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Characteristics of trauma-related death at Gadjah Mada University Academic Hospital

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Abstract

Background: Trauma becomes the main health problem worldwide due to its high mortality rate. Traffic accidents are a trauma with a high incidence and death rate in Indonesia, specifically in Yogyakarta. Factors causing trauma-related death are the lack of hospital infrastructure, the lack of quality human resources, the lack of standardization of trauma management, and the limited number of hospitals providing comprehensive trauma services.
Objective: This research aims to identify the characteristics of trauma patients who died while receiving medical treatment at UGM Academic Hospital and to analyze the mortality of patients according to the trimodal distribution to prepare this hospital to become a trauma center hospital.
Method: This quantitative descriptive research used a cross-sectional method. Data were taken from medical records of patients admitted to the ER of UGM Academic Hospital in 2018-2023 based on predetermined inclusion and exclusion criteria. The research was conducted from March to November 2023.
Result: This research involved 58 patients consisting of 42 (72.4%) male and 16 (27.6%) female patients. The most common cause of death was brain injury (63%), followed by spinal cord injury (13.7%), multi-organ failure and sepsis (8.6%), cardiac and respiratory arrest (6.8%), and comorbidities patients (6.8%).
Conclusion: The majority of death-related trauma patients were male and aged 60-80 years with the main cause of death of brain injury. The patient dies at the late death stage based on trimodal distribution of death time.

Keywords: Death Rate, Injury, Traffic Injury, Trauma, Trauma Center

1. INTRODUCTION

Trauma still becomes a global health problem. International Association of Trauma Surgery and Intensive Care (IATSIC) and WHO report that 16,000 people die every day. Besides, the number of patients who experience disabilities due to trauma reaches tens to hundreds of thousands. Globally, trauma accounts for 16% of total illnesses, and 90% of the case occurs in poor and developing countries, including Indonesia30. Based on age distribution, trauma is one of the main causes of death in the 1-44-year age group. WHO data reveal that 3 of the 5 causes of death in the population aged 5-29 years are caused by trauma, including traffic accidents, murder and suicide. Drowning is the 6th most common cause of death in children aged 5-14 years. Deaths caused by falls from heights reach 684,000 cases per year and this figure is predicted to increase12.

Traffic accidents are the highest cause of trauma-related death. The number of deaths caused by traffic accidents increases every year, from 1.15 million in 2000 to 1.35 million in 2016. Traffic accidents contribute 2.37% of the total 56.9 million deaths worldwide and are the eighth cause of death globally13. Statistics Indonesia reported that traffic accident cases in Indonesia significantly increased from 104,327 cases in 2017 with 30,694 deaths to 116,411 cases in 2019 with 25,671 deaths15. DI Yogyakarta Regional Development Planning, Research and Development Agency reported that traffic accident cases in DI Yogyakarta province increased from 2019 to 2022, although there was a decrease in 2020 due to social restrictions. The total number of traffic accident cases reached 5,944 cases in 2019 with 419 deaths but there were 4,559 cases in 2020 with 346 deaths. Then, it reached 5,350 cases in 2021 with 452 deaths and 7,830 cases in 2022 with 570 death16.

Some factors cause the high death rate due to trauma such as less integrated trauma management, insufficient facilities and infrastructure in hospitals, insufficient health service providers or specialist doctors or consultant doctors, no holistic implementation of trauma treatment, no pre-hospital service system, and no trauma handling team. The trauma service system and trauma centers provide a major contribution to reducing the death rate due to trauma. The trauma service system needs to provide access and quality personnel, appropriate services at the scene of the trauma, fast and safe transportation to the nearest appropriate hospital facility, and appropriate definitive treatment at the hospital30. Therefore, Gadjah Mada University Academic Hospital (RSA UGM) needs to carry out more research to prepare this facility to be a trauma center.

