



## Mortality-Associated Characteristics of Patients with Traumatic Brain Injury at the University Teaching Hospital of Kigali, Rwanda

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**OBJECTIVE:** Traumatic brain injury (TBI) is a leading cause of death and disability. Patients with TBI in low and middle-income countries have worse outcomes than patients in high-income countries. We evaluated important clinical indicators associated with mortality for patients with TBI at University Teaching Hospital of Kigali, Kigali, Rwanda.

**METHODS:** A prospective consecutive sampling of patients with TBI presenting to University Teaching Hospital of Kigali Accident and Emergency Department was screened for inclusion criteria: reported head trauma, alteration in consciousness, headache, and visible head trauma. Exclusion criteria were age <10 years, >48 hours after injury, and repeat visit. Data were assessed for association with death using logistic regression. Significant variables were included in a multivariate logistic regression model and refined via backward elimination.

**RESULTS:** Between October 7, 2013, and April 6, 2014, 684 patients were enrolled; 14 (2%) were excluded because of incomplete data. Of patients, 81% were male with mean age of 31 years (range, 10–89 years; SD 11.8). Most patients (80%) had mild TBI (Glasgow Coma Scale [GCS] score 13–15); 10% had moderate (GCS score 9–12) and 10% had severe (GCS score 3–8) TBI. Multivariate logistic regression determined that GCS score <13, hypoxia, bradycardia, tachycardia, and age >50 years were significantly associated with death.

**CONCLUSIONS:** GCS score <13, hypoxia, bradycardia, tachycardia, and age >50 years were associated with mortality. These findings inform future research that may guide clinicians in prioritizing care for patients at highest risk of mortality.

### INTRODUCTION

Worldwide each year, 10 million people sustain traumatic brain injury (TBI). Globally, TBI is the leading cause of disability in people <40 years old, causing severe disability in 150–200 people per million each year and resulting in loss of the most productive years of life.<sup>1</sup> Low- and middle-income countries (LMIC) have the greatest burden of TBI.<sup>2</sup> Of the 3.9 million deaths and 138 million disability-adjusted life years lost attributable to unintentional injury, >90% of these occur in LMIC.<sup>3</sup> Road traffic injuries (RTIs) are the leading cause of TBIs; thus, as countries develop and motor vehicle use increases, rates of RTIs and TBIs will increase. Despite challenges in data gathering in sub-Saharan Africa, rates of TBI due to RTIs already exceed both the global rate and the rate for other LMIC.<sup>4</sup>

In addition to a higher incidence of TBI in LMIC, the mortality rate is higher in LMIC for the same injury compared with high-income settings. Challenges to quality care in a setting with limited resources are numerous, including limited prehospital care or access to care, less equipment, fewer trained acute and

#### Key words

- Rwanda
- Traumatic brain injury

#### Abbreviations and Acronyms

**A&E:** Accident and Emergency Department  
**CRASH:** Corticosteroid Randomisation After Significant Head Injury  
**CT:** Computed tomography  
**GCS:** Glasgow Coma Scale  
**LMIC:** Low- and middle-income countries  
**PEPFAR:** The U.S. President's Emergency Plan for AIDS Relief  
**RA:** Research assistant  
**RTI:** Road traffic injury  
**TBI:** Traumatic brain injury  
**UTHK:** University Teaching Hospital of Kigali

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intensive care personnel, and limited neurosurgical capacity.<sup>5</sup> An analysis of >8000 hospitalized patients with TBI showed that patients with severe TBI in LMIC have more than twice the odds of death compared with patients treated in high-income countries.<sup>6</sup> Quality audits in TBI care in LMIC have found no global standardization of TBI care, limited local standardization of care, and poor control of secondary brain injury, which compound the resource and personnel challenges in this setting.<sup>7</sup>

The University Teaching Hospital of Kigali (UTHK) is 1 of 2 hospitals with the capacity to provide the highest levels of TBI care with computed tomography (CT), critical care, and neurosurgical services. UTHK is public and available to all Rwandans regardless of their financial resources. Similar to other LMIC, Rwandan patients with TBI have high mortality rates. Unpublished data from a trauma registry at UTHK documented the mortality rate of patients with severe TBI to be 58% (R.T. Petroze, oral communication, September 2012). In 2008, Rwandan patients with severe TBI who had been involved in RTIs had an 89% mortality rate.<sup>8</sup> Critical factors that contributed to these TBI-related deaths, particularly injuries in the acute care setting that are amenable to prompt medical intervention, are largely unknown. We systematically evaluated the presentation of TBI at UTHK to understand the epidemiology, acute care, and stabilization of these patients. Our objective was to evaluate important clinical indicators associated with mortality through prospective sampling of patients with acute TBI presenting for care. Understanding these predictors could guide clinicians in developing clinical practice guidelines to provide appropriate care to the most critically ill patients.

