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Affordability impacts therapeutic intensity of acute management of severe traumatic brain injury patients: An exploratory study in Tanzania

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ABSTRACT

Introduction: Quality health care in low and middle-income countries (LMICs) is constrained by financing of care.
Research question: What is the effect of ability to pay on critical care management of patients with severe traumatic brain injury (sTBI)?
Material and Methods: Data on sTBI patients admitted to a tertiary referral hospital in Dar-es-Salaam, Tanzania, were collected between 2016 and 2018, and included payor mechanisms for hospitalization costs. Patients were grouped as those who could afford care and those who were unable to pay.
Results: Sixty-seven patients with sTBI were included. Of those enrolled, 44 (65.7%) were able to pay and 15 (22.3%) were unable to pay costs of care upfront. Eight (11.9%) patients did not have a documented source of payment (unknown identity or excluded from further analysis). Overall mechanical ventilation rates were 81% (n=36) in the affordable group and 100% (n=15) in the unaffordable group (p=0.08). Computed tomography (CT) rates were 71.6% (n=48) overall, 100% (n=44) and 0% respectively (p<0.01); Surgical rates were 16.4% (n=11) overall, 18.2% (n=8) vs. 13.3% (n=2) (p=0.67) respectively. Two-week mortality was 59.7% overall (n=40), 47.7% (n=21) in the affordable group and 73.3% (n=11) in the unaffordable group (p=0.09) (adjusted OR 0.4; 95% CI: 0.07-2.41, p=0.32).
Discussion and Conclusion: Ability to pay appears to have a strong association with the use of head CT and a weak association with mechanical ventilation in the management of sTBI. Inability to pay increases redundant or sub-optimal care, and imposes a financial burden on patients and their relatives.

1. Introduction

Severe traumatic brain injury (TBI) is a life-threatening condition requiring emergent management and carries an immense medical and social cost. The burden of TBI is increasing in low- and middle-income countries (LMICs) while infrastructural capacity is not keeping up with the growth in disease burden (James et al., 2019; Mangat et al., 2018). This means that poor outcomes after severe TBI disproportionally occur in LMICs where 90% of all TBI-related deaths occur (Johnson and Griswold, 2017). This inequality is due to the double hazard developing countries are facing: higher preponderance of risk factors for TBI combined with limited infrastructure to manage acute and severely ill TBI patients, few neurosurgeons and poor ambulatory and paramedical care (Mangat et al., 2018; Boniface et al., 2017). Therefore, addressing the global burden of TBI not only requires prevention strategies to reduce the incidence of TBI, but also requires health-care systems to ensure adapted response strategies to alleviate the financial and psychological burden for patients and their relatives (Aenderl et al., 2014; Baker et al., 2013).

In Eastern sub-Saharan Africa, the incidence rate of TBI in 2016 was 1.2 million persons per year, of which over 10% occur in Tanzania (James et al., 2019). Furthermore, the incidence of moderate and severe

Abbreviations: GCS, Glasgow Coma Scale; CT, Computed tomography; HIC, High income country; ICU, Intensive care unit; IRB, Institutional Review Board; LMIC, Low- and middle-income country; MNH, Muhimbili National Hospital; MOI, Muhimbili Orthopedic Institute; OOP, Out of pocket; TBI, Traumatic brain injury.

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TBI is the highest in the population aged 20–30 years. In a middle-income country like Tanzania, most victims of road traffic accidents are young males of working age and suffer various degrees of transient or permanent disability (Aenderl et al., 2014; Kiwango et al., 2013). Besides health impairments, the financial burden on healthcare systems and families of victims is high due to a lack of universal health coverage. Indeed, still today half of healthcare financing in low-income countries comes from direct out-of-pocket (OOP) payments (Otieneo and Asiki, 2016).

Several studies have examined the epidemiology of severe TBI in LMIC and reported gaps in the management of patients due to economic barriers (Abiiro et al., 2014; Bonow et al., 2018; Kabore et al., 2017; Stewart et al., 2015). Our group has recently demonstrated excess mortality of 24% in a large cohort of patients at a tertiary referral center in Tanzania, from gaps in in-hospital care of severe TBI patients resulting in a 2-week mortality of 67% (Mangat et al., 2021). However, data on how economic factors directly influence management and outcomes of severe TBI patients in LMIC are lacking.

