Original Article

Predictors of the short-term outcome of emergency neurosurgeries; a cross-sectional study

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Abstract:

Background: Emergency neurosurgery plays a critical role in the management of life-threatening neurological disorders. Previous studies have shown that the initial clinical status and prolonged time interval to surgery affect patient mortality and morbidity. This study aimed to describe the association of the baseline and clinical characteristics of patients and the timing of intervention with the emergency neurosurgical intervention outcomes.

Methods: A retrospective cross-sectional study was conducted involving all patients who received emergency surgery in the theatre of SMBBMU Larkana from June 2021 until 2023. Age, gender, type of surgical procedures, se- verity of trauma, Glasgow coma scale (GCS) at emergency room arrival, time to theatre (TTT), the duration of the operation, and length of stay (LOS) were collected. Mortality was defined as the pri- mary outcome.

Results: 43 emergency surgeries were included. The mean age was 42.35 (±21.85)years and the majority of patients were male (69.8%). 65.1% of patients were trauma cases and 51.2% underwent craniotomy. The median GCS at the time of admission was 9, the median TTT was3 hours, the median duration of surgery was 2.41 hours, and the median LOS was 7 days. After the procedures, the survival rate was 67.4%. The GCS upon admission (p=0.003) and TTT (p=0.044) were significantly associated with the patient's mortality.

Conclusion: GCS at emergency room ar-rival and TTT in emergency surgery were associated with the mortality of emergency neurosurgery patients.

Keywords: Emergency, Neurosurgery, Hospitals, Survival Rate

How to cite this:
Bashir N, Ahmed F, Hussain I, Hussain A. Hussain S, Khatoon S, Predictors of the short-term outcome of emergency neurosurgeries; a cross-sectional study
JIMC 2024; 7.(1) :410-414

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Introduction

Emergency neurosurgery is crucial in treating life- threatening neurological disorders, such as traumatic brain injury and hemorrhagic strokes (1-3). However, the success of such procedures is affected by various cir-cumstances, including the patient's initial clinical condition and the timing of surgical intervention (3-5). De- layed surgery can increase the risk of morbidity and mortality, as well as the length of hospital stay and the cost of care (6-10).

The success of emergency neurosurgery relies on pre- cise clinical evaluation and prioritization of surgical pa- tients who have recently experienced an acute illness (11-13). However, there is insufficient data on the fac- tors that affect the time to theatre (TTT) and the out- comes of emergency neurosurgery in low- and middle- income countries, where the resources and demands for emergency services are often imbalanced. There is cur-rently no consensus on the optimal TTT for different types of emergency neurosurgery cases.

The purpose of this study is to investigate the association between the baseline characteristics of patients and TTT on the outcomes of emergency neurosurgery SMBBMU Larkana

Methods

Study Design

This study was a retrospective observational study with a cross-sectional study design. The study took place at SMBBMU Larkana's emergency room (ER), Bali Province, Indonesia. This research has received an ethical clearance letter from the Udayana University Faculty of Medicine Ethical Review Board with reference number 2740/ SMBBU 4.2.2.VII.14/LT/2023.

Study Population

The subjects were recruited through a consecutive sam-pling method. The study required a minimum sample size of 40, which was determined using the hypothesis tests for two population proportions formula (two-sided test) with a 5% level of significance (α) and 90% power (1-β). Research subject inclusion criteria were patients who received emergency surgery in the last two years (June 2021 until June 2023) and were not transferred from the ER before surgery. No specific diagnostic criteria were used in this study. We identify cases according to the national guidelines for neurosurgery medical ser- vices, as released by the Indonesian Neurosurgery Specialist Association (14).

Data Extraction

A retrograde data extraction was done during the study period. The data documentation was completed using a data collection form provided by the medical record de-partment. The age, gender, type of cases, type of surgery procedures, and outcome were the variables. Age, Glas- gow coma scale (GCS) at ER arrival, TTT, the duration of the operation, and length of stay (LOS) were considered independent variables (predictors). The dependent variable was the outcome (death or survival).

Statistical Analysis

All analysis were conducted in SPSS 25.0 statistical soft- ware for Windows. Numerical data were analyzed for their distribution using the Kolmogorov-Smirnov test.

Mean and standard deviations were not reported in nor- mally distributed numerical data; otherwise, the median and interquartile range (IQR) were reported. Associations between two categorical scale variables were eval- uated using Fisher's exact test or the chi-square test, whichever appropriate. Differences in the means of the two groups were compared using the independent t-test or Mann-Whitney test, depending on the normality of the data obtained. Significant associations identified in the bivariate analysis underwent further examination using the multivariate analysis of variance (MANOVA) test. P-value < 0.05 was considered significant.

Results

A total of 43 patients with emergency surgery were identified. The univariate analyses of the patient's base-line characteristics are shown in Table 1. The mean age of patients was 42.35 years (±21.85) and the majority of them were male (69.8%). 65.1% of patients were trauma cases and 51.2% underwent craniotomy. The overall median GCS at ER arrival was 9 (IQR = 7), TTT was 3 hours (IQR = 4.33), duration of operation was 2.41 hours (IQR = 2.46), and LOS was 7 days (IQR = 5).

