Injury Characteristics and Outcomes in Elderly Trauma Patients in Sub-Saharan Africa

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Published online: 7 July 2016

Abstract

Background Traumatic injury in the elderly is an emerging global problem with an associated increase in morbidity and mortality. This study sought to describe the epidemiology of elderly injury and outcomes in sub-Saharan Africa.

Methods We conducted a retrospective analysis of adult patients ($\geq$ 18 years) with traumatic injuries presenting to the Kamuzu Central Hospital (KCH) in Lilongwe, Malawi, over 5 years (2009–2013). Elderly patients were defined as adults aged $\geq$65 years and compared to adults aged 18–44 and 45–64 years. We used propensity score matching and logistic regression to compare the odds of mortality between age groups using the youngest age group as the reference.

Results 42,816 Adult patients with traumatic injuries presented to KCH during the study period. 1253 patients (2.9 %) were aged $\geq$65 years with a male preponderance (77.4 %). Injuries occurred more often at home as age increased (25.3, 29.5, 41.1 %, $p < 0.001$) and falls were more common (14.1, 23.8, 36.3 %, $p < 0.001$) for elderly patients. Elderly age was associated with a higher proportion of hospital admissions (10.6, 21.3, 35.2 %, $p < 0.001$). Upon propensity score matching and logistic regression analysis, the odds ratio of mortality for patients aged $\geq$65 was 3.15 (95 % CI 1.45, 6.82, $p = 0.0037$) compared to the youngest age group (18–44 years).

Conclusions Elderly trauma in a resource-poor area in sub-Saharan Africa is associated with a significant increase in hospital admissions and mortality. Significant improvements in trauma systems, pre-hospital care, and hospital capacity for older, critically ill patients are imperative.

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Introduction

The world is aging rapidly. From 2000 until 2050, the world's population aged 60 and over will more than triple from 600 million to 2 billion. Most of this increase is occurring in less developed countries where the number of older people will rise from 400 million in 2000 to 1.7 billion by 2050 [1, 2]. In fact, low- and middle-income countries (LMIC) will account for 80 % of people older than 60 years globally by 2050 [3]. The lack of health care and public health infrastructure that currently exists in LMIC, especially countries in sub-Saharan Africa, portends an ominous sign for care of the elderly in the years to come.

Traumatic injury and its associated treatment is a global challenge and is endemic at all ages accounting for 16 % of all adult morbidity and premature death worldwide [4]. The burden is disproportionately high in LMIC, which bears 90 % of global mortality from traumatic injury, particularly from road traffic injuries [5, 6]. Trauma mostly affects the younger segment of society (<45 years) and more emphasis and resources have understandably been extended to this group of trauma patients [7]. With an increasing life expectancy, traumatic injury in the elderly is emerging as a serious public health concern with an associated increase in morbidity and mortality compared to younger patients [8–10].

While traumatic injury in the elderly has been well described in high-income countries, very little data on elderly trauma have been published from sub-Saharan Africa [11–15]. To address this gap, we evaluated the common mechanisms, patterns of injury, and outcomes associated with elderly trauma patients compared to other adult trauma patients presenting to our tertiary trauma center in Lilongwe, Malawi.

Methods

This study is a retrospective analysis of secondary data from the Kamuzu Central Hospital (KCH) Trauma Registry. KCH is a public 600-bed tertiary care hospital in the capital city of Lilongwe, which serves as a referral center for approximately 5 million people in the central region of Malawi. KCH is equipped with four ICU beds and four ventilators and a surgical step-down unit. Trauma and orthopedic surgical services are available 7 days a week. General surgery consultants and Malawian general surgery registrars staff the trauma service. Dedicated neurosurgical expertise or subspecialists are not available.

The KCH Trauma Registry was established to collect patient demographic information, clinical characteristics, and outcome data of all patients presenting to the emergency department with traumatic injuries. We used the Alert, Voice, Pain, Unresponsive (AVPU) Scale which records a patient's level of consciousness as either alert, responding to verbal stimuli, responding to pain stimuli, or unresponsive. It correlates with the Glasgow Coma Scale, and the United States Advanced Trauma Life Support (ATLS) protocol uses it in its primary survey [16, 17]. All adult patients (≥18 years old) who presented to the emergency department with traumatic injuries over 5 years between January 2009 and December 2013 were included in this study. Patients less than 18 years old or patients missing a recorded age or birthdate were excluded from analysis.