As part of a larger project to understand dynamics of care in low-resource settings, this study explores the immediate impact of affordability of care on medical management of patients suffering severe TBI and their outcomes, in a country with a mixed payor system. More specifically, the objective of this study is to determine how affordability of care directly influences the use of life-saving measures such as mechanical ventilation, CT scanning and surgery. In addition, we analyzed the effect of ability to pay on other critical care interventions and 2-week mortality.

2. Methods

2.1. Study design and population

We conducted a retrospective analysis of prospectively collected observational data at Muhimbili Orthopedic Institute (MOI), a tertiary care stand-alone hospital specialized in traumatology, orthopedics and neurosurgery, that is part of a sprawling national hospital (MNH) campus in Dar-es-Salam, Tanzania. Data were collected between June 2016 and July 2018 for patients admitted during that period. All patients admitted with severe traumatic brain injury were included in this study. Patients in a moribund condition at admission were excluded from the study.

2.2. Payor mechanisms and ability to pay

At MOI, payor mechanisms can be classified as follows. Firstly, patients can have insurance: private or national health insurance. Secondly, costs may be covered by social welfare mechanism (sponsored by the government). Thirdly, patients can self-pay and meet expenses OOP. In this category, patients can either afford to pay completely, pool resources from family and friends, or are unable to meet expenses, especially upfront costs. We categorized groups into those who could 'afford to pay' and those who could 'not afford to pay'; this essentially grouped insured, social welfare patients with self-pay patients who could meet OOP expenses, and were compared to those who could not meet OOP expenses.

2.3. Outcomes

Primary outcomes were incidence of interventions such as undergoing mechanical ventilation, CT scan, and neurosurgical intervention. Other outcome measures used were incidence of general critical care interventions, and overall association of affordability with 2-week mortality.

2.4. Data collection

Data on the management of severe TBI patients were collected as part of a TBI quality improvement project. Patient characteristics were reported, and routinely assessed data including Glasgow Coma Scale (GCS) score, oxygen therapy, medications, imaging, surgery and mortality at two-weeks were collected. Data on the funding of healthcare were collected when available. Finally, time of injury and admissions (day and hour) at MOI and MNH were recorded. All data were entered into the Brain Trauma Foundation TBI-trac® database, where subjects are anonymized at entry and no key exists to retrospectively identify patients. The data are stored on the servers of the Brain Trauma Foundation with secure back-up and access limited to the project lead (HSM) only.

2.5. Statistical analysis

Continuous variables were described using means and standard deviations, or median and inter-quartile interval. Categorical variables were described using frequencies and proportions. Chi-square tests or Fisher's exact tests were used to identify differences in baseline characteristics (age categories, GCS score) and differences in management between funding groups. Crude odds and odds ratios with a 95% confidence interval were calculated to identify possible association between funding status of the patient and use of CT, mechanical ventilation, surgery and two-week mortality. Finally, a logistic regression model was used to identify possible independent variables predicting 2-week mortality. Data were analyzed using STATA (StataCorp. 2013. *Stata Statistical Software: Release 13*. College Station, TX). All statistical tests were 2-sided with a significance level of $p < 0.05$.

2.6. Management of severe TBI at MOI

In Dar-es-Salaam, Tanzania, no organized pre-hospital system exists and patients suffering from TBI are brought to the emergency department of the main hospital (MNH) by the community. At MNH, basic life support is provided and depending on the degree of injury, patients are referred to MOI for specialized care. The neurosurgery team at MOI determines whether patients require a head computed tomography (CT) and send the patients back to MNH for imaging. On their return at MOI, patients are managed following a TBI protocol tailored to the Tanzanian healthcare system and implemented in 2014, though compliance varies due to dynamic changes in resources. Intracranial pressure (ICP) monitoring is not performed at MOI due to limited experience and resources. Patients are managed and treated in the Intensive Care Unit (ICU) and wards, depending on the severity of their injury and bed availability. Additionally, payment for CT is required upfront prior to the scan being performed.

2.7. Ethical considerations

The study is deemed as a quality improvement project and utilizes anonymized data. Thus, it was deemed exempt from IRB review by MOI as well as Weill Cornell Medical College IRB board. The TBI-trac® database was made accessible to the team at MOI by the Brain Trauma Foundation.