Table 1: Characteristics and outcomes subjects

Variables	**N (%)**
Age (years old)	
<18	5 (11.1)
18-64	30 (66.7)
>65	10 (22.2)
Gender	
Male	30 (69.8)
Female	13 (30.2)
Type of cases	
Traumatic Brain Injury	28 (65.1)
Mild	7 (16.3)
Moderate	12 (27.9)
Severe	9 (20.9)
Hemorrhagic Stroke	15 (34.9)
Type of Surgical procedures	
Burr holes	4 (9.3)
Craniectomy	2 (4.7)
Craniectomy + EVD	1 (2.3)
Decompressive craniectomy	3 (4.7)
Craniectomy trepanation	1 (2.3)
Craniotomy	22 (51.2)
Debridement	5 (11.6)
EVD	3 (7.0)
VP Shunt	4 (7.0)
Outcome	
Survival	29 (67.4)
Death	14 (32.6)
EVD: External ventricular drain; VP Shunt: shunt	Ventriculoperitoneal

Table 2: Univariate analysis for baseline and surgical characteristics with Mortality

	Outcome; N (%)		p
Variables	**Survive**	**Dead**	
Age (years old)			
Mean ± SD	42.10 ± 22.10	42.86 ± 22.14	0.508
<18	3 (60)	2 (40)	0.785
18-64	19 (65.5)	10 (34.5)	
>65	7 (77.8)	2 (22.2)	
Gender			
Male	20 (66.7)	10 (33.3)	>0.999
Female	9 (69.2)	4 (30.8)	
Type of cases			
Mild TBI	7 (100.0)	0 (0.0)	0.020
Moderate TBI	10 (83.3)	2 (16.7)	
Severe TBI	3 (33.3)	6 (66.7)	
Hemorrhagic Stroke	9 (60)	6 (40)	
GCS at ER arrival – Median (IQR)**	10 (6)	6 (4.50)	0.004
Time to Theatre (hours) – Median (IQR)**	3.3 (3.84)	1.42 (2.13)	0.016
Type of surgical procedures			
Burr holes	1 (25)	3 (75)	0.028
Craniectomy	1 (50)	1 (50)	
Craniectomy + EVD	1 (100)	0 (0)	
Decompressive craniectomy	2 (100)	0 (0)	
Craniectomy trepanation	1 (100)	0 (0)	
Craniotomy	15 (68.2)	7 (31.8)	
Debridement	5 (100)	0 (0)	
EVD	0 (0)	3 (100)	
VP Shunt	3 (100)	0 (0)	
Duration of operation (hours) – Median (IQR)**	2.41 (1.88)	2.21 (2.90)	0.468
Length of stay (days) – Median (IQR)**	7 (5.50)	6.5 (6.25)	0.845
EVD: External ventricular drain; TBI: Traumatic brain injury; VP Shunt: Vent deviation. *Independent sample T-test, **Mann-Whitney U test	riculoperitoneal shunt;	QR: Interquartile range	; SD: Standard

Univariate analyses of patient characteristics and the outcome are provided in Table 2. The univariate anal- yses showed that the type of case (p = 0.020) and surgi- cal procedure (p = 0.028) were associated with the pa- tients' mortality. The GCS at ER arrival (p = 0.004) and TTT (p = 0.016) were associated with the mortality of emergency surgery cases (Table 2).

Finally, the multivariate analysis showed that the initial GCS (p = 0.003) and TTT (p = 0.044) were factors asso- ciated with outcomes in ER patients in this study (Table3).

Discussion

This study aims to investigate the association between the initial patient status and TTT on the outcomes of emergency neurosurgery. We found that initial GCS and TTT were independent factors associated with mortality following emergency neurosurgery. Regarding the time taken to reach the operating room for emergency sur- gery at SMBBMU Larkana, the TTT is consid- ered an essential indicator of operating room efficiency for emergency surgical patients.

This study found that the median TTT for patients who needed emergency surgery was 2.92 hours. Compared to Karolinska University Hospital, the median time for the direct transport of trauma patients to surgery was 3 hours and 39 minutes. In comparison, those with a sec- ondary transport started surgery at 8 hours 47 minutes after trauma based on data from 457 patients (15). In 2017, Mahadewa et al. documented the mean of TTT in emergency surgery at Sanglah Denpasar Hospital as 649.83 minutes or about 10 hours (16). Another study at UCHG (Ireland) reported a mean TTT of 26 hours and 2 minutes out of 7041 operations performed (17). Élthes et al. compared the mean TTT times between patients who died and those who survived in their cohort study at Tîrgu Mureș Hospital (Romania), obtaining results of 9.1 hours in patients who died and 5.57 hours in patients who survived (18). Four other studies demonstrated a reduction in patient survival by about 2.2 to 3% for each additional hour of TTT delay (19-22). Overcrowded ERs can lead to difficulties for medical professionals in offer- ing prompt diagnosis, treatment, and quality control (13, 23, 24). Previous research demonstrated that delays in operating room times increase morbidity and mortal- ity. A mismatch between the availability of facilities and the demand for surgery services frequently leads to de- lays (13, 25). The efficiency of healthcare services, espe- cially emergency surgery, must be given more attentionas the population ages and demands and case complexi- ties increase (16, 26). Due to our traumatology sur- geons' and neurosurgeons' quick diagnosis following re- suscitation and other examinations, their capacity to classify cases as emergency cases has resulted in a me- dian TTT less than earlier publications. In our facility, the neurosurgeons rotated throughout the day, leading to constant availability and prompt action by a consult- ant neurosurgeon.

