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Mobile telephone follow-up assessment of post-discharge death and disability due to trauma in Cameroon

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Abstract

Objectives: In Cameroon, long-term outcomes after discharge from trauma are largely unknown, limiting our ability to identify opportunities to reduce the burden of injury. In this study, we evaluated injury-related death and disability in Cameroonian trauma patients over a six-month period after hospital discharge.

Design: Prospective cohort study

Setting: Four hospitals in the Littoral and Southwest regions of Cameroon

Participants: A total of 1914 patients entered the study, 1304 were successfully contacted. Inclusion criteria were patients discharged after being treated for traumatic injury at each of four participating hospitals during a 20-month period. Those who did not possess a cellular phone or were unable to provide a phone number were excluded.

Primary and secondary outcome measures: The Glasgow Outcome Scale-Extended (GOSE) was administered to trauma patients at two weeks, one month, three months, and six months post-discharge. Median GOSE scores for each time point were compared and regression analyses were performed to determine associations with death and disability.

Results: Of 71 deaths recorded, 90% occurred by two weeks post-discharge. At six months, 22% of patients still experienced severe disability. Median[IQR] GOSE scores at the four timepoints were 4[3-6], 5[4-8], 7[4-8], and 7[5-8], respectively ($p<0.01$). Older age was associated with greater odds of post-discharge disability(OR1.23, 95%CI 1.05,1.43) and mortality(OR1.99, 95%CI 1.38,2.88), while higher education was associated with decreased odds of disability(OR0.64, 95%CI 0.50,0.83) and mortality(OR 0.40, 95%CI 0.22,0.73). Open fractures(OR1.71, 95%CI 1.21,2.40) and closed fractures(OR1.83, 95%CI 1.42,2.36) were associated with greater post-discharge disability, while higher injury severity score(OR2.33, 95%CI 1.66,3.27) and neurological injuries(OR4.69, 95%CI 1.33,16.56) were associated with greater odds of post-discharge mortality.

Conclusion: Mobile follow-up data show significant morbidity and mortality, particularly for orthopedic and neurologic injuries, up to six-months following trauma discharge. These results highlight the need for reliable follow-up systems in Cameroon.

Strengths and limitations of this study

- In this study, we shed light on trauma-related post-discharge death and disability, which are poorly understood in low- and middle-income countries due to insufficient follow-up mechanisms.
- This study contains one of the largest published prospective follow-up cohort for trauma patients in a lower middle-income country to date, and the first of its kind in Cameroon.
- In addition to injury characteristics, social characteristics such as education and socioeconomic status are also represented and assessed for their association with post-discharge death and disability.
- We demonstrate the feasibility of mobile telephone follow-up to re-engage patients to medical care in settings with limited follow-up mechanisms.
- Due to the ongoing nature of the study, a larger portion of this cohort had reached the earlier follow-up timepoints compared to later timepoints when data was exported for analysis. This may potentially have resulted in representational skew of death and disability in the earlier timepoints.

Introduction

Injury accounts for about 10% of deaths around the world each year. Low- and middle-income countries (LMICs) are disproportionately affected by trauma-related mortality, incurring over 90% of the deaths.[1] By 2030, road traffic injuries alone are predicted to be the seventh leading cause of death, rising above HIV/AIDs.[1] However, injury mortality is only a fraction of the impact; many more individuals who survive suffer from disability due to injury and contribute to the overall burden of disease. The Global Burden of Disease Study estimates that over 237 million disability adjusted life years (DALYs) are lost each year from injury, of which 40 million are years lived with disability (YLDs).[2]

Few studies in high income countries (HICs) have used follow-up tools to characterize injury-related disability following discharge.[3 4] The Functional Outcomes and Recovery after Trauma Emergencies (FORTE) project, a multicenter collaboration between three Boston level-one trauma centers in the United States, showed that low levels of education and income are associated with poor long-term outcomes following injury.[5] Meanwhile, injury-related disability in LMICs is poorly characterized, in part due to insufficient follow-up infrastructure for patients after hospital discharge.[6-8] As a result, characterization of disability in LMICs largely relies on community-based surveys that are limited by their cross-sectional designs and subjective participant recall.[9] Comprehensive follow-up mechanisms are needed in LMICs to improve capacity to identify opportunities to reduce the burden of injury.[10]

In Cameroon, trauma accounts for nearly half of all emergency department visits. Moreover, patients do not routinely seek formalized medical follow-up after discharge despite having clear indications for return.[6] Pilot data from a single Cameroonian trauma center demonstrated significant ongoing illness and disability in trauma patients two weeks after discharge as 27% of post-discharge participants needed continued assistance with activities of daily living.[6] For vulnerable populations that are already at increased risk for injury, delays in returning to income-generating activities can lead to significant financial instability.[1 6 11]

Cameroonian demographic statistics have shown that cellular telephones are widely used and growing in prevalence.[12] In a community-based survey in Southwest Cameroon, 95% of patients reported household ownership of a mobile phone. In a pilot mobile telephone follow up study in Cameroon, 75% of patients who provided functional mobile phone numbers were ultimately reached for complication and disability evaluation in the pilot study.[6 13] Thus, mobile telephone follow-up post-discharge for trauma patients in Cameroon has been shown to be a feasible, effective system for re-engaging patients for return to receive formalized medical care.

In this study, we characterize trauma death and disability after hospital discharge in Cameroon using a mobile phone follow-up tool. In doing so, we seek to determine risk factors associated with death and disability during the post-discharge period and identify vulnerable groups that may require targeted early interventions or follow-up protocols.

Methods

Setting and Study Design

Cameroon is a lower-middle income Central African country with annual gross domestic product per capita of 1533.7 USD (2018).[14] The country currently utilizes a fee-for-service healthcare system in which 70% of healthcare expenditures are accounted for by out-of-pocket spending at the point of service delivery.[15]

The present study builds on an existing hospital-based registry—the Cameroon Trauma Registry (CTR)—at four medical centers in the Littoral and Southwest regions of Cameroon, with populations of 3.3 and 1.5 million inhabitants, respectively.[16] In the Littoral region, these included Pouma Catholic Hospital; a small capacity mission hospital; Edea Regional Hospital, a medium capacity regional referral hospital; and Laquintinie Hospital, a large urban tertiary hospital. Limbe Regional Hospital is a medium capacity regional referral hospital in the Southwest region. Detailed data on patient demographics, hospital course, and injury characteristics are recorded in the registry on an ongoing basis. For this study, a cohort of patients who were hospitalized for traumatic injuries in one of four hospitals participating in the study was prospectively followed after being discharged [17 18]

Patient and Public Involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Mobile follow-up procedure

Cellular phone numbers are routinely collected in the CTR for patients presenting to the four hospitals for trauma care. During the 20-month study period, trained research assistants contacted patients via mobile phone at four time points: two weeks, one month, three months, and six months post-discharge. At each time point, patients or their surrogate were contacted up to three times via phone and one time via SMS until the patient or surrogate was successfully reached. During each mobile encounter, patients or their surrogates were administered the Glasgow Outcome Scale- Extended (GOSE) to evaluate their level of disability.

Study Sample

The prospective cohort in this study included all patients who were discharged after being treated for traumatic injury at each of the four participating hospitals from July 2019 to March 2021. Participation in the study required the possession of a cellular phone in the household. Those who were unable to provide a cellular phone number, either due to altered mental status without a surrogate representative available or lack of cellular phone ownership in the household, were excluded from the study.

Study Instruments

The GOSE score is an eight-point outcomes measurement tool used to assess functional outcomes following discharge from hospitalization due to trauma.[19] Though originally developed to evaluate functional traumatic brain injury outcomes, the score has also been showed to effectively assess disability due to bodily injury.[20] GOSE includes questions regarding survival, consciousness, independence at home (ability to perform activities of daily living (ADLs)), independence outside of home (ability to shop and travel), personality changes, ability to return to work, and ability to return to social and leisurely activities. Lower GOSE scores indicate greater disability; a GOSE score of 1 indicates death, 2 indicates vegetative state, 3-4 indicate severe disability, 5-6 indicate moderate disability, 7-8 indicate good recovery **(Table 1)**.