## MATERIALS AND METHODS

### Study Design and Ethics

Between October 7, 2013, and April 6, 2014, we conducted an observational prospective cohort study of all patients with acute TBI who presented to UTHK Accident and Emergency Department (A&E) for care. This 6-month period included an approximately equal portion of days in both dry and rainy seasons in Rwanda, and the duration of data collection represents the limits of available funding for this study. The study protocol was approved by the UTHK ethics committee and the Rwandan National Health Research Council. It was determined to meet criteria as a quality improvement project by the Duke University Medical Center Institutional Review Board (Pro00044873).

### Setting

Rwanda is a small, densely populated country in East Africa with a total population of approximately 11 million; approximately 1.15 million reside in the capital city of Kigali.<sup>9</sup> The decentralized public health care system includes nurse-staffed health centers, district-level hospitals, and referral hospitals and tertiary care centers. UTHK, centrally located in Kigali with approximately 500 patient beds, is the largest public referral center in Rwanda. UTHK A&E includes 30 patient beds, and the hospital has a 5-bed intensive care unit with ventilators available, has a 64-slice CT scanner, and is staffed primarily by general practitioners with on-call neurosurgical care. At the time of this study, there was 1 neurosurgeon on staff at UTHK who was supported by 2 general practitioners, whom he trained to be part of the neurosurgery

service. This neurosurgeon and the 2 general practitioners would accept consultations at any time when they were in Kigali and not otherwise occupied; however, their practical availability was limited by the size of the service, and critical patients could not always be assessed immediately. Plans were being formed during our data collection for formal residency training in neurosurgery at UTHK. Limited operating rooms were available around the clock for emergent craniotomies when not otherwise occupied. Rwanda is engaged in a large Human Resources for Health program to improve health care provider skills and capacity. Funding and support for Human Resources in Health is coordinated by the Rwandan Ministry of Health by reallocation of funds from The U.S. President's Emergency Plan for AIDS Relief (PEPFAR) and The Global Fund to Fight AIDS, Tuberculosis and Malaria.<sup>10</sup>

### Population

Inclusion criteria included signs and symptoms of TBI (headache, reported trauma to the head, visible trauma to the head, or any alteration in consciousness in the context of an injury),  $\geq 10$  years of age, sustaining an injury <48 hours before presentation for care at UTHK, first visit to UTHK for this injury (patients may have received care for this injury at other hospitals before arrival at UTHK) and not dead on arrival. Our patient cohort was continuously enrolled during the data collection period.

### Data Collection Procedures

At UTHK A&E, there is a single entrance where patients present to the triage desk and nurses seeking care. Trained research assistants (RAs) sat near this desk and evaluated every patient that arrived at UTHK A&E for care and further assessed any injured patient for study inclusion criteria. These RAs were hired locally and were fluent in the local language of Kinyarwanda, French, and English. They all completed formal education and worked clinically as nurses in Rwanda before full-time employment on this study team. RAs collected patient demographics, injury characteristics, and treatment rendered by closely observing each patient during a 4-hour observation period while the enrolled patient was cared for in A&E (the period ended at 4 hours, death, discharge or admission). A case report form ([Appendix A](#)) and data log were used to collect data on individual patients. Study coordinators subsequently located all enrolled patients in the hospital to collect follow-up data by a variety of means, including direct observation, discussions with nurses and physicians, or reviewing the patient's chart ([Appendix B](#)). These assessments continued daily until the patient's death or discharge from UTHK.

### Measures

In-hospital mortality defines the dependent variable of death in this study; patients were observed until the time of their death or discharge from UTHK. On initial presentation, RAs assessed airway patency; an unstable airway was defined as the presence of any snoring, gurgling, or blood or secretions in the mouth. The Glasgow Coma Scale (GCS) score was determined at the earliest possible point after patient arrival by physicians and by the trained RAs. RAs observed and recorded the time and values of the first assessed vital signs on arrival at UTHK A&E, including heart rate, respiratory rate, blood pressure, and oxygen saturation. Respiratory rate was dichotomized (<20 or  $\geq 20$  breaths per minute) while

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