Elderly age was defined as age ≥65 years based on the accepted definition in high-income countries [9, 18]. Admittedly, there is debate on the appropriate definition of the elderly in LMICs due to a lower life expectancy. Some studies use 50, 55, or 60 years as their definition [10, 19, 20]. To account for these differing definitions, we created an additional age category, 45–64 years that encompasses these varying definitions of elderly, while also allowing a comparison between elderly, middle-aged, and younger patients. This resulted in three age cohorts for comparison: 18–44 years, 45–64 years, and ≥65 years. We performed bivariate analysis using χ^2 tests for categorical variables and one-way analysis of variance tests or a Kruskal–Wallis test for continuous variables to compare the characteristics between our three age groups. When comparing categorical variables with more than two categories, the aggregate of the remaining categories was used as the referent for comparison. The overall crude mortality was calculated using any deaths declared in the emergency department and any deaths in the hospital against all patients recorded in the trauma registry. In-hospital mortality excluded any deaths from the emergency department.

Additionally, propensity score matching analysis was performed to determine the relative odds of mortality due to age in the 18- to 44-year-old group versus both the 45–64 and ≥65-year-old age groups. All propensity score analysis was done using the R programming language and the R MatchIt package was used to match entries based off of this propensity score [21, 22]. Patients were matched using the covariates of gender, initial AVPU score, and their three primary traumatic injury types. Initially, the three different age categories were randomly sorted. Then the first "treatment" group (patients not in the 18–44 age groups) was matched with the "control group" (18–44 age group), based on the absolute value of the difference between the propensity score of the treatment and control groups under consideration. The closest control unit is selected as a match. The procedure was performed twice. First, the dataset was paired down to just patients ages 18–64 years. Then, patients age 45–64 years were marked as the treatment group. Next, logistic regression was repeatedly performed on the new matched dataset with factors eliminated or added until the maximum numbers of factors were found such that all were deemed to have a statistically significant effect in patient mortality by the Wald z-statistic and the associated p value. We compared the elderly cohort (age ≥65 years) with the control group (age 18–44 years) and the middle age group (age 45–64 years) with the control group. Odds ratios with 95 % confidence intervals are reported.

All other statistical analysis was performed using Stata/SE 13.1 (Stata- Corp LP, College Station, TX, USA). The University of North Carolina Institutional Review Board

Table 1 Bivariate analysis of patient characteristics of adults presenting with traumatic injuries by age group

	18–44 years (n = 36,826)	45–64 years (n = 4737)	≥65 years (n = 1253)	p Value
Patient age (years)				
Mean ± SD	28.5 ± 6.5	52.1 ± 5.3	72.5 ± 6.4	
Gender: n (%)				
Female	8727 (22.5)	1364 (28.8)	439 (35.0)	<0.001
Male	28,523 (77.4)	3370 (71.1)	813 (64.9)	
Missing	31 (0.1)	3 (0.1)	1 (0.1)	
Setting of injury: n (%)				
Home	9311 (25.3)	1395 (29.5)	515 (41.1)	<0.001
Work	4635 (12.6)	568 (12.0)	79 (6.3)	<0.001
Road/street	16,255 (44.1)	2063 (43.6)	442 (35.3)	<0.001
Public space	2600 (7.1)	175 (3.6)	31 (2.5)	<0.001
Other	2060 (5.6)	168 (3.6)	57 (4.6)	<0.001
Missing	1965 (5.3)	368 (7.8)	129 (10.3)	<0.001
Mechanism of injury: n (%)				
Pedestrian hit by vehicle	3034 (8.2)	467 (9.9)	165 (13.2)	<0.001
Driver/passenger in vehicle accident	8.458 (23.0)	1285 (27.1)	243 (19.4)	<0.001
Fall	5185 (14.1)	1128 (23.8)	455 (36.3)	<0.001
Assault	13,599 (36.9)	982 (20.7)	170 (13.6)	<0.001
Collapsed structure	2019 (5.5)	291 (6.2)	80 (6.4)	0.055
Other	3887 (10.6)	460 (9.7)	108 (8.6)	0.036
Missing	644 (1.7)	124 (2.6)	32 (2.5)	<0.001
Hours to presentation from injury				
Median (IQR)	3 (1–13)	4 (1–18)	8 (2–37)	<0.001
Missing (%)	1578 (4.3)	291 (6.1)	109 (8.7)	
Transport to hospital				
Minibus	10,584 (28.7)	1219 (25.7)	280 (22.4)	<0.001
Private Vehicle	15,885 (43.1)	1872 (39.5)	414 (33.0)	<0.001
Ambulance	3073 (8.3)	763 (16.1)	339 (27.1)	<0.001
Walked	1621 (4.4)	159 (3.4)	37 (3.0)	0.001
Police	2345 (6.4)	180 (3.8)	47 (3.8)	<0.001
Other	2250 (6.1)	309 (6.5)	39 (3.1)	<0.001
Missing	1068 (2.9)	235 (5.0)	97 (7.8)	<0.001
Initial AVPU Score: n (%)				
Unresponsive	351 (0.9)	41 (0.9)	23 (1.9)	0.002
Responds to Pain	104 (0.3)	14 (0.3)	3 (0.2)	0.953
Alert or responds to voice	34,844 (94.9)	4402 (92.9)	1114 (88.9)	0.013
Missing	1437 (3.9)	280 (5.9)	113 (9.0)	<0.001
Disposition from casualty: n (%)				
Treated and discharged	29,541 (80.2)	3362 (71.0)	650 (52.0)	<0.001
Admitted to ward	6484 (17.6)	1258 (26.5)	552 (44.0)	<0.001
Admitted to ICU	149 (0.4)	36 (0.8)	8 (0.6)	0.002
Death declared in casualty	413 (1.1)	48 (1.0)	32 (2.5)	<0.001
Missing	239 (0.7)	33 (0.7)	11 (0.9)	0.586
Mortality: n (%)				
Combined casualty and inpatient	642 (1.7)	119 (2.5)	70 (5.6)	<0.001
Inpatient mortality	231 (4.9)	70 (7.6)	38 (9.3)	<0.001
Missing	2130 (5.8)	400 (8.4)	160 (12.8)	<0.001