3. Results

3.1. Epidemiology and general management

In total, 67 patients with severe TBI were included between June 2016 and May 2018. The majority of patients were male (86.6%) and the median age was 30 years (IQR 22–40 years) (Table 1). Thirty-five patients (52.2%) had GCS recorded prior to admission (recorded at MNH) while 58 patients (86.6%) had GCS recorded at the emergency department (recorded at MOI); 44 patients (75.8%) had an admission GCS score of 3–6, 13 patients (22.4%) had a GCS between 7 and 8, and 1 patient (1.7%) had a GCS score above 8 on admission at MOI before neurological deterioration. Head CT was done in 48 patients (71.6%) on admission at

Table 1
Baseline characteristics and management strategy of all severe traumatic brain injury patients (IQR: interquartile range; CT: computed tomography; GCS: Glasgow Coma Scale; MNH: Muhimbili National Hospital; MOI: Muhimibili Orthopedic Institute).

VARIABLES	N = 67	%
Age, median (IQR), years		
	30.0 (22–40)	
Sex		
Male	58	86.6
Female	9	13.4
Source of funding		
Financing available	44	65.7
Direct OOP affordable	5	7.5
Insurance	5	7.5
Cost-sharing	34	50.7
No financing available	15	22.34
Unknown	4	5.97
Did not complete TBI protocol	4	5.97
GCS at MNH		
3–6	21	60.0
7–8	11	31.4
>8	3	8.5
GCS at MOI		
3–6	44	75.8
7–8	13	22.4
>8	1	1.7
Mechanical Ventilation		
Yes	59	88.1
No	8	11.9
CT scan		
Yes	48	71.6
No	19	28.3
Reasons for no CT		
Financing	15	78.9
Medically unstable	1	5.3
Mechanical ventilation	3	15.8
Delay from MOI to CT (median (IQR), hrs)	2.8 (1–12.5)	
<4 h	21	65.6
5–8 h	2	6.2
>8 h	9	28.1
Follow-up CT		
Yes	11	10.5
No	60	89.5
Surgery		
Yes	11	16.4
No	56	83.6
Outcome		
2-week mortality	40	59.7

MOI and 59 (88.1%) were mechanically ventilated. Surgery was performed in 11 patients (16.42%); 2-week mortality was 59.7% (n = 40). Finally, mean time from injury to admission at MNH was 25.6 ± 32.9 h, mean time from injury to admission at MOI was 35.4 ± 34.0 h, and mean time from admission at MOI to first head CT was 8.9 ± 5.8 h.

3.2. Payor mechanisms

The payor mechanisms were distributed as follows: 44 patients (65.7%) were in the category 'able to pay' (5 patients had private insurance, 5 could afford upfront OOP payment and 34 paid from social welfare, cost-sharing or upfront family contributions). Of the remaining patients, 15 (28.4%) were patients who were 'unable to pay', all of whom were in the OOP group. Four patients (6.0%) did not have payor mechanism documented and were therefore excluded from further analyses. Another 4 patients were too medically instable to continue the TBI management protocol, and thus did not incur costs of care, for example, a CT scan. Therefore, these patients were also excluded from further analysis on the impact of affordability on critical care management. There were no significant differences in age ($p = 0.19$), GCS score on admission ($p = 0.63$), or delay in arrival at the hospital ($p = 0.43$) between the 2 payor groups (Table 2).

3.3. Payor mechanism associated with interventions

In the 'able to pay' group, 36 patients (81.8%) were mechanically ventilated whereas all patients in the 'unable to pay' group were mechanically ventilated ($p = 0.10$) (Table 2). Head CTs were done in all 44 (100%) patients in the 'able to pay' group compared to 0 patients in the 'unable to pay' category ($p < 0.01$). Surgery was not associated with ability to pay: 8 (18.2%) 'able to pay' patients underwent surgery compared to 2 (13.3%) patients who were 'unable to pay' ($p = 1.00$). Finally, 2-week mortality in those 'able to pay' was 47.7% (n = 21) compared to 73.3% (n = 11) in those 'unable to pay' ($p = 0.09$).

In critical care management, there was a significantly higher rate of enteral feeding (86.4% (n = 38) vs. 53.3% (n = 8) $p = 0.01$), use of antiseizure prophylaxis (95.5% (n = 42) vs. 73.3% (n = 11), $p = 0.03$), ulcer prophylaxis (90.9% (n = 40) vs. 60.0% (n = 9), $p = 0.01$), and mannitol use (75.0% (n = 33) vs. 46.7% (n = 7), $p = 0.04$) in patients who could afford upfront costs (Table 2). ICU admission frequency was also higher though not statistically significant (40.9% (n = 18) vs. 26.7% (n = 4), p

Table 2
Baseline characteristics and management of severe TBI patients grouped by payor mechanism (GCS: Glasgow Coma Scale; MOI : Muhimibili Orthopedic Institute; MNH: Muhimbili National Hospital; ICU: Intensive Care Unit; DVT: Deep Vein Thrombosis; GI : Gastrointestinal; CT: computed tomography. Bold text indicates $p < 0.05$)
*Fisher's exact test\.

