Outcomes and Predictors of Mortality in Neurosurgical Patients at Mbarara Regional Referral Hospital

by

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Thesis submitted in partial fulfillment of
the requirements for the degree of
Master of Science in the Duke Global Health Institute
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ABSTRACT

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Abstract

Background:

Knowing the scope of neurosurgical disease at Mbarara Hospital is critical for infrastructure planning, education and training. In this study, we aim to evaluate the neurosurgical outcomes and identify predictors of mortality in order to potentiate platforms for more effective interventions and inform future research efforts at Mbarara Hospital.

Methods:

This is retrospective chart review including patients of all ages with a neurosurgical disease or injury presenting to Mbarara Regional Referral Hospital (MRRH) between January 2012 to September 2015. Descriptive statistics were presented. A univariate analysis was used to obtain the odds ratios of mortality and 95% confidence intervals. Predictors of mortality were determined using multivariable logistic regression model.

Results:

A total of 1876 charts were reviewed. Of these, 1854 (had complete data and were?) were included in the analysis. The overall mortality rate was 12.75%; the mortality rates among all persons who underwent a neurosurgical procedure was 9.72%, and was 13.68% among those who did not undergo a neurosurgical procedure. Over 50% of patients were between 19 and 40 years old and the majority of were males (76.10%). The overall median length of stay was 5 days. Of all neurosurgical admissions, 87% were trauma patients. In comparison to mild head injury, closed head injury and intracranial hematoma patients were 5 (95% CI: 3.77, 8.26) and 2.5 times (95% CI: 1.64,3.98) more likely to die respectively. Procedure and diagnostic imaging were independent negative predictors of mortality ($P < 0.05$). While age, ICU admission, admission GCS were positive predictors of mortality ($P < 0.05$).

Conclusions:

The majority of hospital admissions were TBI patients, with RTIs being the most common mechanism of injury. Age, ICU admission, admission GCS, diagnostic imaging and undergoing surgery were independent predictors of mortality. Going forward, further exploration of patient characteristics is necessary to fully describe mortality outcomes and implement resource appropriate interventions that ultimately improve morbidity and mortality.

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1. Introduction

While 60% of the world's population lives in low- and middle-income countries (LMICs), only 3% of surgeries occur in these settings (Weiser, Regenbogen et al. 2008, Meara, Leather et al. 2015). More than 95% of the population in Sub-Saharan Africa (SSA) do not have access to surgical care as compared to less than 5% in high-income countries (Alkire, Raykar et al. 2015), with 3800 DALYS per 100,000 people are attributed to surgical conditions (Jamison, Breman et al. 2006). An assessment of operating theatre density suggested that 90% of the population of SSA has access to one operating theatre per 100,000 persons and 70% of operating theatres lack anesthesia equipment and vital monitoring devices such as pulse oximetry (Funk, Weiser et al. 2010).

Within the field of neurosurgery, the capacity is even scarcer with a wide disparity between LMICs. In 2001, the incidence of neuro-trauma in LMICs alone was quantified and reported to vary from 67 to 317 per 100,000 (Basso, Previgliano et al. 2001). Access to neurosurgical procedures in developing countries is extremely limited due to the lack of the neurosurgical infrastructure and workforce. There is lack of current data on the neurosurgical workforce in SSA, however in 1998, excluding South Africa, sub-Saharan Africa had 81 neurosurgeons for 515 million population or 1 neurosurgeon for every 6,368,000 people (El Khamlichi 1998). In northern Africa and South Africa, there are approximately 486 neurosurgeons for 174 million people (1: 358,000), in comparison to North America, there are 4,583 neurosurgeons serving 370 million people (1: 81,000) (El Khamlichi 2005).

Within Uganda, current surgical capacity assessment reveals a significant lack of trained surgeons and resources in the public hospitals; one surgeon and 0.2 operating theatres per 100,000 people, 73% of the operations are performed on an emergency basis (Linden, Sekidde et al. 2012). In the field of neurosurgery, in 2005 there were five neurosurgeons serving 30 million people in the public sector (1:6 million) (El Khamlichi 2005), as of 2015 there were 7 neurosurgeons (1 neurosurgeon for every 5,368,571 people).

Uganda has been one of the main targets for surgical capacity building due to its large population size, low surgical capacity, and its long-term collaborations with western institutions (Pirani, Naddumba et al. 2009, Haglund, Kiryabwire et al. 2011, Lipnick, Mijumbi et al. 2013). A large scale community based study using the Surgeons OverSeas Assessment of Surgical Need (SOSAS) survey has, for the first time, shed light on Uganda’s current surgical burden (Fuller, Butler et al. 2015). The community based survey identified a prevalence of surgical conditions of 1 in 10 persons and a lifetime occurrence of 1 in 4 persons (Butler, Tran et al. 2015).