The median surgery preparation time in SMBBMU Larkana was 2.92 hours or 175.2 minutes, faster than the previous studies. The hospital's fastest emergency surgery duration reached 0.85 hours and the long- est was 5.58 hours. The ER usually takes longer than ex- pected because of the waiting list for surgery, the readi- ness of the patient and the patient's family to give writ- ten consent for surgery, emergency surgery prepara- tions, special precautions taken before the procedure, consultation with other departments, the need for a blood transfusion, the preparation of tools and implants,and changes in the nurses' shifts or duty hours (15, 27- 30). Our institution's preparation for operations is significantly faster than other hospitals because of the centralized ER evaluation laboratory tests and imaging, the 24-hour consultation line with other departments in the ER, and the availability of internal medicine and anesthesia specialists who are on call 24 hours a day.

The previous study showed that emergency surgery at the general surgery department was known to have higher morbidity in men and elderly patients (31, 32). The oldest patient who underwent surgery in our study was 84, with a median age of 45. Patients at our hospital presented to the ER with a median GCS of 9 (moderate head injury) and were predominately male (71.1%). However, prolonged waiting times increase patient morbidity; therefore, our hospital strives to conduct prompt, appropriate investigations and management. A thorough history taking, physical examination, additional examination, and resuscitation lasting no longer than six hours are all recommendations made in our hospital for patients getting ready for surgery. Among the 1367 neurosurgery cases registered as emergency surgeries at the University Hospital, Edmonton, Alberta, the mean LOS after surgery was 6.78 days for discharged patients and 21.23 days for patients who were referred back (33). Khan et al. at Lady Reading Hospital (LRH, Tertiary Care Hospital), Peshawar, noted that 1818 patients were admitted during the study period, and neurosurgery was performed on 823 patients with an average length of stay of 6.5 ± 5 days (34).

Van Veen-Berkx recommended creating a dedicated operating room for emergencies in response to operating room usage, overtime, and cancellation of operations in teaching hospitals (35). Numerous other research re- vealed that additional factors, such as the number of consultations with other departments and surgery dur- ing working hours, were anticipated to contribute to the delay of emergency surgeries (15, 27-30). Acute surgical access became challenging during working hours due to the high demand for current operating days (5, 28, 35). According to this study, post-surgical improvement wasachieved in 64.4% of cases, 31.1% died and 2 patients(4.4%) were eventually referred. Grevfors et al.'s uni variate analysis revealed a significant positive link be- tween improved outcomes and a longer time between trauma and surgery for patients operated within 24 hours following trauma ($p = 0.023$) (15). Due to less con- flict and the new surgery protocol's focus on time, an ac- celeration of the procedure was anticipated in our insti- tution. Identifying patients who need emergency sur- gery is one aspect that is crucial to the effectiveness of acute surgical time. Our study showed that the patient's outcome was associated with GCS at ER arrival and TTT. This research supports previous studies by Kim that found GCS in the ER and TTT had a substantial effect on the mortality of patients with traumatic brain injuries (36). Furthermore, the research by Kamabu et al. had 324 participants in total, with a 10.2% mortality rate. The majority of patients had their procedure postponed. Patients who had surgery within 24 hours after the acci- dent had a median time of death of two days, whereas patients who had surgery beyond 24 hours had a median time of death of four days (p=0.004) (37).

Although significant and consistent with previous re- search, this study has limitations. The first constraint is the insufficient data acquired from medical records. Only a subgroup of ER registrations reliably docu- mented the time to operation, resulting in a smaller sam- ple size than intended. Additionally, the time from injury to ER admission could not be included in the study due to the unavailability of data. Secondly, this study was conducted at a single center and had a relatively small sample size, which may limit the generalizability of the results. This is because different centers may have dif- ferent regulations for emergency surgery, resulting in different findings. Additionally, various organizational structures and process factors that could impact the up- time and performance of the emergency surgery were not identified in this study.

CONCLUSION

This research, focusing on the TTT for emergency surgery at SMBBMU Larkana, identified that the majority of cases were men, trauma cases, with general anesthesia and craniotomy procedures. The patient's outcome was associated with the GCS at ER arrival and TTT. As a recommendation, the availability of a 24-hour consultation service to reduce waiting times for consultations in a teaching hospital, the availability of a 24- hour emergency operation, and the availability of a definite funding source for neurosurgery in the form of national health insurance can reduce the TTTs

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