Table 1: Glasgow Outcome Score– Extended (GOSE) breakdown[21]

GOSE	Category	Description
1	Dead	Dead
2	Vegetative state	No evidence of responsiveness
3	Lower severe disability	Requires daily assistance with ADLs, needs someone to be home
4	Upper severe disability	Requires daily assistance with ADLs, cannot shop or travel locally, can be at home alone
5	Upper moderate disability	Cannot resume normal work, school, social activities, has constant personality issues
6	Lower moderate disability	Can partially resume work, school, social activities, has frequent personality issues
7	Lower good recovery	Still has problems related to injury that affect daily life, occasional personality issues, participates in >50% of social activities
8	Upper good recovery	Full recovery or minor symptoms that do not affect daily life

GOSE = Glasgow Outcome Score– Extended
ADL = Activities of daily living

The injury severity score (ISS) was used in the CTR as an anatomical injury scoring system to assess the overall injury severity in patients with multiple injuries. The ISS is derived

from abbreviated injuries scores (AIS), which are assigned to individual injuries across six anatomical locations (head & neck, face, extremities, chest, abdomen, and pelvis) on a six-point scale. The three anatomical locations with the highest AIS scores are squared and summed to obtain an overall 75-point ISS score.[22] ISS scores have previously been shown to have a reliable area under the ROC curve (AUC) across different races and genders.[23] To account for the lack of linearity in ISS scores in the study population, ISS was further categorized by mild injury (ISS 1-8), moderate injury (ISS 9-15), severe injury (ISS 16-24), and very severe injury (ISS >25), which are considered to be potentially fatal.[23]

EconomicClusters Model

Patients were stratified by socioeconomic status (SES) using five variables: cell phone ownership, residence status (owned, rented, or free residence), setting (urban or rural), agricultural land ownership, and cooking fuel source (credit given to the most expensive fuel used). Patients were scored given their responses to these variables and assigned to one of two rural SES clusters: Rural Poor, Rural Wealthy; or four urban SES clusters: Urban Poor, Urban Middle Class Homeowners, Urban Middle Class Tenants, and Urban Wealthy. This algorithm was previously developed, optimized, and validated in the Cameroonian context using the nationally representative Demographic Health Survey (DHS) Wealth Index, a process that facilitates health disparities research within LMICs through a more systematic accounting of an individual's assets.[24, 25]

Data Analysis

Statistical analysis and data management were performed using STATA/IC 16.1. Patient demographic and injury data from CTR were merged with mobile follow-up data by linking data sets through CTR patient identification numbers. Median GOSE scores were calculated for each post-discharge time point and compared using the Kruskal-Wallis test.

Logistic regression analyses were performed to determine the association of patient and injury characteristics with post-discharge functional outcomes and mortality. Because the dependent variable, GOSE score, is an ordinal categorical variable, multivariate ordered logistic regression analyses were performed to determine proportional odds ratios for a unit increase in disability. Standard multivariate regression was used to determine the odds ratios for the binary dependent variable of mortality. Independent variables listed in Table 2 with $p<0.1$ on univariate analysis were selected for inclusion into multivariate regression models. An alpha of 0.05 was used for significance in the multivariate model. Odds ratios in the disability analysis can be

interpreted as the odds of having a unit of worsening disability given a unit increase in or presence of the independent variable. Odds ratios for mortality can be interpreted as the odds of death given a unit increase in or presence of the independent variable.

Ethical Approval:

This study involves human participants and was approved by the University of California, Los Angeles Institutional Review Board (ID#19-000086) and the University of Buea Institutional Review Board (ID#2020/868-11/UB/SG/IRB/FHS). Informed consent was obtained for all participants in this study. For minors, informed consent was obtained from a parent or guardian decision maker.

Results

Patient demographics and injury characteristics

Across four sites, a total of 1914 patients were contacted for mobile phone follow-up and 1304 (68%) patients were successfully reached for least one follow-up timepoint**.** Due to the ongoing nature of the study, not all patients had reached the later post-discharge timepoints when data were exported from the registry and were therefore not yet eligible for contact. Of the 1914 patients eligible for two-week follow-up, 1090 (57%) were successfully reached. Of 946 patients eligible for one-month follow-up, 812 (86%) were successfully reached. Of 734 patients eligible for three-month follow-up, 645 (88%) were successfully reached. Of 514 patients eligible for six-month follow-up, 471 (91%) were successfully reached. The cohort's median age was 32 years [IQR:24-43] and the majority of participants were male (n=922, 71%)(**Table 2**). By injury severity score (ISS), 353 (27%) patients had minor injuries, 475 (37%) patients had moderate injuries, 256 (20%) had severe injuries, and 205 (16%) had very severe injuries. The most common injury mechanisms were road traffic injuries (n=923, 73%) followed by falls (n=120, 9%) and strike injuries (n=97, 8%). Injuries occurred mostly in the extremities (n=231, 18%), followed by the face (n=153, 12%) and head and neck (n=92, 7%). For injury types, 612 (47%) were bruises or abrasions, 356 (27%) were superficial lacerations, and 353 (27%) were closed fractures. The largest SES cluster was comprised of urban wealthy patients (n=518, 47%).

Table 2: Demographic and injury characteristics of participants (n=1304)

Patient characteristic	n	%
Age (years) (n=1301)		
<15	102	7.8%
15-44	888	68.3%
45-59	206	15.8%
≥60	105	8.1%
Median: 32 IQR [24,43]		
Sex (n=1302)		
Male	922	70.8%
Female	380	29.2%
Education (n=1211)		
≤ Primary school	380	29.1%
≥ Secondary school	831	63.7%
SES Clusters (n=1100)		
Rural poor	5	0.5%
Rural wealthy	97	8.8%
Urban poor	13	1.2%
Urban middle-class homeowner	113	10.3%
Urban middle-class tenants	354	32.2%
Urban wealthy	518	47.1%
Injury severity score (n=1289)		
Mild injury (ISS 0-8)	353	27.4%
Moderate injury (ISS 9-15)	475	36.9%
Severe injury (ISS 16-24)	256	19.9%
Very severe injury (ISS≥25)	205	15.9%
Injury mechanism (n=1272)		
Road traffic injury	923	72.6%
Fall	120	9.4%
Strike	97	7.6%
Stab/cut	94	7.4%
Animal bite	18	1.4%
Other -	20	1.6%
Injury location*		
Extremities	231	17.7%
Face	153	11.7%
Head and neck	92	7.1%
Chest	33	2.5%
Pelvis	12	0.9%
Abdomen	5	0.4%
Injury type*		
Bruise or abrasion	612	46.9%
Deep laceration	364	27.9%
Superficial laceration	356	27.3%
Closed fracture	353	27.1%
Hematoma	183	14.0%
Open fracture	152	11.7%
Sprain or strain	95	7.3%
Degloving	35	2.7%
Avulsion/amputation	26	2.0%
Neurological deficit	26	2.0%
Dislocation	25	1.9%
Other -	33	2.5%
Total patients reached	1304	

IQR = interquartile range
% calculated over the total number of patients with data available for the variable category.
* % calculated over total n=1304 (multiple injury types and locations exist per individual patient)
- Injury characteristics with <1% of total n were grouped into "Other"

Post-discharge death and disability

In total, there were 71 post-discharge deaths in our cohort with an overall mortality rate of 5.4%. The majority of total deaths (64, 90%) occurred by two weeks post-discharge. A total of 17 patients were in a vegetative state at two week follow-up. The proportion of patients experiencing severe disability (GOSE 3-4) was 51.5% at two weeks, 46.8% at one month, and 29.6% at three months (**Figure 1)**. At six months post-discharge, 22.1% of patients were still experiencing severe disability. The proportion of patients experiencing moderate disability (GOSE 5-6) was 14.1% at two weeks, 13.3% at one month, 8.8% at three months, and 7.2% at six months. Meanwhile, 27.3% of patients experienced good recovery (GOSE 7-8) at two weeks, 39.7% at one month, 60.2% at three months, and 70.3% at six months. Median GOSE scores were 4 [IQR: 3-7] at two weeks, 5 [IQR: 4-8] at one month, 7 [IQR: 4-8] at three months, and 7 [IQR: 5-8] at six months. Median scores were significantly different amongst post-discharge timepoints (P<0.01).

Factors associated with death and disability

Univariate regression was performed on demographics and injury characteristics variables with GOSE score or death as the dependent variable. On ordinal multivariate regression analysis, older age category (OR1.23, 95% CI 1.05, 1.43) and female sex (OR 1.31, 95% CI 1.06, 1.64) were significantly associated with greater odds of disability (lower GOSE score) post-discharge (**Table 3**).