To overcome the lack of surgical services and build surgical capacity in Uganda, through the collaboration between Mulago National Referral Hospital, Duke University Medical Center and Duke Global Health Institute, an integrative neurosurgical twinning program was established at Mulago Hospital in Kampala Uganda in 2007 (Haglund, Kiryabwire et al. 2011). The twinning program aimed to improve neurosurgical capacity in Uganda through three core initiatives: service, education, and training. In the years since the program’s inception, neurosurgical cases performed in Mulago increased by 180% and two neurosurgical residents have successfully completed their residency at Mulago Hospital. Based on the success of the twining program in improving the neurosurgical capacity at Mulago, they are expanding to Mbarara Regional Referral Hospital (MRRH), the only other public facility in Uganda with a neurosurgery department. As the program expands to Mbarara, knowing the scope of neurosurgical disease at MRRH is critical for infrastructure planning, education and training.

In this study, we aim to evaluate the neurosurgical outcomes and identify predictors of mortality in order to plan effective interventions tailored to the current need and inform future research efforts at Mbarara Hospital.

2. Methods

2.1 Setting

This study took place in Mbarara Regional Referral Hospital (MRRH), a regional referral hospital, located in Mbarara, Western Uganda. MRRH is located approximately 260 kilometers from Kampala, the capital of Uganda, and serves as the teaching hospital for Mbarara University of Science and Technology. MRRH, with a bed capacity of 300, had 3,785 total hospital admissions and 1,640 surgical operations in 2015. In 2012, a neurosurgery department was established and the hospital currently employs one neurosurgeon and several nurses and medical interns which are shared with other surgical specialties in the hospital. The department manages approximately 500 patients and 150 operations per year.

2.2 Study design and participants

A retrospective chart review of all neurosurgery patients admitted to MRRH from January 2012 to September 2015 was carried out.

Patients admitted to MRRH with a neurosurgical disease or injury were eligible for this study. Neurosurgical disease or injury was defined as traumatic and non-traumatic brain injury, spinal cord fracture or injury, intracranial and central nervous system (CNS) tumors, intracranial and CNS infections, hydrocephalous, spina bifida, disc disorders and other spinal cord diseases.

2.3 Data collection and management

Medical charts and surgical logbooks were retrieved from MRRH medical records department. Four research assistants were trained to extract the data from the medical chart and surgical logbooks. To improve accuracy of data entry, the researcher and a research nurse crosschecked the database for errors and completion. The research assistants recorded all the required variables on an excel spreadsheet data collection tool (Appendix A).

Data recorded from the medical charts included: patient number (assigned by research assistant to avoid duplication), hospital assigned inpatient number, patient’s name, age, sex, date of admission, diagnosis(es), diagnostic test results, patient’s comorbidities (i.e. any identified chronic medical conditions), mechanism of injury (for trauma patients), referral hospital or clinic, date of discharge/referral or date of death and last follow up date.

Inpatient numbers and names were collected to check for duplicates, as inpatient numbers could be reassigned in the following fiscal year. After crosschecking for completion, the data was de-identified, coded and cleaned. It was stored on the principal investigator’s (PI) secured laptop and then uploaded to HIPAA-compliant Duke surgery servers.

2.4 Analysis

The data was analyzed using Stata software version 12 (StataCorp 2012).The main outcome of interest was mortality, which was defined as death on admission or during the hospital stay.

Demographics and clinical covariates included patient age, sex, length of stay (LOS), primary diagnosis, type of procedure, co-diagnosis, other diagnosis (non-neurological), comorbidities, infection, ICU admission, diagnostic imaging, mechanism of injury and admission Glasgow coma scale (GCS).
Age was categorized into 4 groups: 0-18, 19-40, 41-65 and 65 and above.
Primary diagnosis was coded into11 categories: mild head injury (unconsciousness, or soft tissue injury), closed head injury (brain edema or contusion), intracranial hematoma (epidural, subdural, subarachnoid, or intracerebral hemorrhage), skull fracture, spinal injury or fracture, hydrocephalous, spina bifida, CNS tumor (intracranial or spinal cord tumor), spine (spondylopathy, disc disorders or malformations of the spine), intracranial abscess and others (meningitis, encephalitis, stroke, scalp abscess or lipoma).

Type of procedure was coded into 9 categories, burr hole drainage or biopsy, craniotomy, cranioplasty, ventriculoperitoneal shunting, spina bifida repair, spine surgery (discectomies, fusion, decompression), surgical toilet and suturing and other (excisional biopsy, incisional biopsy, abscess drainage, CSF leak repair). A dichotomous measure of procedure or no procedure was used in the regression modelling.

Co-diagnosis was categorized into none, skull fracture or closed head injury.
Comorbidities, other diagnosis, infection, ICU admission, and diagnostic imaging were all dichotomized into 0 or 1 (0 indicating none/no and 1 indicating present/yes). Mechanism of injury was categorized into road traffic incident (RTI),

fall, assault or other. Admission GCS was categorized into mild (GCS of 13-15), moderate (GCS of 9-12) and severe (GCS of 3-8).

The median with the 25th and 75th percentiles were calculated for continuous variables. Kruskal–Wallis equality-of-populations rank test was used to differences in the distributions of continuous variables in relation to the dichotomized outcome. Frequency distributions were presented for all categorical variables. The Pearson chi-square test or Fisher exact test served to study distributional differences for categorical variables. P-values < 0.05 were considered statistically significant.

Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for tabular analysis of categorical variables, and univariate logistic regression was used to obtain the crude odds ratios and 95% confidence intervals for variables with more than 2 categories.

Predictors of mortality were determined using multivariable logistic regression. Analysis was restricted to subjects with complete data (complete case analysis). To develop a good-fit model, all significant variables at p value of 0.20 derived from the univariate analysis were entered into the model. Variables significant at 5% were included in the multivariable logistic regression using backward elimination, with mortality as the dependent variable.

3. Results

During the study time frame, a total of 1876 charts were reviewed. Of these 22 were excluded because they did not have a neurosurgical diagnosis or were not managed by the neurosurgery department and 1854 were included in the analysis. Of the 1854, 1512 had complete data, a univariate analysis comparing the the dataset with complete data to the original dataset showed that the data is missing at random, therefore the final sample size was 1854. The overall mortality rate among patients admitted into MRRH was 12.75%. The mortality rates among all persons who underwent a neurosurgical procedure was 9.72%, and was 13.68% among those who did not undergo a neurosurgical procedure.

Demographics

The median age of all hospitalized patients was 27 years (range18-39), for those who underwent a neurosurgical procedure the median age was 30 (range 17-50) and those who did not the median age was 26 (range 18-36). Over 50% of patients were between 19 and 40 years old. The majority of patients were male (76.10%) and of the patients who underwent a neurosurgical procedure 72.43% were males, of those who did not 77.40% were males. The overall median length of stay (LOS) was 5 days (range:2.5-10), 8 (range: 5-15) for those who underwent a neurosurgical procedure, 4 (range: 2-9) for those who did not.

A univariate analysis of mortality rates and ORs in association with demographic variables, stratified by whether the patient underwent a neurosurgical procedure, are shown in Table 1. For all subjects, those who died were significantly older than those who survived (p value: 0.02), when stratified by surgery the difference was only significant for those who did not undergo a neurosurgical procedure (P value 0.03 respectively). For age as a categorical variable, there was a significant difference in mortality among 19-40 age group (P value: 0.011); they had a 1.63 higher odds of dying as compared to 0-18 age group.

For all subjects, there was a significant difference in mortality between males and females, males had 1.66 higher odds of dying as compared to females. When stratified by surgery there was no significant difference in mortality between males and females for those who underwent a neurosurgical procedure and those who did not.

For all subjects, those who died had significantly shorter LOS as compared to those who survived (P value < 0.001). The difference was still significant when stratified by surgery for both groups (P value < 0.001).

For all subjects, those who died had significantly lower LOS as compared to those who survived (P value < 0.001). The difference was still significant when stratified by surgery for both groups (P value < 0.001).

Primary diagnosis

Of all neurosurgical admissions, 87% were trauma patients (Figure 1). A univariate analysis of mortality rates and ORs in association with primary diagnosis, stratified by whether the patient underwent a neurosurgical procedure are presented in Table 2. The highest mortality rate (24%) was observed among those with closed head injury (brain edema or contusion). In comparison to mild head injury (concussion or lacerations), closed head injury patients were 5 times (95% CI: 3.77, 8.26) more likely to die. The second highest mortality rate (13%) was among those who had an intracranial hematoma. In comparison to mild head injury, intracranial hematoma patients were 2.5 times (95% CI: 1.64,3.98) more likely to die. Among non-trauma patients, the highest mortality rate was for brain abscess and tumor, 27% and 16.7% respectively. In comparison to mild head injury, tumor patients were 3.6 times (95% CI: 1.57,8.28) more likely to die. For trauma patients who underwent a neurosurgical procedure, closed head injury patients were 7 times (95% CI: 2.36, 20.51) more likely to die than mild head injury patients.

Type of procedure

Of all the procedures performed, 49.5% were craniotomies with a mortality rate of 16.33%. Mortality rates in association with the type of procedure performed are presented in Table 3.

Other clinical covariates

A univariate analysis of mortality rates and ORs in association with other clinical covariates, stratified by whether the patient underwent a neurosurgical procedure are presented in table 4. For those who underwent a neurosurgical procedure, the mortality rate for co-diagnosis (skull fracture or closed head injury) was significantly higher than those with no co-diagnosis (p value of 0.008 and 0.004 respectively). However, there was no difference in mortality for co-diagnosis among all subjects or the group who did not undergo a neurosurgical procedure.

For all subjects, those with an additional non-neurological diagnosis (other diagnosis) were 1.53 times (95% CI: 1.07, 2.18) more likely to die than those who didn’t have an additional non-neurological diagnosis, and for the subset who had surgery, they were 2.28 times (95% CI: 1.07, 4.89) more likely to die.

Overall, those admitted to the ICU were 4 times (95% CI: 2.75, 6.37) more likely to die than those who were not, with similar ORs observed when stratified by surgery. Overall, diagnostic imaging was negatively associated with mortality; those who had any sort of diagnostic imaging done were 0.27 (95% CI: 0.55, 0.97) less likely to die than those who didn’t. However, the effect is not significant after stratification by surgery.