Variables	Able to pay (N = 44) n (%)	Unable to pay (N = 15) n (%)	p-value
Age*, median (IQR), years			
<30	32 (22–47)	28 (23.5–34)	0.19
≥30	21 (48.8)	9 (75.0)	
	22 (51.2)	3 (25.0)	
Gender*			
Male	36 (81.8)	14 (93.3)	0.42
GCS score at MOI*			
3–6	29 (76.3)	10 (66.7)	
7–8	8 (21.1)	5 (33.3)	0.63
Delay to MNH, median (IQR), hours*			
<4 h	12 (0–24)	24 (0–24)	
>4 h	12 (32.4)	4 (50.0)	0.43
	25 (67.6)	4 (50.0)	
Transfer from other medical facility			
	27 (61.36)	12 (80.0)	0.19
Admission to ICU	18 (40.9)	4 (26.7)	0.33
Nutrition*	38 (86.4)	8 (53.3)	**0.01**
Antiseizure prophylaxis*	42 (95.5)	11 (73.3)	**0.03**
DVT prophylaxis*	8 (18.8)	3 (20.0)	1.00
GI prophylaxis*	40 (90.9)	9 (60.0)	**0.01**
Mannitol use	33 (75.0)	7 (46.7)	**0.04**
Mechanical ventilation*	36 (81.8)	15 (100)	0.10
Head CT	44 (100)	0 (0)	< **0.01**
Surgery*	8 (18.2)	2 (13.3)	1.00
14-days mortality	21 (47.7)	11 (73.3)	0.09

= 0.33) in patients who could afford upfront payments.

3.4. Outcomes

Patients with a delay of more than 4 h between injury and admission were less likely to die at two weeks compared to patients with a delay of up to 4 h (crude OR 0.3, 95%CI 0.1–1.0, p = 0.04), there being no difference between delays in the two affordability groups (Table 3). Admission to ICU was also significantly associated with lower 2-week mortality (crude OR 0.1, 95%CI 0.0–0.4, p < 0.01), as was enteral feeding (crude OR 0.2, 95% CI 0.0–0.9, p = 0.01). Head CT (crude OR 0.3, 95% CI 0.1–1.3, p = 0.09) and ability to pay (crude OR 0.3, 95% CI 0.1–1.3, p = 0.09) had a weak association with 2-week mortality. Due to multiple collinearities, mortality was adjusted for delay to arrival to the hospital, ICU admission and ability to pay only, with those able to pay having an adjusted odds ratio for 2-week mortality of 0.4 (95% CI: 0.07–2.41, p = 0.32).

4. Discussion

Patients with severe TBI had a high overall two-week mortality of 59.7% in this study, which is consistent with our earlier published results (Mangat et al., 2021). Our data show a high rate of patients dependent on financial aid (50.7%), a low insurance coverage (7.5%) and high risk of inability to pay (22.3%) amongst severe TBI victims arriving at MNH in urban Dar-es-Salaam. Affordability of upfront costs is associated with lower number of neurocritical as well as general critical care interventions in severe TBI patients. There was no evidence of association of lower incidence of appropriate interventions with 2-week mortality, however, this may merely reflect the small size of this study which was not powered to detect this difference as an exploratory study.

Age and sex did not differ between those who could afford to pay upfront costs versus those who could not, nor did it impact delays to arrival in patients who presented to the hospital. There was a trend towards younger patients being more likely to suffer unaffordability (75% of the patients unable to pay were younger than 30 years, compared to 48.8% in the group of patients who could afford to pay), which may arise from lower liquidity due to employment status or lower pay and (or) greater financial liabilities. A larger sample size is needed to further explore this trend.

From the use of critical care therapies, a possible theme emerges. Enteral feeding, anti-seizure prophylaxis, ulcer prophylaxis and mannitol use were significantly greater in patients who could afford upfront costs, whereas mechanical ventilation was inversely related and no patient who could not afford costs of CT scan received one. It would appear that if one could not afford a CT, they subsequently were mechanically ventilated yet received less interventions, possibly as a self-fulfilling prophecy of poor outcome. This may be justified if no active intervention can be made neurosurgically, though that occurs in only about 20% of severe TBI patients in this hospital (Mangat et al., 2021). Those that can afford to undergo a head CT are likely deemed to survive and therefore receive more interventions, and those who do not undergo a head CT scan on arrival are less likely to have a good outcome. Even if no surgical intervention is performed, non-surgical care must be optimized in these patients, or a joint informed decision made with the patients' family about not pursuing aggressive care.