Table 3: Ordinal multivariate logistic regression of patient and injury characteristics associated with disability (GOSE score) (n=1304)

Patient characteristic	Odds Ratio	Std. Err.	P value	[95% Conf. Interval]
Age category†	1.23	0.10	0.01*	[1.05, 1.43]
Sex†	1.31	0.15	0.01*	[1.06, 1.64]
≥Secondary school education-	0.64	0.08	<0.01*	[0.50, 0.83]
Urban SES cluster	0.97	0.08	0.74	[0.83, 1.14]
Injury mechanism				
Fall	1.23	0.22	0.25	[0.86, 1.76]
Stab or cut	0.63	0.12	0.02*	[0.43, 0.92]
Animal bite-	0.18	0.08	<0.01*	[0.08, 0.41]
Injury type				
Bruise of abrasion-	0.70	0.08	<0.01*	[0.56, 0.87]
Sprain or strain	1.22	0.23	0.28	[0.85, 1.76]
Superficial laceration	0.90	0.12	0.42	[0.70, 1.16]
Deep laceration	1.06	0.14	0.65	[0.82, 1.36]
Closed fracture†	1.83	0.24	<0.01*	[1.42, 2.36]
Open fracture†	1.71	0.30	<0.01*	[1.21, 2.40]
Dislocation	1.75	0.52	0.06	[0.98, 3.14]
Degloving	1.01	0.27	0.98	[0.60, 1.68]

Variables with p<0.1 on univariate analysis were included in the multivariate regression model presented in this table.
† = significant association with odds ratio>1
- = significant association with odds ratio<1
*= p<0.05

Higher education (≥ secondary school) (OR 0.64, 95% CI 0.50, 0.83) was also associated with decreased odds of disability. With regards to injury mechanism, animal bites (OR 0.18, 95% CI 0.08, 0.41) were associated with lower odds of disability post-discharge. In terms of injury type, closed fractures (OR 1.83, 95% CI 1.42, 2.36) and open fractures (OR 1.71, 95% CI 1.21, 2.40) were associated with greater odds of post-discharge disability. Bruise or abrasion injuries (OR 0.70, 95% CI 0.56, 0.87) were associated with decreased odds of disability.

When looking at mortality independent of GOSE score, multivariate logistic regression showed that older age category (OR 1.99, 95% CI 1.38, 2.88), greater injury severity score (OR 2.33, 95% CI 1.66, 3.27), and injuries resulting in neurological deficits (OR 4.69, 95% CI 1.33, 16.56) were associated with greater odds of death post-discharge (**Table 4**). Higher education (OR 0.40, 95% CI 0.22, 0.73) and road traffic injuries (OR 0.32, 95% CI 0.15, 0.67) were associated with decreased odds of death post-discharge.

Table 4: Multivariate logistic regression of patient and injury characteristics for mortality (n=1304)

Patient characteristic	Odds Ratio	Std. Err.	P value	[95% Conf. Interval]
Age category†	1.99	0.37	<0.01*	[1.38, 2.88]
≥Secondary school education-	0.40	0.12	<0.01*	[0.22, 0.73]
Injury Severity Score category†	2.33	0.40	<0.01*	[1.66, 3.27]
Injury mechanism				
Road traffic injury-	0.32	0.12	<0.01*	[0.15, 0.67]
Fall	1.04	0.42	0.93	[0.47, 2.29]
Injury Location				
Extremities	1.09	0.58	0.87	[0.39, 3.10]
Face	0.56	0.49	0.52	[0.11, 3.08]
Head & neck	0.52	0.57	0.55	[0.06, 4.39]
Injury type				
Bruise of abrasion	0.93	0.29	0.83	[0.50, 1.73]
Neurological deficit†	4.69	3.01	0.02*	[1.33, 16.56]

Variables with p<0.1 on univariate analysis were included in the multivariate regression model presented in this table.
† = significant association with odds ratio>1
- = significant association with odds ratio<1
*= p<0.05

Discussion

Much of what we know about trauma-related disease burden in LMICs is limited to mortality, in-hospital data, and condition at the time of discharge.[26-28] Studies that have looked into post-discharge death and disability have largely taken place in HICs that have substantial follow-up infrastructure.[3 4 29] In this study, we used mobile phone follow-up to shed light on the lesser-known details regarding disability due to trauma following discharge in the lower-middle income country of Cameroon. As a crucial step in building a comprehensive, formalized follow-up system, we have scaled up efforts from our initial single-institution pilot study to include four hospitals and over 1300 patients. In our prospective cohort, we found substantial trauma-related mortality shortly following discharge from the hospital and persistent severe disability at the final

endpoint of six months. We also identified demographic and injury factors significantly associated with death and disability post-discharge.

We found that the median age (32 years, IQR: 24-43 years) and the male to female ratio (2.4:1) of our patient population closely parallels published data from large-scale trauma registries from LMICs.[30] Our cohort had substantial morbidity and mortality at two weeks post-discharge, as 5.8% of the patients reached at two weeks had died while 51.8% were severely disabled and in need of assistance with ADLs. Close to 90% of total deaths occurred within the first two weeks post-discharge, suggesting that the immediate post-discharge time period may be the most crucial for re-engaging patients to formal medical care. Additionally, if the large majority of injury-related deaths can be captured two weeks post-discharge, there may be less need for extensive investment into longitudinal follow-up in future mortality studies. Patients experiencing good recovery increased with each timepoint, but only 70% of patients experienced good recovery at six months post-discharge. Although the proportion of patients having severe disability decreased with each timepoint, 22% still experienced severe disability at six months. This finding closely parallels a similar, smaller scale study conducted in a low-income country, Ethiopia, where 22% of patients still had severe disability by six months post-discharge.[31] Such a persistence of severe disability at six months suggests a need for more coordinated re-engagement with formal medical care to address potential complications in the post-discharge period.

Significant persistent disability due to injuries can have substantial socioeconomic consequences for families.[32] A community based survey of 8065 participants in Southwest Cameroon showed that 34% of households experienced severe financial hardship after injury, the greatest occurring in those who sought formal medical care.[33] Poverty is a significant consequence of seeking formal medical care in Cameroon and patients from lower SES status households are especially vulnerable. In the present study, patients of lower SES status comprise only a small minority of the population that sought formal medical care for trauma in our cohort (0.5% rural poor, 1.2% urban poor), presumably due to foresight of the significant financial consequences. Meanwhile, 47.1% came from the urban wealthy. We also found that even after adjusting for socioeconomic status, higher education was associated with lower odds of post-discharge death and disability due to injury. The protective effect of higher education can potentially be explained by greater literacy surrounding ideal practices for enhanced recovery from injury. Additionally, there is evidence that among patients recovering from TBI, those with greater educational attainment have greater odds for disability-free recovery with a dose-response relationship.[34] Higher health literacy rates in individuals with higher education has

previously been shown to be associated with greater self-reported physical and mental health.[35] Such findings highlight the importance of education on health outcomes and the potential positive impact that development of health education programs can have on recovery from disability due to injury.

Although the large majority of patients in this cohort were male, female sex was associated with greater post-discharge disability. This association has also previously been reported in Iran and the Netherlands[3 36] although other studies have also shown males to have higher long-term disability due to injury.[20] It is likely that the association of sex with post-discharge disability is dependent on a variety of social considerations unique to the study context that are currently not clearly defined. Caregivers for disabled persons in LMICs are largely female (74%), suggesting that injured female patients may not receive adequate household support during their recovery process post-discharge.[37]

In terms of injury type, closed fractures were associated with the highest odds ratio for post-discharge disability, followed by open fractures. These findings were expected as orthopedic injuries directly impair mobility, often requiring extensive follow-up and physical therapy to achieve functional improvement over a long period of time. Re-engagement with formal medical care can be crucial to monitor bone healing and progress in rehabilitation.

Injuries resulting in neurological deficit had the highest odds ratio of death with a post-discharge mortality rate of 23%, all of which occurred in the first two weeks. High post-discharge mortality rates due to neurological injury are well-documented in HICs, and our findings also closely parallel data on post-discharge mortality due to TBI in other LMICs.[38-41] Successful management of patients with neurological injuries requires close monitoring and re-evaluation, availability of neurocritical care and neurosurgical expertise, and accessibility of neuroimaging technology. Therefore, formalized medical follow-up systems are crucial to providing neurotrauma patients with appropriate, specialized care and connections to resources for follow-up studies.

Limitations

This mobile follow-up assessment of post-discharge death and disability is made possible by near-ubiquitous use of personal or household cellular phones. However, our study likely underestimates mortality rates in our cohort because a large portion of patients provided personal cellular phone numbers, and deceased patients can no longer be reached via cellular phone. However, deceased patients with families who still possessed the patient's cellular phone and patients who provided surrogate contacts were still captured in our dataset. Another

limitation is the decrease in patients contacted at each follow-up timepoint. This is due to the ongoing nature of the study—patients included near the end of the study period had not reached the later follow-up dates by the time the database was analyzed for this study. When looking at attrition rates for patients that were more than six months post-discharge, we found that a larger proportion of patients were successfully reached than in the more immediate post-discharge time period.

Future directions

By building a mobile telephone follow-up tool on the foundations of the existing Cameroon Trauma Registry, we continue to grow our cohort of follow-up patients. Traditionally, trauma registries have been limited to reporting in-hospital patient and injury data. Through mobile follow-up, we have expanded our database to include the long-term functional outcomes in our patient population. In future studies, we will also use this mobile follow-up tool to evaluate long-term economic disability in our patient cohort and understand the relationship between financial risk and care-seeking behaviors. Additionally, we have ongoing initiatives to use mobile follow-up for post-discharge trauma patients and assess their need to return to the hospital. By cross-validating mobile phone triage with in-person assessments, we plan to create a feasible, effective system to identify patients who would benefit from further medical care.