For all subjects, the mechanism of injury for 60% of patients was road traffic incident and 60% of the patients had a GCS of 13-15 on admission, those who had a GCS of 3-8 were 27 times (95% CI: 17.91,40.74) more likely to die than those who had a GCS of 13-15.

Predictors of Mortality

Table 5 shows the crude odds ratios for mortality in association with primary diagnosis. Due to small sample sizes, all non-trauma patients in primary diagnosis were collapsed into a single ‘Other’ category for regression modeling, and univariate analysis was performed to evaluate for inclusion in the multivariable regression model.

Dichotomous procedure status, age, sex, primary diagnosis, other diagnosis, ICU admission, diagnostic imaging, mechanism of injury, and admission GCS (categorical) were all significant at P< or =0.20 and therefore included in the multivariable logistic regression model.

Table 6 describes the adjusted odds ratios for predictors of mortality. Of the 1854 charts reviewed, 1512 patients had complete data and were therefore included in the regression analysis. Procedure and diagnostic imaging were independent negative predictors of mortality (P <0.05). While age, ICU admission, admission GCS were positive predictors of mortality (P <0.05). Sex, primary diagnosis, other diagnosis and mechanism of injury were not significant after the multivariable adjustment. In comparison to those who did not undergo a neurosurgical procedure, those who underwent a neurosurgical procedure were 0.40 less likely to die (95% CI: 0.36, 1.01). Those who had any type of diagnostic imaging done were 0.40 less likely to die (95% CI: 0.42, 0.87) as compared to those who did not have any diagnostic imagine done. In comparison to the 0-18 age group, the 19-40 and 41-65 were twice as likely to die (95% CI: 1.25, 3.11 and 1.03,3.55 respectively). While those who were 65 and above were 3.5 times as likely to die (95% CI: 1.53, 8.33). Those admitted to the ICU were 1.88 times more likely to die (95% CI: 1.034, 3.41) as compared to those who were not admitted to the ICU. In comparison to those with a GCS of 13-15, those with a GCS of 9-12 and 3-8 were 4.4 times (95% CI: 2.72, 7.08) and 29 times(95% CI: 18.17, 46.47) more likely to die.

Table 1 Mortality rate in relation to demographics stratified by surgery (univariate analysis)

		All subjects					Surgery					No Surgery				
Variable		All	Deaths	Alive	OR (95% CI)	P-value	All	Deaths	Alive	OR (95% CI)	P-value	All	Deaths	Alive	OR (95% CI)	P-value
Age	Median (25th,75th)	27 (18,39)	30 (21,40)	26 (17,38)	-	0.024	30 (17,50)	31 (25,57)	29 (16,50)	-	0.272	26 (18,36)	29 (20,39)	25 (17,36)	-	0.030
	N (%)	1804	207 (11.47)	1597 (88.53)			424	38 (8.96)	386 (91.04)			1380	169 (12.25)	1211 (87.75)		
	Missing	50														
Age categories N (%)	0-18	482 (27.45)	41 (8.51)	452 (91.49)	ref	-	116 (27.36)	5 (13.16)	111 (28.76)	ref	-	367 (26.56)	41 (17.83)	331 (27.75)	ref	-
	19-40	918 (51.03)	118 (13.17)	778 (86.83)	1.63 (1.12,2.36)	0.011	167 (39.39)	21 (55.26)	146 (37.82)	3.19 (1.17,8.73)	0.024	730 (52.82)	97 (51.32)	633 (53.06)	1.40 (0.94,2.10)	0.099
	41-65	296 (16.17)	34 (11.97)	250 (88.03)	1.43 (0.89,2.31)	0.143	88 (20.75)	7 (18.42)	81 (20.98)	1.92 (0.59,6.26)	0.280	198 (14.33)	27 (14.29)	171 (14.33)	1.41 (0.83,2.40)	0.202
	65+	97 (5.35)	14 (14.89)	80 (85.11)	1.86 (0.97,3.56)	0.062	53 (12.50)	5 (13.16)	48 (12.44)	2.31 (0.64,8.36)	0.201	87 (6.30)	29 (15.34)	58 (4.86)	2.44 (1.08,5.47)	0.031
	Missing	50														
Sex N (%)	Female	431 (23.90)	38 (8.82)	393 (91.18)	ref	0.006	118 (27.57)	7 (17.07)	111 (28.68)	ref	0.114	322 (22.60)	31 (16.40)	291 (23.54)	ref	0.102
	Male	1372 (76.10)	192 (13.99)	1180 (86.01)	1.66 (1.15,2.40)		310 (72.43)	34 (82.93)	276 (71.32)	1.95 (0.84,4.54)		1068 (77.40)	158 (83.60)	945 (76.46)	1.57 (1.04,2.36)	
	Missing	51														
LOS	Median (25th,75th)	5 (2.5,10)	1 (0,4)	6 (3,11)	-	<0.001	8 (5,15)	4 (1,11)	9 (5,16)	-	<0.001	4 (2,9)	1 (0,4)	5 (3,10)	-	<0.001
	N	1708														
	Missing	146														
LOS-Preop	Median (25th,75th)	2 (1,6)	1 (0,3)	2 (1,7)	-	0.002	2 (1,6)	1 (0,3)	2 (1,7)	-	0.002	-	-	-	-	-
LOS-Postop	Median (25th,75th)	4.5 (3,8)	2 (0,5)	5 (3,8)	-	<0.001	4.5 (3,8)	2 (0,5)	5 (3,8)	-	<0.001	-	-	-	-	-