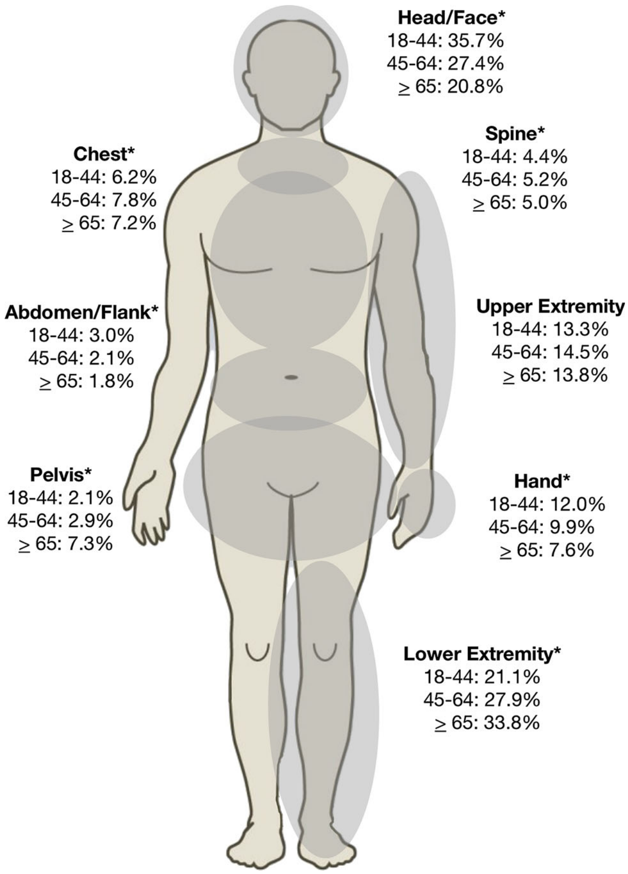

Fig. 1 Most severe traumatic injury location by age group (*$p < 0.05$)

and the Malawi National Health Services Review Committee approved this study.

Results

68,162 patients with traumatic injuries presented to KCH during the study period with 42,816 adult patients (age ≥18 years). 931 patients (2.2 %) were missing a recorded age and were not included in the analysis. 36,826 (86.0 %) patients were aged 18–44 years, 4737 (11.1 %) aged 45–64 years, and 1253 (2.9 %) aged ≥65 years with a male preponderance of 77.4, 71.1 and 64.9 % for each age category, respectively ($p < 0.001$) (Table 1).