Conclusion

The creation of a formalized system for routine post-discharge follow-up care is ultimately critical for the reduction of injury-related death and disability in Cameroon. Such a system must be optimized to provide accessible, formal follow-up for patients across incomes and education levels. In this study, we present large-scale, prospective cohort data regarding post-discharge death and disability due to injury in the lower-middle income country of Cameroon. We found that mortality is the greatest within the first two weeks post-discharge and that there is significant long-term disability remaining at six months post-discharge. The study identified significant contributors to post-discharge death and disability including orthopedic and neurological injuries. The data provide us with a more complete understanding of the true burden of disease due to injury and highlight opportunities for the development of systems-level follow-up interventions.

Figure legends:

Figure 1:
GOSE = Glasgow Outcome Scale-Extended
death: GOSE =1; vegetative state: GOSE = 2; severe disability: GOSE 3-4; moderate disability: GOSE 5-6; good recovery: GOSE 7-8.
n=number of patients successfully reached at post-discharge timepoint (% of patients successfully reached at post-discharge timepoint)
Median GOSE scores were significantly different at each post-discharge timepoint ($p<0.01$) according to Kruskal-Wallis test.

Contributorship statement: K.D. participated in study execution, carried out data management, analysis and interpretation, and manuscript writing. P.J.S. contributed to data management, data analysis, and manuscript writing and revision. M.A.M., F.D.D., M.S.T., F.Y.M., F.E., and G.E.M. played critical roles in on-site study execution, study design, data acquisition, and manuscript revision. M.C. and R.A.O. contributed to study design, data acquisition, data interpretation, and manuscript revision. G.A.E.M., S.A.C., C.J., and A.C.M. conceived of the study design and protocol, provided critical intellectual and logistical oversight, and manuscript revision. K.D. and C.J. have full access to collected data and take responsibility for the integrity of the research and analysis presented in this manuscript.

Competing Interests: None

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Data sharing: Data are available upon reasonable request. Data relevant to the study are included in the article.

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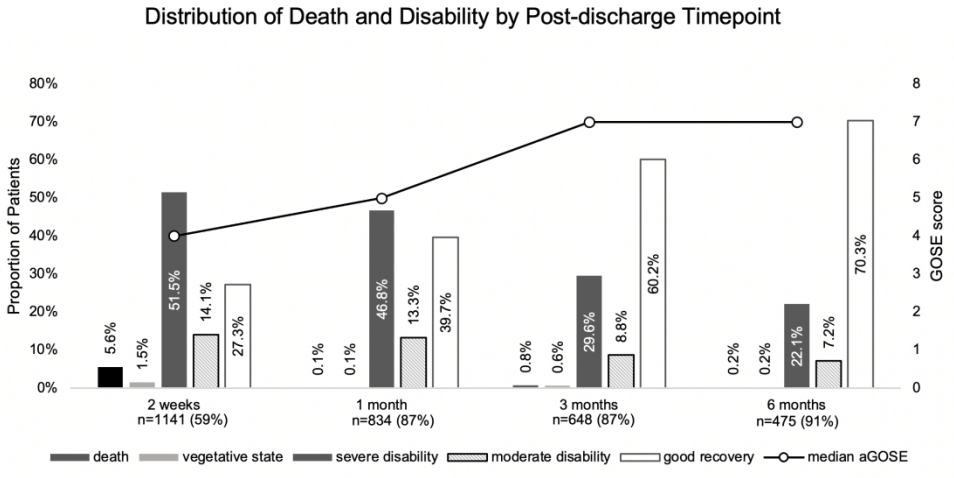

Figure 1:
GOSE = Glasgow Outcome Scale-Extended
death: GOSE =1; vegetative state: GOSE = 2; severe disability: GOSE 3-4; moderate disability: GOSE 5-6; good recovery: GOSE 7-8.
n=number of patients successfully reached at post-discharge timepoint (% of patients successfully reached at post-discharge timepoint)
Median GOSE scores were significantly different at each post-discharge timepoint ($p<0.01$) according to Kruskal-Wallis test.

418x206mm (144 x 144 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (*b*) For matched studies, give matching criteria and number of exposed and unexposed	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	13
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding (*b*) Describe any methods used to examine subgroups and interactions (*c*) Explain how missing data were addressed (*d*) If applicable, explain how loss to follow-up was addressed (*e*) Describe any sensitivity analyses	6
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	8
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	8-9
Outcome data	15*	Report numbers of outcome events or summary measures over time	8-10

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	8-11
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Mobile telephone follow-up assessment of post-discharge death and disability due to trauma in Cameroon: a prospective cohort study

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Mobile telephone follow-up assessment of post-discharge death and disability due to trauma in Cameroon: a prospective cohort study

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Abstract

Objectives: In Cameroon, long-term outcomes after discharge from trauma are largely unknown, limiting our ability to identify opportunities to reduce the burden of injury. In this study, we evaluated injury-related death and disability in Cameroonian trauma patients over a six-month period after hospital discharge.

Design: Prospective cohort study

Setting: Four hospitals in the Littoral and Southwest regions of Cameroon

Participants: A total of 1914 patients entered the study, 1304 were successfully contacted. Inclusion criteria were patients discharged after being treated for traumatic injury at each of four participating hospitals during a 20-month period. Those who did not possess a cellular phone or were unable to provide a phone number were excluded.

Primary and secondary outcome measures: The Glasgow Outcome Scale-Extended (GOSE) was administered to trauma patients at two weeks, one month, three months, and six months post-discharge. Median GOSE scores for each timepoint were compared and regression analyses were performed to determine associations with death and disability.

Results: Of 71 deaths recorded, 90% occurred by two weeks post-discharge. At six months, 22% of patients still experienced severe disability. Median[IQR] GOSE scores at the four timepoints were 4[3-7], 5[4-8], 7[4-8], and 7[5-8], respectively ($p<0.01$). Older age was associated with greater odds of post-discharge disability(OR1.23, 95%CI 1.07,1.41) and mortality(OR2.15, 95%CI 1.52,3.04), while higher education was associated with decreased odds of disability(OR0.65, 95%CI 0.58,0.73) and mortality(OR 0.38, 95%CI 0.31,0.47). Open fractures(OR1.73, 95%CI 1.38,2.18) and closed fractures(OR1.83, 95%CI 1.42,2.36) were associated with greater post-discharge disability, while higher injury severity score(OR2.44, 95%CI 2.13,2.79) and neurological injuries(OR4.40, 95%CI 3.25,5.96) were associated with greater odds of post-discharge mortality.

Conclusion: Mobile follow-up data show significant morbidity and mortality, particularly for orthopedic and neurologic injuries, up to six-months following trauma discharge. These results highlight the need for reliable follow-up systems in Cameroon.

Strengths and limitations of this study

- This study contains one of the largest prospective follow-up cohorts for trauma patients in a lower middle-income country to date, and the first of its kind in Cameroon.
- Although the prospective nature of this study provides a longitudinal view of post-discharge outcomes and avoids the recall bias of community studies, it is limited to individuals who seek formal medical care and hospitalization.
- By combining functional outcome data collected via mobile phone with patient and injury characteristics from our national trauma registry, we identified characteristics associated with death and disability post-discharge.
- We demonstrate the feasibility of using mobile phones as a method of contacting patients for follow-up and re-engagement with medical care in settings with limited follow-up infrastructure.
- Due to the ongoing nature of the study, a larger portion of this cohort had reached the earlier follow-up timepoints compared to later timepoints when data was analyzed.

Introduction

Injury accounts for about 10% of deaths around the world each year. Low- and middle-income countries (LMICs) are disproportionately affected by trauma-related mortality, incurring over 90% of the deaths.[1] By 2030, road traffic injuries alone are predicted to be the seventh leading cause of death, rising above HIV/AIDs.[1] However, injury mortality is only a fraction of the impact; many more individuals who survive suffer from disability due to injury and contribute to the overall burden of disease. The Global Burden of Disease Study estimates that over 237 million disability adjusted life years (DALYs) are lost each year from injury, of which 40 million are years lived with disability (YLDs).[2]

As defined by the World Health Organization (WHO), "injuries are caused by acute exposure to physical agents such as mechanical energy, heat, electricity, chemicals, and ionizing radiation interacting with the body in amounts or at rates that exceed the threshold of human tolerance. In some cases (for example, drowning and frostbite), injuries result from the sudden lack of essential agents such as oxygen or heat."[3] Multiple studies in high income countries (HICs) have used follow-up tools to characterize injury-related disability following discharge.[4-8] For example, the Functional Outcomes and Recovery after Trauma Emergencies (FORTE) project, a multicenter collaboration between three Boston level-one trauma centers in the United States, showed that low levels of education and income are associated with poor long-term outcomes following injury.[8] Meanwhile, injury-related disability in LMICs is poorly characterized, in part due to insufficient follow-up infrastructure for patients after hospital discharge.[9-11] As a result, characterization of disability in LMICs largely relies on community-based surveys that are limited by their cross-sectional designs and subjective participant recall.[12] Comprehensive follow-up mechanisms are needed in LMICs to improve capacity to identify opportunities to reduce the burden of injury.[13]

In Cameroon, trauma accounts for nearly half of all emergency department visits. Moreover, patients do not routinely seek formalized medical follow-up after discharge despite having clear indications for return.[9] Pilot data from a single Cameroonian trauma center demonstrated significant ongoing illness and disability in trauma patients two weeks after discharge--27% of post-discharge participants needed continued assistance with activities of daily living.[9] For vulnerable populations that are already at increased risk for injury, delays in returning to income-generating activities can lead to significant financial instability.[1 9 14]

Cameroonian demographic statistics have shown that cellular telephones are widely used and growing in prevalence.[15] In a community-based survey in Southwest Cameroon, 95%

of patients reported household ownership of a mobile phone. In a pilot mobile telephone follow up study in Cameroon, 75% of patients who provided functional mobile phone numbers were ultimately reached for complication and disability evaluation in the pilot study.[9 16] Thus, mobile telephone post-discharge follow-up for trauma patients in Cameroon has been shown to be a feasible, effective system for re-engaging patients for return to receive formalized medical care.