2. METHOD

This quantitative descriptive research used a cross-sectional design. Data were obtained from medical records of trauma patients who died in 2020-2023 at UGM Academic Hospital based on predetermined inclusion and exclusion criteria. The inclusion criteria were patients with physical trauma caused by traffic accidents, falls from heights, suicide by hanging, etc. who were admitted to the emergency room of UGM Academic Hospital and died. The exclusion criteria were patients with incomplete medical records. Patient data were divided according to time of death, namely immediate death, early death, and late death. Immediate death is the time of death immediately within minutes after trauma. Early death is the time of death less than 24 hours after trauma. Late death is the time of death more than 24 hours after trauma.

3. RESULTS

In this research, a total of 58 patients met the inclusion and exclusion criteria. In terms of time of death, it covered immediate death (9 patients), early death (9 patients), and late death (40 patients). The patients consisted of 42 male patients (72.4%) and 16 female patients (27.6%). In terms of age groups, they consisted of 2 patients (3%) in 0-18 years, 10 patients (17.24%) in 18-40 years, 20 patients (34.5%) in 40-60 years old, 23 patients (39.6%) in 60-80 years, 3 patients (5%) in >80 years. Concerning alcohol consumption, 3 people (5%) consumed alcohol and 55 people (95%) did not consume alcohol (**Table 1**).

Table 1. The characteristics of patients by sex, age and risk factors for alcohol consumption

	Total (N: 58) N(%)	**Immediate death** (N:9) N (%)	**Early death** (N: 9) N (%)	**Late death** (N: 40) N (%)
1. Sex				
Male	42(72.4)	8(88.8)	8(88.8)	28(70)
Female	16(27.6)	1(11.1)	1(11.1)	12(30)
2. Age (years old)				
0-18	2(3)	0(0)	1(11.1)	1(11.1)
18-40	10(17.20)	5(55.5)	1(11.1)	4(10)
40-60	20(34.5)	1(11.11)	4(44.44)	15(37.5)
60-80	23(39.6)	3(33.33)	3(33.33)	17(29.3)
>80 years	3(5)	0(0)	0(0)	3(7.5)
3. Alcohol consumption				
Yes	3 (5)	0(0)	0(0)	3(7.5)
No	55(95)	10(100)	8(100)	37(92.5)

The most common cause of death (Table 2) was brain injury which was found in 37 patients (63%), followed by spinal cord injury in 8 patients (13.7%), multi-organ failure and sepsis in 5 patients (8.6%), cardiac and respiratory arrest in 4 patients (6.8%) and comorbidities in 4 patients (6.8%). In immediate death, the most common cause was brain injury, namely 7 patients (77.7%), spinal cord injury in 1 patient (11.11%), and cardiac and respiratory arrest in 1 patient (11.11%) due to electrical injury. In early death, 7 deaths (77.7%) were caused by head injuries, and 2 deaths (22.2%) were caused by cardiac and respiratory arrest due to electrical injury and traffic accidents. The most common cause of late death was brain injury which was found in 23 patients (57.5%), spinal cord injury in 7 patients (17.5%), multiorgan failure and sepsis in 5 patients (12.5%), and cardiac and respiratory arrest in 1 patient (2.5%) due to costal trauma and pulmonary contusion. Concerning the late death, 4 deaths were caused by comorbidities even though the trauma was not life-threatening.

Table 2. Cause of death associated with time of death

	Total (N:58)	**Immediate death N(%)**	**Early death N(%)**	**Late death N(%)**
Brain injury	37(63)	7(77.7)	7(77.7)	23(57.5)
Spinal cord injury	8(13.7)	1(11.11)	0(0)	7(17.5)
Multi organ failure+sepsis	5(8.6)	0(0)	0(0)	5(12.5)
Cardiac and respiratory arrest	4(6.8)	1(11.11)	2 (22.22)	1(2.5)
Comorbidities	4(6.8)	0(0)	0(0)	4(10)

The majority of patients had a diagnosis of brain injury (such as ICH, IVH, SDH, SAH, EDH), followed by spinal cord injury (SCI), femoral neck/Intertrochanteric femur fracture/midshaft femur, radius fracture, rib fracture and hemothorax, electrical injury, humerus fracture, and maxillofacial trauma (**Table 3**).