*LOS-Length of stay

Table 2 Mortality rate and odds ratios in relation to primary diagnosis stratified by surgery (univariate analysis)

		All subjects					Surgery				No Surgery			
		Total	Deaths	Alive			Total	Deaths	Alive		Total	Deaths	Alive	
	Primary diagnosis	N (%)	N (%)	N (%)	OR (95%CI)	P-value	N (%)	N (%)	N (%)	OR (95%CI)	N (%)	N (%)	N (%)	OR (95%CI)
Trauma	MHI	511 (27.56)	29 (5.68)	482 (94.32)	Ref	-	25 (5.84)	4 (16.00)	21 (84.00)	Ref	486 (34.08)	25 (5.14)	461 (94.86)	-
	CHI	445 (24.00)	109 (24.49)	336 (75.51)	5.58 (3.77, 8.26)	<0.001	26 (6.07)	7 (26.92)	19 (73.08)	6.96 (2.36,20.51)	419 (29.38)	102 (24.34)	317 (75.66)	4.61 (3.10,6.86)
	ICH	384 (20.71)	50 (13.02)	334 (86.98)	2.56 (1.64,3.98)	<0.001	211 (49.30)	24 (11.37)	187 (88.63)	2.33 (1.09,5.02)	173 (12.13)	26 (15.03)	147 (84.97)	2.55 (1.50,4.34)
	Skull fracture	209 (11.27)	18 (8.61)	191 (91.39)	1.61 (0.90,2.88)	0.112	30 (7.01)	1 (3.33)	29 (96.67)	-	179 (12.55)	17 (9.50)	162 (90.5)	1.50 (0.82,2.73)
	Spine fracture or Injury	73 (3.94)	7 (9.59)	66 (90.41)	1.82 (0.78,4.25)	0.164	9 (2.10)	1 (11.11)	8 (88.89)	-	64 (4.49)	6 (9.38)	58 (90.62)	1.49 (0.60,3.68)
	N(%)	1622 (87.49)												
Non-trauma	Hydrocephalous	34 (1.83)	2 (5.88)	32 (94.12)	-	-	19 (4.44)	0 (0.00)	19 (100.00)	-	15 (1.05)	2 (13.33)	13 (86.67)	-
	Spina bifida	23 (1.24)	0 (0.00)	23 (100)	-	-	19 (4.44)	0 (0.00)	19 (100.00)	-	4 (0.28)	0 (0.00)	4 (100.00)	-
	Tumor	48 (2.59)	8 (16.67)	40 (83.33)	3.60 (1.57,8.28)	0.002	27 (6.31)	3 (11.11)	24 (88.89)	-	21 (1.47)	5 (23.81)	16 (76.19)	-
	Spine	62 (3.34)	3 (4.84)	59 (95.16)	-	-	34 (7.94)	0 (0.00)	34 100	-	28 (1.96)	3 (10.71)	25 (89.29)	-
	Brain Abscess	11 (0.59)	3 (27.27)	8 (72.73)	-	-	9 (2.10)	1 (11.11)	8 (88.89)	-	2 (0..53)	2 (100.00)	0 (0.00)	-
	Other	54 (2.91)	1 (1.85)	53 (98.15)	-	-	19 (4.44)	0 (0.00)	19 (100.00)	-	35 (2.45)	1 (2.86)	34 (97.14)	-
	N (%)	232 (12.51)												
	N Total	1854												

MHI-Mild head injury, CHI, Closed head injury, ICH-Intracranial hematoma

MHI-soft tissue injury, unconsciousness, CHI-brain edema, contusion, ICH- epidural, subdural, intracerebral or subarachnoid hemorrhage, Other tumor- any CNS tumor, Spine-Disc disorder, spine deformity or spondylopathy, Other-meningitis, encephalitis, stroke, scalp abscess...etc.