In this study, we characterize trauma death and disability after hospital discharge in Cameroon using a mobile phone follow-up tool. In doing so, we seek to determine risk factors associated with death and disability during the post-discharge period and identify vulnerable groups that may require targeted early interventions or follow-up protocols.

Methods

Setting and Study Design

Cameroon is a lower-middle income Central African country with annual gross domestic product per capita of 1533.7 USD (2018).[17] The country currently utilizes a fee-for-service healthcare system in which 70% of healthcare expenditures are accounted for by out-of-pocket spending at the point of service delivery.[18]

The present study builds on an existing hospital-based registry—the Cameroon Trauma Registry (CTR)—at four medical centers in the Littoral and Southwest regions of Cameroon, with populations of 3.3 and 1.5 million inhabitants, respectively.[19] In the Littoral region, these included Pouma Catholic Hospital; a small capacity mission hospital; Edea Regional Hospital, a medium capacity regional referral hospital; and Laquintinie Hospital, a large urban tertiary hospital. Limbe Regional Hospital is a medium capacity regional referral hospital in the Southwest region. Detailed data on patient demographics, hospital course, and injury characteristics are recorded in the registry on an ongoing basis. For this study, a cohort of patients who were hospitalized for traumatic injuries in these four hospitals participating in the study were prospectively followed after being discharged [20 21]

Patient and Public Involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Study Sample

The prospective cohort in this study included all patients who were discharged after being treated for traumatic injury at each of the four participating hospitals from July 2019 to March

2021. Participation in the study required the possession of a cellular phone in the household. Those who were unable to provide a cellular phone number, either due to altered mental status without a surrogate representative available or lack of cellular phone ownership in the household, were excluded from the study.

Mobile follow-up procedure

Patient and/or surrogate contact cellular phone numbers are routinely collected in the CTR for patients presenting to the four hospitals for trauma care. Obtaining phone numbers and surrogate contacts was performed by trained research assistants who administered the survey. For patients below the age of 18, a surrogate contact number of a parent, guardian, or caretaker was also obtained, if available. During the 20-month study period, trained research assistants contacted patients and/or surrogates via mobile phone at two weeks, one month, three months, and six months post-discharge for verbal informed consent to participate in the study. Those who consented to the study were administered the GOSE interview at each post-discharge timepoint. At each timepoint, patients or their surrogate were contacted up to three times via phone and one time via SMS until the patient or surrogate was successfully reached. During each mobile encounter, patients or their surrogates were administered the Glasgow Outcome Scale- Extended (GOSE) to evaluate their level of disability. Although there was no formal process for evaluating the patient or surrogate's capacity to respond to survey questions, research assistants used their judgement as to whether patients were coherent and sufficiently oriented to complete the questionnaire. In situations where a surrogate was reached rather than the patient, the respondent was asked if they were together and could respond in conjunction. If they could not respond together, another number was requested to directly contact the patient. If the patient was unable to respond, but the surrogate contact was knowledgeable of the patient's condition, then the surrogate was administered the survey.

Study Instruments

The GOSE score is an eight-point outcomes measurement tool used to assess functional outcomes following discharge from hospitalization due to trauma at all four timepoints following discharge.[22] Though originally developed to evaluate functional traumatic brain injury (TBI) outcomes, the score has also been showed to effectively assess disability due to bodily injury.[23] GOSE includes questions regarding survival, consciousness, independence at home (ability to perform activities of daily living (ADLs)), independence outside of home (ability to shop and travel), personality changes, ability to return to work, and ability to return to social and

leisurely activities. Lower GOSE scores indicate greater disability; a GOSE score of 1 indicates death, 2 indicates vegetative state, 3-4 indicate severe disability, 5-6 indicate moderate disability, 7-8 indicate good recovery **(Table 1)**.

Table 1: Glasgow Outcome Score– Extended (GOSE) breakdown[24]

GOSE	Category	Description
1	Dead	Dead
2	Vegetative state	No evidence of responsiveness
3	Lower severe disability	Requires daily assistance with ADLs, needs someone to be home
4	Upper severe disability	Requires daily assistance with ADLs, cannot shop or travel locally, can be at home alone
5	Upper moderate disability	Cannot resume normal work, school, social activities, has constant personality issues
6	Lower moderate disability	Can partially resume work, school, social activities, has frequent personality issues
7	Lower good recovery	Still has problems related to injury that affect daily life, occasional personality issues, participates in >50% of social activities
8	Upper good recovery	Full recovery or minor symptoms that do not affect daily life

GOSE = Glasgow Outcome Score– Extended
ADL = Activities of daily living

The injury severity score (ISS) was used in the CTR as an anatomical injury scoring system to assess the overall injury severity in patients with multiple injuries. The ISS is derived from abbreviated injuries scores (AIS), which are assigned to individual injuries across six anatomical locations (head & neck, face, extremities, chest, abdomen, and pelvis) on a six-point scale. The three anatomical locations with the highest AIS scores are squared and summed to obtain an overall 75-point ISS score.[25] ISS scores have previously been shown to have a reliable area under the ROC curve (AUC) across different races and genders.[26] To account for the lack of linearity in ISS scores in the study population, ISS was further categorized by mild injury (ISS 1-8), moderate injury (ISS 9-15), severe injury (ISS 16-24), and very severe injury (ISS >25), which are considered to be potentially fatal.[26]

EconomicClusters Model

Patients were stratified by socioeconomic status (SES) using five variables: cell phone ownership, residence status (owned, rented, or free residence), setting (urban or rural), agricultural land ownership, and cooking fuel source (credit given to the most expensive fuel used). Patients were scored given their responses to these variables and assigned to one of two rural SES clusters: Rural Poor, Rural Wealthy; or four urban SES clusters: Urban Poor, Urban Middle Class Homeowners, Urban Middle Class Tenants, and Urban Wealthy. This algorithm was previously developed, optimized, and validated in the Cameroonian context using the nationally representative Demographic Health Survey (DHS) Wealth Index, a process that

facilitates health disparities research within LMICs through a more systematic accounting of an individual's assets.[27, 28]

Data Analysis

Statistical analysis and data management were performed using STATA/IC 16.1. Patient demographic and injury data from CTR were merged with mobile follow-up data by linking data sets through CTR patient identification numbers. Median GOSE scores were calculated for each post-discharge timepoint and compared using the Kruskal-Wallis test.

Logistic regression analyses were performed to determine the association of patient and injury characteristics with post-discharge functional outcomes and mortality across all follow-up timepoints. Because the dependent variable, GOSE score, is an ordinal categorical variable, multivariate ordered logistic regression analyses were performed to determine proportional odds ratios for a unit increase in disability. Standard multivariate logistic regression was used to determine the odds ratios for the binary dependent variable of mortality. In order to mitigate potential skew due to larger numbers of patients in earlier timepoints, multivariate analyses were clustered by post-discharge timepoint. Independent variables listed in Table 2 with $p<0.1$ on univariate analysis were selected for inclusion into multivariate regression models. An alpha of 0.05 was used for significance in the multivariate models. This method of selecting variables to include in the multivariate model was used as an iterative process that avoids overfitting the regression and optimizes readability and interpretation of the regression output. Additionally, variables that were selected in this process also align with published literature regarding patient and injury characteristics associated with post-discharge death and disability.[4-7 29 30] This approach was chosen over automated or stepwise processes that can often falsely highlight noise in the dataset and fit models that vary depending on the order of variables included or excluded.[31-33] Odds ratios in the disability analysis can be interpreted as the odds of having a unit of worsening disability given a unit increase in or presence of the independent variable. Odds ratios for mortality can be interpreted as the odds of death given a unit increase in or presence of the independent variable.