Traumatic injuries occurred more often at home as patients increased in age (25.3, 29.5, 41.1 %, $p < 0.001$) with road traffic-associated trauma decreasing as age increased (44.1, 43.6, 35.3 %, $p < 0.001$). There were also significant differences in the mechanism of injury between groups. Falls increased dramatically as patients aged (14.1, 23.8, 36.3 %, $p < 0.001$), while assaults decreased (36.9, 20.7, 13.6 %, $p < 0.001$). Within motor vehicle related trauma, there were variations between groups. The incidence of driver- or passenger-related injury decreased with each age cohort (23.0, 27.1, 19.4 %, $p < 0.001$), while the incidence of vehicular-related injury to pedestrians increased (8.2, 9.9, 13.2 %, $p < 0.001$). Elderly patients presented later compared to other age groups with a median time from injury to presentation of 8 h (IQR 2–37 h) compared to 3 h (IQR 1–13 h) and 4 h (IQR 1–18 h) in the 18–44 years old and 45–64 years old age groups, respectively ($p < 0.001$). Elderly patients were also more likely to arrive by ambulance (8.3, 16.1, 27.1 %, $p < 0.001$) and less likely by a private vehicle (43.1, 39.5, 33.0 %, $p < 0.001$). The GCS score and the Revised Trauma Score (RTS) were not reliably recorded in the registry until 2011, but for those patients with recorded scores differences were small and not clinically significant.

Injury patterns between age groups were very different. In the elderly population, fractures were three times more common than in the youngest age group (10.6, 21.3, 35.2 %, $p < 0.001$). (Figure 1) In terms of injury location, the most significant differences were in the head/face and lower extremity injuries. Head and face injuries were much more common in younger patients (35.7, 27.4, 20.8 %, $p < 0.001$), while lower extremity injuries (21.1, 27.9, 33.8 %, $p < 0.001$) and pelvic injuries (2.1, 2.9, 7.3 %, $p < 0.001$) were more common in elderly patients. (Figure 2).

Most patients were evaluated, treated, and discharged home from the emergency department (80.3, 71.1, 52.0 %, $p < 0.001$), but proportionally far more elderly patients were admitted to the hospital compared to the other age groups (18.0, 27.3, 44.6 %, $p < 0.001$). Additionally, there

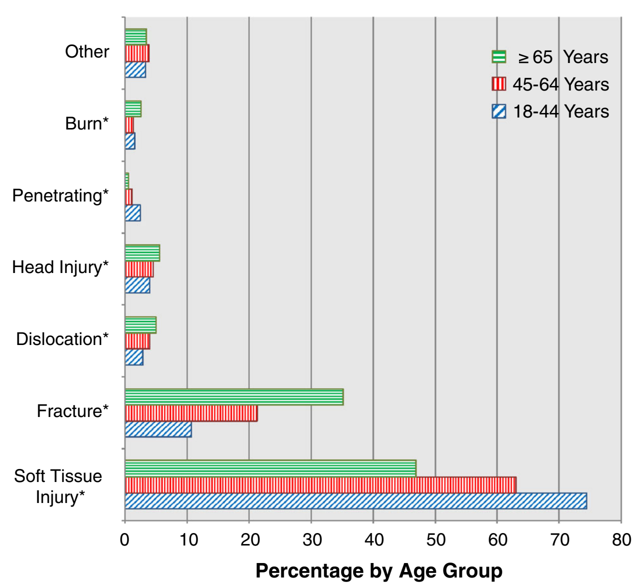

Fig. 2 Most severe traumatic injury type by age group (*$p < 0.05$)

were more deaths declared in the emergency room for elderly patients (1.1, 1.0, 2.5 %, $p < 0.001$). Once hospitalized, the mean hospital length of stay (± SD) was significantly longer for elderly patients (10.8 ± 17.1, 13.2 ± 17.9, 18.1 ± 19.3 days, $p < 0.001$). For all patients, only fractures were associated with an increased length of stay (mean 9.3 ± 16.4 vs. 16.7 ± 18.8 days, $p < 0.001$). There were differences in surgical intervention for the admitted patients between the age groups with a slightly greater proportion of younger patients receiving an operation (15.5, 14.0, 11.9 %, $p = 0.032$). Elderly patients underwent a much greater proportion of orthopedic procedures and fewer wound repairs. The three most common procedures performed by age group were wound debridement/repair (55.1, 46.4, 23.6 %, $p < 0.001$), orthopedic procedures (21.1, 29.4, 51.4 %, $p < 0.001$), and exploratory laparotomy (8.4, 4.1, 2.8 %, $p = 0.034$).