Table 3 Mortality rate in relation to type of procedure

	Total	Deaths	Alive	
Procedure	N (%)	N (%)	N (%)	P-value
Burr hole	101 (23.65)	4 (3.96)	97 (96.04)	<0.001
Craniotomy	196 (45.9)	32 (16.33)	164 (83.67)	
Cranioplasty	9 (2.11)	0 (0.00)	9 (100.00)	
VP shunting	13 (3.04)	0 (0.00)	13 (100.00)	
Ventriculostomy	9 (2.11)	1 (11.11)	8 (88.89)	
Spina bifida repair	19 (4.45)	0 (0.00)	19 (100.00)	
Spine surgery	54 (12.65)	0 (0.00)	54 (100.00)	
STS	15 (3.51)	0 (0.00)	15 (100.00)	
Other	11 (2.58)	4 (36.36)	7 (63.64)	

VP shunting- Ventriculoperitoneal shunting, STS-Surgical Toilet and Suturing

Table 4 Mortality rate and odds ratios in relation to other clinical variables stratified by surgery (univariate analysis)

Clinical variable		All subjects					Surgery					No Surgery				
		All	Deaths	Alive	OR (95% CI)	P- value	All	Deaths	Alive	OR (95% CI)	P- value	All	Deaths	Alive	OR (95% CI)	P- value
Co-diagnosis	None	1653 (90.63)	207 (12.52)	1446 (87.48)	ref	-	396 (92.52)	32 (8.08)	364 (91.92)	ref	-	1307 (91.65)	175 (13.39)	1132 (86.61)	ref	-
	CHI	120 (6.65)	18 (15.00)	102 (85.00)	1.23 (0.74, 2.07)	0.360	23 (5.37)	6 (26.09)	17 (73.91)	4.01 (1.53,10.62)	0.004	97 (6.80)	12 (12.37)	85 (87.63)	0.91 (0.4, 1.69)	0.776
	Skull fracture	31 (1.72)	5 (16.13)	26 (83.87)	1.34 (0.53, 3.42)	0.500	9 (2.10)	3 (33.33)	6 (66.67)	5.69 (1.49, 21.91)	0.008	22 (1.54)	2 (9.09)	20 (90.91)	0.65 (0.00, 2.52)	0.556
	N	1854														
Other Diagnosis	None	1543 (85.53)	185 (11.99)	1358 (88.01)	ref	0.019	370 (87.26)	31 (8.83)	339 (91.62)	ref	0.033	1212 (84.99)	154 (12.71)	1058 (87.29)	ref	0.147
	One or more	261 (14.47)	43 (17.24)	216 (82.76)	1.53 (1.07, 2.18)		58 (13.68)	10 (17.24)	48 (82.76)	2.28 (1.07, 4.89)		214 (15.01)	35 (16.36)	179 (83.64)	1.34 (0.90, 2.00)	
	N	1854														
Co-morbidities	None	1736 (96.23)	222 (12.79)	1514 (87.21)	ref	0.804	399 (94.10)	40 (10.03)	359 (89.97)	ref	0.245	1384 (97.05)	182 (13.15)	1202 (86.85)	ref	0.508
	One or more	68 (3.77)	8 (11.76)	60 (88.24)	0.91 (0.44, 1.90)		29 (5.90)	1 (3.45)	28 (96.55)	0.32 (0.00, 1.91)		42 (2.95)	7 (16.67)	35 (83.33)	1.32 (0.59, 2.96)	
	N	1854														
Infection	No	1571 (87.08)	199 (12.67)	1372 (87.33)	ref	0.785	315 (65.08)	29 (9.21)	286 (90.79)	ref	0.661	1301 (91.23)	170 (13.07)	1131 (86.93)	ref	0.502
	Yes	233 (12.92)	31 (13.30)	202 (86.70)	1.05 (0.70, 1.58)		113 (34.92)	12 (10.62)	101 (89.38)	1.17 (0.58, 2.36)		125 (8.77)	19 (19.20)	106 (84.80)	1.19 (0.72, 1.99)	
	N	1854														
ICU Admission	No	1695 (93.96)	192 (11.33)	1503 (88.67)	ref	<0.001	359 (84.67)	23 (6.41)	336 (93.59)	ref	<0.001	1384 (96.92)	169 (12.21)	1215 (87.79)	ref	<0.001
	Yes	109 (6.04)	38 (34.86)	71 (65.14)	4.19 (2.75, 6.37)		69 (13.33)	18 (26.09)	51 (73.91)	5.16 (2.62, 10.14)		42 (2.94)	20 (47.62)	22 (52.38)	6.54 (3.53, 12.13)	
	N	1854														
Diagnostic Imaging	No	1008 (55.88)	144 (13.29)	864 (85.71)	ref	0.028	177 (41.36)	18 (10.17)	159 (89.83)	ref	0.728	863 (60.52)	126 (14.60)	737 (85.40)	ref	0.063
	Yes	796 (44.12)	86 (10.80)	710 (89.20)	0.73 (0.55, 0.97)		251 (59.64)	23 (9.16)	228 (90.84)	0.89 (0.47, 1.69)		563 (39.48)	63 (11.19)	500 (88.81)	0.74 (0.53, 1.02)	
	N	1854														

