higher proportion of the various comorbidities in the geriatric population susceptible to the morbid nature of traumatic injuries. It is not uncommon to find multiple comorbidities in the geriatric population. Our study emphasized the fact that a large proportion of the geriatric population is hypertensive (50%), diabetic (27%). About 25% of them had sustained at least one episode of cerebrovascular accident, about 30% of them had diminished vision and 28% of them had diminished hearing respectively. These comorbidities have a significant impact on the response to a traumatic event in the geriatric population, who are already less healthy as compared to their younger counterparts. It is evident that the comorbidity profile in the geriatric age group is an important and independent risk factor for higher morbidity and mortality.

In our study, both the geriatric and non-geriatric trauma populations were subjected to operative interventions or otherwise afforded conservative management. About 45.3% of the geriatric population underwent various operative interventions while the rest of them were afforded conservative management. It should also be noted that the crude mortality rate of the geriatric age group is also higher compared to the non-geriatric population (39.3% vs 26.3%). Age is an independent

risk factor for mortality in the geriatric age group and thus, a major operative intervention in the setting of an already compromised geriatric physiology with a superadded traumatic event is a major risk factor for mortality in such cases. Similarly, the majority of cases in the geriatric population were secondary to ground level falls leading to mainly head and extremity injuries as previously illustrated. It is interesting to note that the geriatric age group had a higher proportion of orthopedic and spinal surgeries as compared to craniotomies (22.8% vs 44.9%). A severe head injury is more life threatening is afforded priority in the case of a poly-trauma and thus, decides the line of management in such patients. It was observed that severe head injuries in the geriatric population (GCS </=8) were, more often than not, managed conservatively.

The non-geriatric population had a higher rate of undergoing operative interventions compared to the geriatric counterparts (56% vs 45.3%) with a crude mortality rate in the non-geriatric age group being 26.3%. This group had a higher percentage of Craniotomies and Laparotomies performed compared to the geriatric trauma population while the percentages of immediate lifesaving interventions like intercostal drain insertions were comparable in both groups. It is also noted that the geriatric trauma population group was afforded conservative management more commonly than operative interventional procedures. This could be attributed to the fact that a major operative intervention is a major risk factor for morbidity and mortality in geriatric trauma patients. An operative intervention has inherent risk factors including both surgical and anesthetic complications. However, it affects the geriatric population more than the non-geriatric population considering the already compromised physiology secondary to the process of aging.

In conclusion, elderly patients with trauma must be triaged, evaluated, and treated differently from their younger counterparts. Older adults have unique physiologic and structural differences and are at a higher risk of mortality even in minor trauma. Thus, Trauma care should have special considerations and protocols to meet specific needs of older patients during trauma.

5. References

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