CT scan cannot be performed on mechanically ventilated patients due to shortage of transport ventilators and is therefore often withheld until CT can be done, which explains the higher incidence of mechanical ventilation in patients who do not undergo CT scanning. An overall trend towards higher mortality in patients with mechanical ventilation has

Table 3
Analysis of predictors of two-week mortality (OR: odds ratio; GCS : Glasgow Coma Scale; MOI : Muhimbili Orthopedic Institute; MNH: Muhimbili National Hospital; ICU : Intensive Care Unit; CT: computed tomography; ref – reference). † Adjusted for delay to MNH, ICU admission, funding source; ‡ due to collinearity not included in adjustment model.

VARIABLES	Dead (N/%)	Crude OR (95% CI)	p-value	Adjusted OR† (95% CI)	p-value
Age					
<30 years	16 (53.3)	ref	0.70		
>30 years	12 (48)	0.8 (0.3–2.4)			
Sex					
Male	27 (46)	ref	0.93		
Female	5 (55.6)	1.1 (0.3–4.5)			
GCS score at MOI					
3–6	24 (61.5)	1.0 (0.3–3.0)	0.64		
7–8	7 (53.8)	ref			
Delay to MNH					
<4 h	11 (61.1)	ref	**0.04**	0.4 (0.10–1.82)	0.26
>4 h	3 (27.3)	0.3 (0.1–1.0)			
Transfer from other medical facility					
Yes	21 (53.8)	0.9 (0.3–2.8)	0.93		
No	11 (55)	ref			
Admission to ICU					
Yes	4 (18.2)	0.1 (0.0–0.4)	**< 0.01**[a]	0.2 (0.04–0.72)	**0.02**
No	28 (75.7)	ref			
Mannitol use					
Yes	19 (47.5)	0.4 (0.1–1.4)	0.13		
No	13 (68.4)	ref			
Mechanical ventilation					
Yes	29 (56.9)	2.2 (0.5–10.5)	0.31		
No	3 (37.5)	ref			
Nutrition‡					
Yes	21 (45.7)	0.2 (0.0–0.9)	**0.01**		
No	11 (84.6)	ref			
Head CT‡					
Yes	21 (47.7)	0.3 (0.1–1.3)	**0.09**		
No	11 (73.3)	ref			
Surgery					
Yes	6 (60)	1.3 (0.3–5.3)	0.69		
No	26 (53.1)	ref			
Financing					
Yes	21 (47.7)	0.3 (0.1–1.3)	0.4 (0.07–2.41)	**0.09**	0.32
No	11 (73.3)	ref			

been reported in several studies in LMIC. Indeed, invasive mechanical ventilation in LMICs is associated with a crude mortality between 36 and 72% compared to 32 and 34% in high income countries (HICs) (Inglis et al., 2019), and may be explained by the above observations. In addition, ventilated patients in LMICs seem to be at a greater risk of ventilator-associated complications compared to their counterparts in HICs, which further adds to cost of care.

Interestingly, there was no difference in rate of surgical intervention, though the occurrence of surgery overall was very low at 16%. Since exploratory surgery is still performed in patients unable to undergo a head CT, this illustrates that surgical decisions may not be influenced by payor status. This differs from many studies conducted in high-income countries that have shown lower procedure rates in uninsured patients (Greene et al., 2018; McQuistion et al., 2016). However, a larger cohort would be required to make any meaningful conclusion.

Overall, payor mechanisms varied a lot between patients admitted at MOI with severe TBI. A majority of patients paid the costs through cost sharing or by themselves. Criteria to apply for social welfare or cost sharing with the hospital exist and are mostly based on salary. It is therefore unclear why 19 patients could not avail this benefit. A recent study conducted in Burkina Faso with a similar system of healthcare financing (mostly based on OOP) showed similar results, with 26% of patients with TBI unable to get a head CT due to unaffordability (Kabore et al., 2017). Our data reveals that although measures towards universal healthcare are taken (e.g. insurance, social welfare), effectiveness of the systems in place is lacking. This underlines the need to evaluate programs of healthcare financing in resource limited settings.