MOI	RTA	1082 (59.98)	153 (14.14)	929 (85.86)	ref	-	162 (37.85)	24 (14.81)	138 (85.19)	ref	-	943 (66.13)	129 (13.68)	814 (86.32)	ref	-
	Fall	114 (6.32)	13 (11.40)	101 (88.60)	0.78 (0.43, 1.43)	0.413	22 (5.14)	1 (4.55)	21 (95.45)	-	-	95 (6.66)	12 (12.63)	83 (87.37)	0.91 (0.28, 1.71)	0.776
	Assault	332 (18.40)	37 (11.14)	295 (88.86)	0.76 (0.52, 1.12)	0.148	73 (17.06)	8 (10.96)	65 (89.04)	0.77 (0.33, 1.80)	0.571	269 (18.86)	29 (10.78)	240 (89.22)	0.77 (0.50, 1.19)	0.214
	Other	276 (15.30)	27 (9.78)	249 (90.22)	0.66 (0.43, 1.01)	0.042	171 (39.95)	8 (9.58)	163 (95.32)	0.32 (0.14, 0.72)	0.006	119 (8.35)	19 (15.97)	100 (84.03)	1.29 (0.76, 2.20)	0.498
	N	1854														
Admission GCS	Mild (13-15)	990 (60.66)	37 (3.74)	953 (96.26)	ref	-	223 (64.08)	8 (3.59)	215 (96.41)	ref	-	788 (59.61)	29 (3.68)	759 (96.32)	ref	-
	Moderate (12-9)	390 (23.90)	51 (13.08)	339 (86.92)	3.87 (2.49, 6.02)	<0.001	72 (20.69)	10 (13.89)	62 (86.11)	4.27 (1.62, 11.30)	0.003	325 (24.58)	41 (12.62)	284 (87.38)	3.78 (2.30, 6.21)	<0.001
	Severe (3-8)	252 (15.44)	129 (51.19)	123 (48.81)	27.01 (17.91,40.74)	<0.001	53 (15.23)	19 (35.85)	34 (64.15)	16.24 (6.55, 40.27)	<0.001	209 (15.81)	110 (52.63)	99 (47.37)	30.55 (19.23, 48.54)	<0.001
	N	1670														
	Missing	184														

MOI-Mechanism of Injury, GCS-Glasgow Coma Scale

Table 5 Mortality rate and odds ratios in relation to primary diagnosis (univariate analysis with non-trauma collapsed as other)

	Total	Deaths	Alive	
Primary Diagnosis	N	N (%)	N (%)	OR (95%CI)
MHI	511 (27.56)	29 (5.68)	482 (94.32)	ref
CHI	445 (24.00)	109 (24.49)	336 (75.51)	5.39 (3.50, 8.31)
ICH	384 (20.71)	50 (13.02)	334 (86.98)	2.49 (1.54, 4.01)
Skull fracture	209 (11.27)	18 (8.61)	191 (91.39)	1.57 (0.85, 2.89)
Spine fracture or Injury	73 (3.94)	7 (9.59)	66 (90.41)	1.76 (0.74, 4.18)
Other	232 (12.51)	17 (7.33)	215 (92.67)	1.31 (0.71, 2.44)
N	1854			

MHI-Mild head injury, CHI, Closed head injury, ICH-Intracranial hematoma
MHI-soft tissue injury, unconsciousness, CHI-brain edema, contusion, ICH- epidural, subdural, intracerebral or subarachnoid hemorrhage, Other- hydrocephalous, spina bifida, tumors, spine, meningitis, encephalitis, stroke, scalp abscess..etc.

Table 6 Adjusted odds ratios for predictors of mortality (multivariable regression analysis

Predictor		OR	95% CI	P-value
Procedure	No	ref	-	-
	Yes	0.60	(0.36, 1.01)	0.053
Age	0-18	ref	-	-
	19-40	1.97	(1.25, 3.11)	0.003
	41-65	1.92	(1.03, 3.55)	0.039
	65+	3.57	(1.53, 8.33)	0.003
ICU Admission	No	ref		
	Yes	1.88	(1.034, 3.41)	0.039
Imaging	No	-	-	-
	Yes	0.60	(0.42, 0.87)	0.007
GCS	Mild (13-15)	ref	-	-
	Moderate (12-9)	4.39	(2.72, 7.08)	<0.001
	Severe (8-3)	29.06	(18.17, 46.47)	<0.001

MHI-Mild head injury, CHI, Closed head injury, ICH-Intracranial hematoma, GCS-Glasgow Coma Scale

4. Discussion

This study has shown that traumatic brain injuries (TBI) are predominant cause of neurosurgical admissions at MRRH and are associated with a significant rate of death; 93%% of all deaths are attributed to traumatic brain injury. The overall mortality rate since the establishment of the neurosurgery department in 2012 up to September 2015 was 12.75%. A majority of the admissions were males and the median length of stay was 5 days. Age, ICU admission, admission GCS and procedure (dichotomous variable) were independent predictors of mortality.

Traumatic brain injury (TBI)

In this study, 90% of admission were traumatic brain injury patients. The mortality rate from TBI overall was 13%, while mortality from severe TBI was around 50%. A study by Staton et al. in Moshi, Tanzania had similar results where 9% of all TBI patients died and 47% of severe TBI patients died. While a study by Tran et al. at Mulago hospital in Kampala, Uganda reported a 26% mortality rate for severe TBI patients (Tran, Fuller et al. 2015). A four-month prospective study at Jimma University Hospital, Ethiopia, reported a mortality rate of 21% for all TBI patients (Aenderl, Gashaw et al. 2014).