Ethical Approval:

This study involves human participants and was approved by the University of California, Los Angeles Institutional Review Board (ID#19-000086) and the University of Buea Institutional Review Board (ID#2020/868-11/UB/SG/IRB/FHS). Verbal informed consent was obtained from all patients ab initio at the time of inclusion into the CTR. At each post-discharge timepoint,

verbal informed consent was also obtained via mobile phone for all participants in this study. For minors, informed consent was obtained from a parent or guardian decision maker. Those that declined to participate in the study were excluded and no longer contacted.

Results

Patient demographics and injury characteristics

Across four sites, a total of 1914 patients were contacted for mobile phone follow-up and 1304 (68%) patients were successfully surveyed for least one follow-up timepoint**.** The numbers of patients included and excluded from the study are detailed in a flowchart (**Figure 1**). Due to the ongoing nature of the study, not all patients had reached the later post-discharge timepoints when data were exported from the registry and were therefore not yet eligible for contact. Of the 1914 patients eligible for two-week follow-up, 1090 (57%) were successfully reached. At one month, 812 (86%) of 946 eligible patients were successfully reached. 645 (88%) of 734 patients were reached for three-month follow-up, and 471 (91%) of 514 patients were reached for six month follow-up. The cohort's median age was 32 years [IQR:24-43] and the majority of participants were male (**Table 2**). In terms of injury severity score (ISS) categories, moderate injuries were most common, followed by minor injuries, severe injuries, and very severe injuries. The most common injury mechanisms were road traffic injuries, followed by fall and strike injuries. Injuries occurred mostly in the extremities, followed by the face and the head & neck. For injury types, bruises or abrasions were the most common, followed by superficial lacerations and closed fractures. The largest SES cluster was comprised of urban wealthy patients.

Table 2: Demographic and injury characteristics of participants (n=1304)

Patient characteristic	n	%
Age group (years) (n=1301)		
<15	102	7.8%
15-44	888	68.3%
45-59	206	15.8%
≥60	105	8.1%
Median: 32 IQR [24,43]		
Sex (n=1302)		
Male	922	70.8%
Female	380	29.2%
Education (n=1211)		
≤ Primary school	380	29.1%
≥ Secondary school	831	63.7%
SES Clusters (n=1100)		
Rural poor	5	0.5%
Rural wealthy	97	8.8%
Urban poor	13	1.2%

Urban middle-class homeowner	113	10.3%
Urban middle-class tenants	354	32.2%
Urban wealthy	518	47.1%
Injury severity score (n=1289)		
Mild injury (ISS 0-8)	353	27.4%
Moderate injury (ISS 9-15)	475	36.9%
Severe injury (ISS 16-24)	256	19.9%
Very severe injury (ISS≥25)	205	15.9%
Injury mechanism (n=1272)		
Road traffic injury	923	72.6%
Fall	120	9.4%
Strike	97	7.6%
Stab/cut	94	7.4%
Animal bite	18	1.4%
Other -	20	1.6%
Injury location*		
Extremities	231	17.7%
Face	153	11.7%
Head and neck	92	7.1%
Chest	33	2.5%
Pelvis	12	0.9%
Abdomen	5	0.4%
Injury type*		
Bruise or abrasion	612	46.9%
Deep laceration	364	27.9%
Superficial laceration	356	27.3%
Closed fracture	353	27.1%
Hematoma	183	14.0%
Open fracture	152	11.7%
Sprain or strain	95	7.3%
Degloving	35	2.7%
Avulsion/amputation	26	2.0%
Neurological deficit	26	2.0%
Dislocation	25	1.9%
Other -	33	2.5%
Total patients reached	1304	

IQR = interquartile range; SES = Socioeconomic status; ISS = Injury Severity Score
% calculated over the total number of patients with data available for the variable category.
* % calculated over total n=1304 (multiple injury types and locations exist per individual patient)
- Injury characteristics with <1% of total n were grouped into "Other"

Post-discharge death and disability

In total, there were 71 post-discharge deaths in our cohort with an overall mortality rate of 5.4%. The majority of total deaths (n=64, 90%) occurred by two weeks post-discharge. A total of 17 patients were in a vegetative state at two-week follow-up. The proportion of patients experiencing severe disability (GOSE 3-4) was 51.5% at two weeks, 46.8% at one month, and 29.6% at three months (**Figure 2**). At six months post-discharge, 22.1% of patients were still experiencing severe disability. The proportion of patients experiencing moderate disability (GOSE 5-6) was 14.1% at two weeks, 13.3% at one month, 8.8% at three months, and 7.2% at six months. Meanwhile, 27.3% of patients experienced good recovery (GOSE 7-8) at two

weeks, 39.7% at one month, 60.2% at three months, and 70.3% at six months. Median GOSE scores were 4 [IQR: 3-7] at two weeks, 5 [IQR: 4-8] at one month, 7 [IQR: 4-8] at three months, and 7 [IQR: 5-8] at six months. Median scores were significantly different amongst post-discharge timepoints (P<0.01).

Factors associated with death and disability

Univariate regression was performed on demographics and injury characteristics variables with GOSE score or death as the dependent variable. On ordinal multivariate regression analysis, increased age group and female sex were significantly associated with greater odds of disability (lower GOSE score) post-discharge (**Table 3**).

Table 3: Ordinal multivariate logistic regression of patient and injury characteristics associated with disability (GOSE score) (n=1304)

Patient characteristic	Odds Ratio	Std. Err.	P value	[95% Conf. Interval]
Age group†	1.23	0.09	<0.01*	[1.07, 1.41]
Female sex†	1.30	0.07	<0.01*	[1.18, 1.44]
≥Secondary school education-	0.65	0.04	<0.01*	[0.58, 0.73]
Urban SES cluster	0.99	0.04	0.73	[0.92, 1.06]
Injury mechanism				
Fall	1.28	0.19	0.10	[0.95, 1.71]
Strike	1.08	0.09	0.33	[0.92, 1.26]
Stab or cut-	0.60	0.03	<0.01*	[0.55, 0.66]
Animal bite-	0.16	0.08	<0.01*	[0.06, 0.43]
Injury location				
Extremities†	1.51	0.10	<0.01*	[1.32, 1.72]
Injury type				
Bruise or abrasion-	0.63	0.05	<0.01*	[0.54, 0.72]
Sprain or strain	1.19	0.12	0.08	[0.98, 1.45]
Superficial laceration	0.93	0.04	0.15	[0.85, 1.02]
Deep laceration†	1.06	0.03	0.04*	[1.00, 1.12]
Closed fracture†	1.83	0.24	<0.01*	[1.42, 2.36]
Open fracture†	1.73	0.20	<0.01*	[1.38, 2.18]
Dislocation†	1.63	0.40	0.04*	[1.01, 2.66]
Degloving	1.03	0.05	0.62	[0.93, 1.13]
Neurological deficit	1.11	0.15	0.43	[0.85, 1.46]

SES = Socioeconomic status; GOSE=Glasgow Outcome Scale Extended
Variables with p<0.1 on univariate analysis were included in the multivariate regression model presented in this table. Reference values for independent variables are lower age group, male sex, ≤ secondary school education, lower urban socioeconomic cluster, or the absence of the injury characteristic, respectively.
† = significant association with odds ratio>1
- = significant association with odds ratio<1
*= p<0.05

Higher education (≥ secondary school) was associated with decreased odds of disability. With regards to injury mechanism, animal bites were associated with lower odds of disability. Injury types associated with greater odds of disability included closed fractures, open fractures, deep lacerations, and dislocations, while bruise or abrasion injuries were associated with decreased

odds of disability. With regards to location, injuries to the extremities were associated with greater odds of disability.

When looking at mortality independent of GOSE score, standard multivariate logistic regression showed that increased age group, female sex, greater injury severity score category, falls, and injuries resulting in neurological deficits were associated with greater odds of death post-discharge (**Table 4**). Higher education, road traffic injuries, and closed fractures were associated with decreased odds of death post-discharge.