The overall mortality prevalence for elderly patients was over three times the prevalence for the younger age group and two times the prevalence of the middle age group (1.7, 2.5, 5.6 %, $p < 0.001$). (Table 1) After excluding deaths in the emergency department, the inpatient mortality prevalence was also higher for elderly patients (4.9, 7.6, 9.3 %, $p < 0.001$). Upon propensity score matching, logistic regression analysis revealed an odds ratio of death for elderly patients to be 3.15 (95 % CI 1.45, 6.82, $p = 0.0037$) compared to the youngest age group (18–44 years) when adjusting for severe injury types and initial AVPU score. Middle-aged patients (45–64 years) also had an increased odds ratio of death compared to the youngest age group at 1.82 (95 % CI 1.15, 2.89, $p = 0.0109$) adjusting for severe injury types and initial AVPU score.

Within injury types, head injury had the highest mortality rate at 22.6 % for all patients. All other injury types had a mortality rate lower than 8 %. When examining injury-specific mortality by age, mortality was much higher with head injury for elderly patients compared to younger patients (21.1, 25.2, 45.7, $p < 0.001$), but older patients had a lower mean initial GCS (13.5 ± 3.4, 13.0 ± 3.7, 9.7 ± 5.7, $p < 0.001$). Logistic regression modeling adjusting for initial GCS, gender, and hours to presentation revealed an increased adjusted odds ratio of death of 3.12 (95 % CI 1.05, 9.25, $p = 0.040$) for elderly patients compared to the youngest age group in the presence of a head injury.

We performed a sensitivity analysis comparing patients missing an outcome with those who had an outcome recorded to assess if these data variables were missing at random. 2931 (6.7 %) were missing a recorded outcome with more elderly patients missing this variable than other age groups (5.8, 8.4, 12.8 %, $p < 0.001$). For those missing a recorded outcome, there were no significant differences between admission disposition ($p = 0.66$), length of stay ($p = 0.29$), GCS score ($p = 0.67$), or RTS score ($p = 0.20$) across age groups.

Discussion

The elderly population in sub-Saharan Africa is increasing and will rise exponentially over the next four decades [1]. While Malawi has a shorter life expectancy compared to high-income countries, it has improved substantially over the last decade from only 50 years in 2006 to 63 years in 2014, increasing the size of the elderly population [23]. This is consistent with the rest of sub-Saharan Africa, which has also improved over the same time span from 53.4 years in 2006 to 58.6 years in 2014 [24]. Consequently, there is an urgent need to understand the impact of this segment of the population on the health-care system, particularly in this region, where most health-care systems are resource constrained.

This study shows a significant increase in mortality in the elderly trauma cohort compared to other adult trauma patients. This observed difference in mortality is primarily attributable to traumatic brain injury (TBI). Furthermore, in the elderly trauma cohort, admission rates were double that of the younger cohort as was hospital length of stay. Our findings are consistent with several studies, which demonstrate that older age is an independent predictor of trauma-associated mortality, with some studies showing mortality rates in the elderly to be more than double those of younger patients [7–10, 25–28]. The described mortality rates vary widely, but a 2014 meta-analysis reported an in-hospital mortality rate of 14.8 %, a finding comparable to ours [9].

With regard to TBI, there is clear evidence that mortality is strongly associated with increasing age, even with less severe injuries, and that the risk may start increasing as early as age 30 years with some reported mortality rates as high as 30 % [29–33]. While our reported mortality is higher than that reported in the literature, the trend is similar with an exceptionally high mortality for elderly patients compared to younger adults, even when controlling for GCS. With nearly a 50 % mortality rate among elderly patients with TBI, only 0.6 % of this elderly cohort was admitted to the ICU.

This demonstrates that there is much room for improvement with regard to TBI management in Malawi and throughout the region. At our institution, we only have four ICU beds and four working ventilators available for the entire hospital. A larger ICU is currently under construction, but appropriate physician and nursing personnel will likely not be available for most beds. While our general and orthopedic surgery programs are well staffed with trainees and consultants, sub-specialists are often not available. The entire country relies on the intermittent availability of one neurosurgeon and neuro-critical care is non-existent. Few of the surgeons are competent to perform Burr holes. Further complicating the situation for neurosurgical care is the lack of advanced imaging. Our hospital previously had a CT scanner, but it has been non-operational for more than a year due to a lack of maintenance funding. A lack of sub-specialty care, limited critical care capacity, and the absence of advance imaging create a lethal triad of system deficiencies for elderly trauma patients with TBI, or any complex trauma injury.