Delays in management exist regardless of payment method. This underlines the presence of challenges in the system beyond cost of care and economic burden that prevent efficient and timely management of severe TBI. Delays in management are likely to occur at multiple levels and may be due to non-existent pre-hospital emergency care, insufficient human resources and inadequately trained healthcare practitioners for intensive care, and administrative delays for social welfare and cost sharing procedures. Delays in the management of TBI patients have been associated with increased mortality in LMICs (Gupta et al., 2020). Our data suggest that patients who had been admitted more than 4 h after injury were somewhat more likely to survive at two-weeks. This could reflect a higher a priori chance of surviving at 14 days for those patients who had already survived more than 4 h after the trauma.

As an exploratory study to determine what aspects of care are financially dependent and need to be thoroughly investigated, this study was not powered to evaluate effect of affordability on outcomes. We found no significant determinants of outcome other than admission to the ICU. Outcomes of severe and moderate TBI patients in LMICs suggest that only 38% have a good recovery. More striking was that three months and six months after injury, respectively 50% and 30.4% become economically dependent(Samanamalee et al., 2018). This underlines the catastrophic financial effects of severe TBI, especially among young patients that are in their active years and therefore provide their families with incomes.

Data collection and analysis of healthcare utilization, as presented here, are crucial to monitor the performance of social measures in healthcare and paramount to further improve universal health coverage inclusive of the poor. Although Tanzania has been transitioning from a voluntary health insurance scheme to mandatory or voluntary insurance schemes for civil workers, private sector workers and groups in the informal sector, most Tanzanians do not fall under one of these schemes, leaving the majority of the population uninsured and forced to pay user fees (McIntyre et al., 2013; Mills et al., 2012; Mtei and Makawia, 2014). In a population where still 88% have a purchasing power parity of less than one dollar a day and where health service coverage remains low, victims of TBI face catastrophic health expenditures (McIntyre et al., 2013). Moreover, Tanzania is highly reliant on donor funding for its healthcare financing with 60% of total healthcare expenditure coming from donor funds (McIntyre et al., 2013). Therefore, unsustainable donor funds and poor health insurance coverage contribute to impoverishment and catastrophic payments for the victims' relatives. Although in the past decade over 100 LMICs have taken measures towards universal health care, OOP spending remains high and government spending in sub-Saharan Africa remains low at 11% (World Health, 2019). There is growing evidence however, that better health can increase personal and national income. In fact, a study from Jamison and colleagues revealed that 11% of the economic growth in the LMICs between 1970 and 2000 resulted from reduced adult mortality (Jamison et al., 2006). The Copenhagen Consensus, a global development priority-setting project identified health as a top-5 development investment opportunity (Jamison et al., 2013). The return of investment in health is also reflected by the results of Arrow and colleagues who concluded that health contributes to more wealth than other sources of wealth (Arrow KDPGLMK Oleson, 2012). As the implementation of the Global Surgery 2030 and the Bogota Declaration for Global Neurosurgery occurs, universal healthcare remains the greatest tool to diminish this source of healthcare constraints that have economic impacts on individuals, families, and societies as a whole (McIntyre et al., 2013; Dewan et al., 2019; ICRAN, 2016; Meara et al., 2015).

4.1. Limitations

This study has several limitations. We performed an exploratory study to determine where to direct further research in financing burden of acute severe TBI. Therefore, our sample size was small. We were also constrained by the inability to accurately ascertain ability to pay prospectively. We were limited by missing data elements due to inadequate recording of patient information and difficulty to retrieve data from patient files. Moreover, precise diagnosis could not be made due to the absence of head CT in several severe TBI patients. Furthermore, the generalizability of this study is limited to tertiary care centers in urban settings of LMICs, and one must be vigilant that health systems remain dynamic. More importantly, the follow-up period was short; it is likely that the mortality of these patients significantly increased at 3 months. However, the aim of this study was to capture the effect of affordability of care on immediate life-saving health measures. It is also likely that our data under-estimate the number of patients with unknown identity and who are unable to pay because these patients possibly do not reach the hospital in the first place.

5. Conclusion

In Tanzania, affordability of care has a direct impact on therapeutic intensity of life-saving interventions in severe TBI patients admitted to a tertiary hospital in Dar-es-Salam, Tanzania. Ability to pay impacts life-saving interventions and can also increase redundant or sub-optimal care which may not directly result in mortality benefit yet imposes a financial burden. To address these challenges, trauma care must be considered as part of universal health care.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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