Table 4: Standard multivariate logistic regression of patient and injury characteristics for mortality (n=1304)

Patient characteristic	Odds ratio	Std. Err	P value	[95% Conf. Interval]
Age group†	2.15	0.38	<0.01*	[1.52, 3.04]
Female sex†	0.56	0.11	<0.01*	[0.38, 0.81]
≥ Secondary school education-	0.38	0.04	<0.01*	[0.31, 0.47]
Injury Severity Score category†	2.44	0.17	<0.01*	[2.13, 2.79]
Injury mechanism				
Road traffic injury-	0.33	0.07	<0.01*	[0.21, 0.51]
Fall†	1.38	0.13	<0.01*	[1.15, 1.65]
Strike	0.76	0.16	0.19	[0.51, 1.14]
Injury type				
Bruise or Abrasion	0.91	0.15	0.58	[0.67, 1.25]
Closed fracture-	0.64	0.08	<0.01*	[0.50, 0.82]
Avulsion or amputation	1.01	0.27	0.97	[0.60, 1.69]
Neurological deficit†	4.40	0.68	<0.01*	[3.25, 5.96]

Variables with p<0.1 on univariate analysis were included in the multivariate regression model presented in this table.
Reference values for independent variables are lower age group, male sex, ≤ secondary school education, or the absence of the injury characteristic, respectively.
† = significant association with odds ratio>1
- = significant association with odds ratio<1
* = p<0.05

Discussion

Much of what we know about trauma-related disease burden in LMICs is limited to mortality, in-hospital data, and condition at the time of discharge.[34-36] Studies that have looked into post-discharge death and disability have largely taken place in HICs that have substantial follow-up infrastructure.[4-7 37] In this study, we used mobile phone follow-up to shed light on the lesser-known details regarding disability due to trauma following discharge in the lower-middle income country of Cameroon. As a crucial step in building a comprehensive, formalized follow-up system, we have scaled up efforts from our initial single-institution pilot study to include four hospitals and over 1300 patients. In our prospective cohort, we found substantial trauma-related mortality shortly following discharge from the hospital and persistent severe disability at the final endpoint of six months. By determining demographic and injury factors significantly associated with death and disability post-discharge, we will be able to identify patients that may be

particularly vulnerable in the post-discharge period and provide more targeted follow-up interventions.

We found that the median age (32 years, IQR: 24-43 years) and the male to female ratio (2.4:1) of our patient population closely parallels published data from large-scale trauma registries from LMICs.[38] Our cohort had substantial morbidity and mortality at two weeks post-discharge, as 5.8% of the patients reached at two weeks had died while 51.8% were severely disabled and in need of assistance with ADLs. Close to 90% of total deaths occurred within the first two weeks post-discharge, suggesting that the immediate post-discharge time period may be the most crucial for re-engaging patients to formal medical care. Additionally, if the large majority of injury-related deaths can be captured two weeks post-discharge, there may be less need for extensive investment into longitudinal follow-up in future mortality studies. Patients experiencing good recovery increased with each timepoint, but only 70% of patients experienced good recovery at six months post-discharge. Although the proportion of patients having severe disability decreased with each timepoint, 22% still experienced severe disability at six months. This finding closely parallels a similar, smaller scale study conducted in a low-income country, Ethiopia, where 22% of patients still had severe disability by six months post-discharge.[29] Such a persistence of severe disability at six months suggests a need for more coordinated re-engagement with formal medical care to address potential complications in the post-discharge period.

Significant and persistent disability due to injuries can have substantial socioeconomic consequences for families.[39] A community-based survey of 8065 participants in Southwest Cameroon showed that 34% of households experienced severe financial hardship after injury, the greatest occurring in those who sought formal medical care.[40] Poverty is a significant consequence of seeking formal medical care in Cameroon and patients from lower SES status households are especially vulnerable. In the present study, patients of lower SES status comprise only a small minority of the population that sought formal medical care for trauma in our cohort (0.5% rural poor, 1.2% urban poor), presumably due to foresight of the significant financial consequences. Meanwhile, 47.1% came from the urban wealthy. We also found that even after adjusting for socioeconomic status, higher education was associated with lower odds of post-discharge death and disability due to injury. The protective effect of higher education can potentially be explained by greater literacy surrounding ideal practices for enhanced recovery from injury. Additionally, there is evidence that among patients recovering from TBI, those with greater educational attainment have greater odds for disability-free recovery with a dose-response relationship.[41] Higher health literacy rates in individuals with higher education has also

been shown to be associated with greater self-reported physical and mental health.[42] Such findings highlight the importance of education on health outcomes and the potential positive impact that the development of health education programs can have on recovery from disability due to injury.

Although the large majority of patients in this cohort were male, female sex was associated with greater post-discharge disability. This association has also previously been reported in several countries[4 5 7 30 43] although other studies have also shown males to have higher long-term disability due to injury.[23] It is likely that the association of sex with post-discharge disability is dependent on a variety of social considerations unique to the study context that are currently not clearly defined. One multi-center study in the United States showed that women may at be greater risk for worse functional and psychological outcomes after major trauma than men.[44] Another consideration is that caregivers for disabled persons in LMICs are largely female (74%), suggesting that injured female patients may not receive adequate household support during their recovery process post-discharge.[45] On the other hand, female sex was associated with decreased odds of post-discharge mortality due to injury. This finding that has been consistently replicated in past studies and attributed to the higher rates homicide, suicide, and unintentional injury among males.[46-48]

In terms of injury type, closed fractures were associated with the highest odds ratio for post-discharge disability, followed by open fractures. These findings were expected as orthopedic injuries directly impair mobility, often requiring extensive follow-up and physical therapy to achieve functional improvement over a long period of time. This explanation is additionally corroborated by our finding that extremity injuries and dislocations are also associated with greater post-discharge disability. Re-engagement with formal medical care can be crucial to monitor bone healing and progress in rehabilitation.

Injuries resulting in neurological deficit had the highest odds ratio of death with a post-discharge mortality rate of 23%, all of which occurred in the first two weeks. High post-discharge mortality rates due to neurological injury are well-documented in HICs, and our findings also closely parallel data on post-discharge mortality due to TBI in other LMICs.[49-52] Successful management of patients with neurological injuries requires close monitoring and re-evaluation, availability of neurocritical care and neurosurgical expertise, and accessibility of neuroimaging technology. Therefore, formalized medical follow-up systems are crucial to providing neurotrauma patients with appropriate, specialized care and connections to resources for follow-up studies.

Limitations

This mobile follow-up assessment of post-discharge death and disability is made possible by near-ubiquitous use of personal or household cellular phones. However, our study likely underestimates mortality rates in our cohort because a large portion of patients provided personal cellular phone numbers, and deceased patients can no longer be reached via cellular phone. The same issue may also occur with patients in a vegetative state. However, these patients with families who still possessed the patient's cellular phone and patients who provided surrogate contacts were still captured in our dataset.

Another limitation is the decrease in patients contacted at each follow-up timepoint. This is due to the ongoing nature of the study—patients included near the end of the study period had not reached the later follow-up dates by the time the database was analyzed for this study. When looking at attrition rates for patients that were more than six months post-discharge, we found that a larger proportion of patients were successfully reached than in the more immediate post-discharge time period. However, it is also important to consider that attrition rates may be greater for patients who do not have the support of caregiver or family member surrogates, or those who lose access to mobile devices during the course of follow-up as a result of the physical or financial consequences of their injury.

Additionally, as this study represents data from four institutions in the Littoral and Southwest regions of Cameroon, it may not be generalizable to the entirety of the country. Furthermore, individuals from rural areas constitute 43.6% of the Cameroonian population, but only 9.3% of patients in our study. Although these results may not generalize to the entire socioeconomic and geographic population of Cameroon, they provide a snapshot of death and disability in patients who seek medical attention for injury in a region of Cameroon with limited follow-up infrastructure and financial resources for medical care.

Future directions

By building a mobile telephone follow-up tool on the foundations of the existing Cameroon Trauma Registry, we continue to grow our cohort of follow-up patients. Traditionally, trauma registries have been limited to reporting in-hospital patient and injury data. Through mobile follow-up, we have expanded our database to include the long-term functional outcomes in our patient population. In future studies, we will also use this mobile follow-up tool to evaluate long-term economic disability in our patient cohort and understand the relationship between financial risk and care-seeking behaviors. Additionally, we have ongoing initiatives to use mobile follow-up for post-discharge trauma patients and assess their need to return to the hospital. By

cross-validating mobile phone triage with in-person assessments, we plan to create a feasible, effective system to identify patients who would benefit from further medical care.

Conclusion

The creation of a formalized system for routine post-discharge follow-up care is ultimately critical for the reduction of injury-related death and disability in Cameroon. Such a system must be optimized to provide accessible, formal follow-up for patients across incomes and education levels. In this study, we present large-scale, prospective cohort data regarding post-discharge death and disability due to injury in the lower-middle income country of Cameroon. We found that mortality is the greatest within the first two weeks post-discharge and that there is significant long-term disability remaining at six months post-discharge. The study identified significant contributors to post-discharge death and disability including orthopedic and neurological injuries. The data provide us with a more complete understanding of the true burden of disease due to injury and highlight opportunities for the development of systems-level follow-up interventions.

Figure legends:

Figure 1

Figure 2
GOSE = Glasgow Outcome Scale-Extended
death: GOSE =1; vegetative state: GOSE = 2; severe disability: GOSE 3-4; moderate disability: GOSE 5-6; good recovery: GOSE 7-8.
n=number of patients successfully reached at post-discharge timepoint (% of patients successfully reached at post-discharge timepoint)
Median GOSE scores were significantly different at each post-discharge timepoint ($p<0.01$) according to Kruskal-Wallis test.