While no age category is immune, in our study 60% of individuals with TBI were between 19 and 40 years, this is consistent with the literature on this topic. In a study by Basso et al., TBI was found to be a major cause of mortality and disability in the population under 40 years old (Basso, Previgliano et al.

2001).The other demographic characteristics results echo similar numbers in the literature where young working males are most vulnerable (Basso, Previgliano et al. 2001, Saidi, Mutiso et al. 2014, Staton, Msilanga et al. 2015, Tran, Fuller et al. 2015).

Road traffic incidents (RTIs) were most common mechanism of injury in our study. Data from around the world show that 85% of RTIs occur in developing countries (Contini 2007). Although only 4% of motor vehicles in the world are in Africa, one tenth of deaths are in Africa secondary to RTIs and a higher burden of TBI is anticipated in the future (Saidi, Mutiso et al. 2014, Wong, Linn et al. 2015).

Predictors of Mortality

Imaging was found to be negatively associated with mortality, those who got any form of diagnostic imaging were 40% less likely to die than those who did not. This finding could be explained by several things other than the direct effect of imaging on mortality. For instance, severity of injury could be a confounder. Severity of injury could affect the ability to get a diagnostic image; if the patient has suffered a severe injury, they might not be stable enough to have imaging done. Similarly, the more severe the injury the higher the chances of mortality. Another confounder that should be considered is socioeconomic status, as the patient has to be able to pay for imaging in order to get it in that setting. Patients admitted to the ICU were twice as likely to die as compared to patients who were not, however these findings could be explained by the lack of staff for postoperative care, at MRRH there are 8 ICU beds and only 1 ICU nurse. Despite the negative association between undergoing surgery and mortality, the mortality rate was still high. These findings suggest an urgent need to expand the surgical workforce, improve the surgical infrastructure, and strengthen other supporting services (Meara, Hagander et al. 2014).

4.1 Implications

To be able to better explain mortality outcomes, more specific variables need to be explored, such as heart rate; blood pressure; temperature; oxygen saturation; blood electrolytes; blood glucose level; intracranial pressure and CSF analysis results. Further analysis of ICU patients is needed to explore the reasons for the high mortality rate and identify where on the care continuum is intervention needed to improve mortality and morbidity outcomes. To conduct such thorough analysis, encouraging better documentation of patient data is necessary.

The hospital would benefit from investing in electronic health records. Prospective, systematic tracking of practice patterns and patient outcomes will allow neurosurgeons to improve the quality and efficiency and, ultimately, the value of care for Ugandan patients. Studies have shown that adoption of electronic medical record systems will lead to major health care savings, reduce medical errors, and improve health (Hillestad, Bigelow et al. 2005).

Opportunities exist to improve patient outcomes by investing in infrastructure and training. Strengthening collaborations with western institutions could be used to expand the neurosurgical workforce, improve neurosurgical capacity and ultimately improve outcomes.

4.2 Limitations

There is inherent limitation in the retrospective nature of the study as it only depends on available data, which may not include the full extent of clinical and nonclinical relevance. Furthermore, the documentation of data was not consistent and the lack of patient baseline characteristics (such as vital signs) makes it hard to draw conclusions.

We could not rule out the possibility of systematic bias, as we did not have access to the admissions book and we could not therefore identify the number of missing charts.

Patients who survive severe or moderate traumatic brain injury may have residual neurological deficits with significant impairment in quality of life. In this study we were not able to address morbidity outcomes which is a very crucial measure of hospitals' performance.

5. Conclusion

The overall mortality rate was 12.75%. The majority of hospital admissions were TBI patients. Young males (age: 19-40) were most likely to present with TBI. Procedure and diagnostic imaging were independent negative predictors of mortality. While age, ICU admission, admission GCS were positive predictors of mortality. Further exploration of patient characteristics is necessary to fully describe mortality outcomes and draw conclusions.

Resource appropriate interventions throughout the health system are needed to improve outcomes. Collaborating with institutions from developed countries to share expertise and resources is advised to improve neurosurgical capacity and ultimately improve outcomes. In addition, prospective, systematic tracking of practice patterns and patient outcomes is needed to allow neurosurgeons to improve the quality and efficiency and, ultimately, the value of care for Ugandan patients.

Appendix A: Data Collection Tool

Serial Number	Patient's name	Age	Sex	Inpatient Number	Date of Admission	Primary Diagnosis 1	Primary Diagnosis 2	Other Diagnoses	Co-morbidities	Operation	Date of Operation	Died/ Discharged	Date of Death/ Discharge	Infection pre-op	Antibiotics Used (Pre)	Infection post-op	Antibiotics Used (Post)	Temperature (Pre)	WBC count (Pre)	Temperature (Post)	WBC count (Post)	CT Results	GCS Score Admission	GCS Score Final	Mechanism of Injury	ICU Admission	Notes	Referral Hospital	Last Follow up date	Follow up notes

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