Improvement to the care of the elderly trauma patient will require significant systematic changes in pre-hospital care as well. While the elderly in our study utilized pre-hospital services more frequently compared to younger patients, less than one-third were transported via ambulance. Data from the USA demonstrate that large-scale trauma systems can improve outcomes in severely injured elderly patients, but these are difficult to implement [34]. Recent management guidelines for elderly trauma patients in the USA focused on aggressive triage, correction of coagulopathy, and limitation of care in patients with a very poor prognosis [35]. These recommendations highlight the deficiencies in our environment where emergency departments are understaffed, banked blood is often unavailable, and hospice care and counseling are non-existent.

In contrast to our findings, the evidence is conflicting on whether elderly age is associated with an increase in hospital admissions in developed countries with some data suggesting that the elderly may have disparate access to care, resulting in lower admission and transfer rates to tertiary trauma centers [27, 36]. However, it does appear that a longer length of stay can lead to exceptionally high costs, even for simple falls [37]. At our center, fractures, which are much more common in the elderly, were the only injury type associated with an increased length of stay. While our study did not include a cost analysis, the combination of a significantly higher admission rate with a longer length of stay, especially for those with fractures, suggests that elderly trauma patients likely account for a higher proportion of trauma-associated health-care costs in an environment already constrained by limited resources.

There is a paucity of data on the characteristics and outcomes of the elderly trauma patient in sub-Saharan Africa. A few studies have been published, mostly with very small cohorts of elderly patients and most without comparison to younger patients [11–15]. The most relevant studies were from neighboring Tanzania and Kenya. Saidi et al. showed similar patterns of injury to our study with a comparable percent of elderly patients in their trauma population (4.5 vs. our 2.9 %) [11]. Chalya et al. had different findings in neighboring Tanzania, where nearly 25 % of all patients were 60 years or older [12], They also had a very high rate of assault (52.1 vs. our 13.6 %) with an associated increase in upper extremity injuries. Their high assault rate compared to our study and Saidi's report is likely explained by local socioeconomic factors. Despite their small cohort, like our study, Saidi also found that older patients were more likely to have a head injury, unintentional injury, and a non-traffic-related mechanism. Both studies had similar in-hospital mortality to ours with Chalya's study at 14.9 % and Saidi's study reporting 13.9 %. Odihiambo's verbal autopsy study suggested that trauma was a significant problem for the elderly and may contribute to death more often in older patients than in younger patients [15].

While the limitations of our study are consistent with the limitations of retrospective data analysis methodology, our study presents data from the largest published cohort of elderly patients suffering traumatic injury in sub-Saharan Africa. There is likely some selection bias, because we do not have data on trauma-associated pre-hospital mortality. There is evidence that elderly patients suffer a greater pre-hospital mortality than younger patients and thus we may be underrepresenting the number of elderly patients suffering traumatic injuries and associated mortality [19]. However, the proportion of the elderly cohort in our trauma population mirrors that of the Malawian population at approximately 3 % [38].

Also, we acknowledge the issues of missing data, especially some variables that were only recorded in the last 3 years of the study period such as GCS. We are also missing more outcome data for geriatric patients compared to younger patients, which may mean we are underreporting the mortality rate for this population. Lastly, while we do not have comorbidity data in our database, in this setting most patients do not have access to primary health-care services and would not have any known medical conditions. There is also conflicting evidence in developed countries on the importance of medical comorbidities on mortality from traumatic injury [39].

Conclusion

Trauma in elderly patients in sub-Saharan Africa is associated with a significant increase in hospital admission rate and mortality. The setting, mechanism, and pattern of injury differ between elderly and other adult patients, and trauma centers in low-resource settings must be prepared to meet the growing needs of aging trauma patients. Significant improvements in trauma systems, pre-hospital care, and hospital capacity for older, critically ill patients are imperative.

Acknowledgments The basic human body outline image was provided for free by ClipArtBest at http://www.clipartbest.com/clipart-RiA6aqxLT.

Funding Financial support was provided by the North Carolina Jaycee Burn Center in the Department of Surgery at the University of North Carolina.

Compliance with ethical standards

Conflict of interest The authors have no conflict of interest to disclose.

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