Contributorship statement: K.D. participated in study execution, carried out data management, analysis and interpretation, and manuscript writing. P.J.S. contributed to data management, data analysis, and manuscript writing and revision. M.A.M., F.D.D., M.S.T., F.Y.M., F.E., and G.E.M. played critical roles in on-site study execution, study design, data acquisition, and manuscript revision. M.C. and R.A.O. contributed to study design, data acquisition, data interpretation, and manuscript revision. G.A.E.M., S.A.C., C.J., and A.C.M. conceived of the study design and protocol, provided critical intellectual and logistical oversight, and manuscript revision. K.D. and C.J. have full access to collected data and take responsibility for the integrity of the research and analysis presented in this manuscript.

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Data sharing: Data are available upon reasonable request. Data relevant to the study are included in the article.

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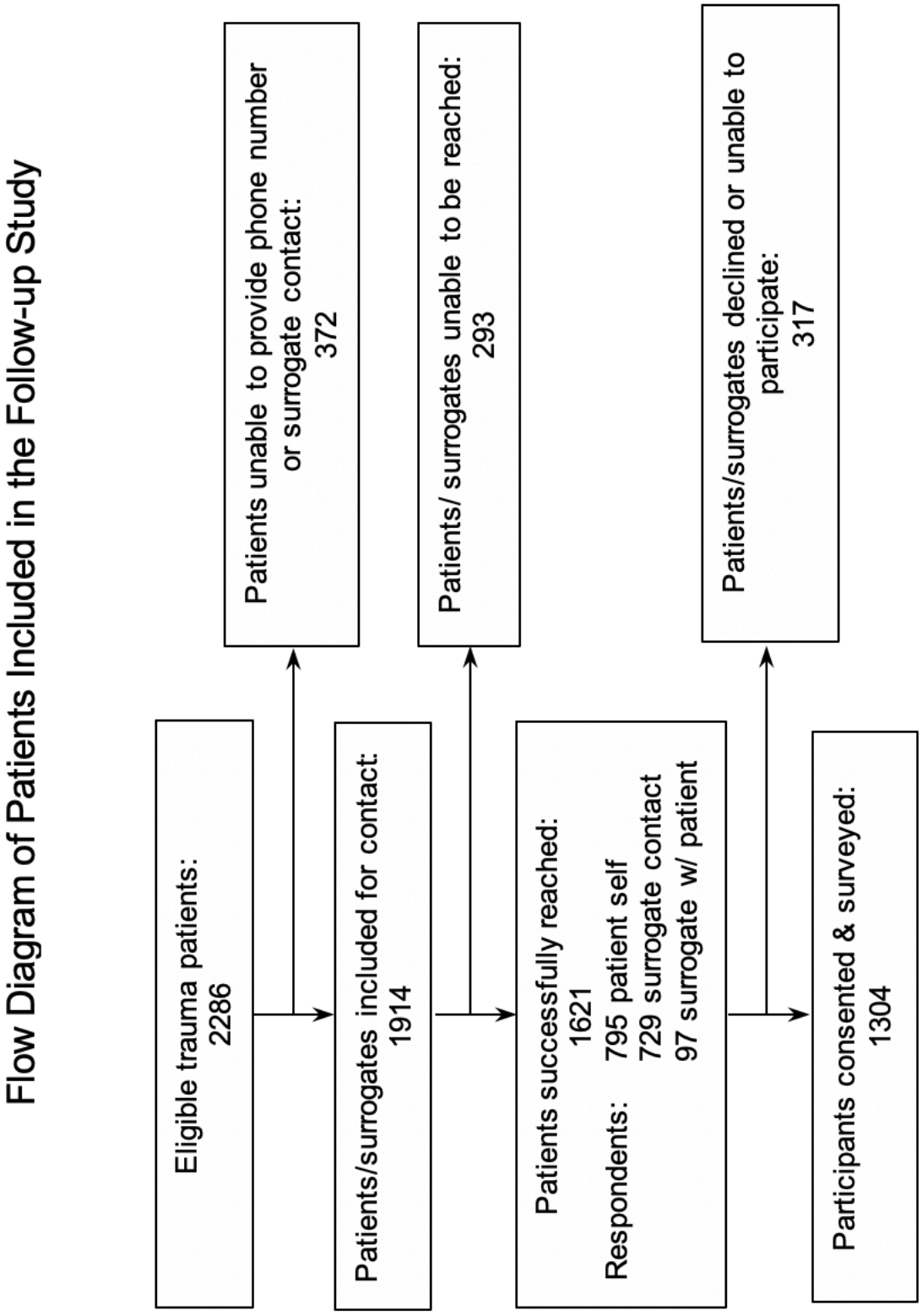

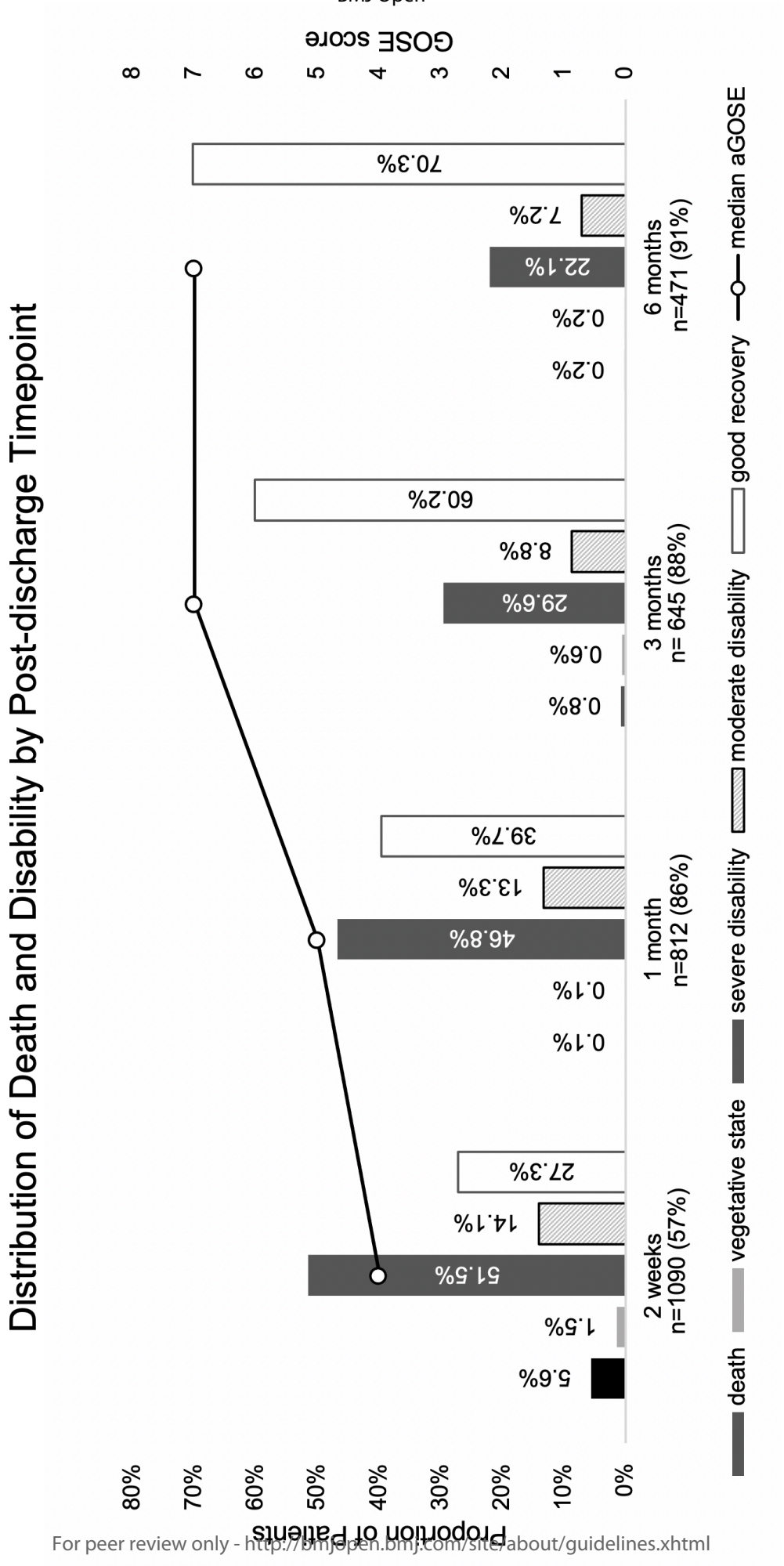

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (*b*) For matched studies, give matching criteria and number of exposed and unexposed	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	13
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding (*b*) Describe any methods used to examine subgroups and interactions (*c*) Explain how missing data were addressed (*d*) If applicable, explain how loss to follow-up was addressed (*e*) Describe any sensitivity analyses	6
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	8
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	8-9
Outcome data	15*	Report numbers of outcome events or summary measures over time	8-10

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	8-11
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.