Table 3. Patients' diagnosis associated with time of death

	Immediate death	**Early death**	**Late death**
Brain injury	7	7	25
Spinal cord injury	1	1	10
Subarachnoid hemorrhage (SAH)	0	1	7
Subdural hemorrhage (SDH)	0	2	10
Intracerebral hemorrhage (ICH)	0	1	4
Epidural hemorrhage (EDH)	0	0	4
Intraventrikular hemorrhage (IVH)	0	0	1
Collum fracture / intertrochanter femur/midshaft femur	0	2	5
Radius fracture	0	0	3
Rib fracture and hemothorax	0	0	1
Abdominal trauma	0	1	1
Electrical injury	1	2	0
Humerus fracture	0	1	1
Rib fractures and pulmonary contusions	0	1	2
Maxillofacial trauma	0	0	2

In immediate death, all patients had not had a radiological examination because when they arrived at the emergency room, they were in severe condition or already died. In early death, 4 patients had radiological examination, while 5 patients did not **(Table 4**). .

In immediate death, no operative action was performed, while in early death, only 1 patient had a decompression craniectomy. In late death, 14 patients underwent operative treatment, namely decompression craniectomy in 8 patients, ORIF in 2 patients, laparotomy in 1 patient, decompression stabilization in 1 patient, kyphoplasty in 1 patient, and hemiarthroplasty in 1 patient.

In immediate and early death, all patients came with ESI 1, while in late death 11 patients came in with ESI 1, 18 people with ESI 2, and 11 patients with ESI 3.

In terms of delay, a total of 47 patients were critical and did not experience delay but the death was purely because of the patient's critical condition. However, 1 patient in early death condition experienced delay because the victim

was slow to find. In late death cases, 6 patients experienced delays due to referrals from other health facilities, 2 patients experienced delays due to waiting for the family to, 1 patient experienced delays because of going to the hospital late after being sent home by another hospital, 1 patient experienced delayed because the ICU room is full and the ventilator is all used.

Table 4. Patients' Radiological examination, treatment, ESI, and Delayed / No Delayed associated with time of death

	Immediate death	Early death	Late death
1. Radiological examination			
Yes	0	4	40
No	9	5	0
2. Patient treatment			
a. Operative treatment	0	1 Decompressive craniectomy	14 Decompressive craniectomy: 8 ORIF: 2 Laparotomy: 1 Stabilization decompression: 1 Kyphoplasty: 1 Hemiarthroplasty: 1
b. Non-operative treatment	9	8	26
3. Emergency Severity Index (ESI)			
ESI 1	9	9	11
ESI 2	0	0	18
ESI 3	0	0	11
4. Delayed/No			
Delayed due to referral from another health facility	0	0	6
Delayed because the victim was slow to find	0	1	0
Delayed due to waiting for the family	0	0	2
Delayed because the patient arrived late at the hospital after being sent home by another hospital	0	0	1
Delayed because the ICU was full and all ventilators were used	0	0	1
No delays/purely due to critical/unoperable conditions	9	8	30

Patients had some comorbidities and this condition was only discovered in late-death cases, namely no comorbidities (17 patients), hypertension (6 patients), diabetes mellitus (6 patients), hypertensive heart disease (3 patients), bronchitis (1 patient), renal failure (5 patients), stroke (1 patient), arrhythmia (5 patients), anemia (3 patients), pneumonia (3 patients), geriatric anorexia (1 patient), and decubitus ulcer (1 patient) (**Table 5**).

Table 5. Patients' comorbidity associated with time of death

Comorbidity	Immediate death	Early death	Late death
Hypertension	0	0	6
Diabetes mellitus	0	0	6
Hipertensive heart disease	0	0	3
Bronchitis	0	0	1
Renal failure	0	0	5
Stroke	0	0	1
Arrhythmia	0	0	5
Anemia	0	0	3
Pneumonia	0	0	3
Geriatric anorexia	0	0	1
Decubitus ulcer	0	0	1
No comorbidity	0	0	17

4. DISCUSSION

Based on all data of trauma patients treated at UGM Academic Hospital from 2020 to 2023, the incidence is higher in men, namely 42 patients (72.4%) compared to females, namely 16 patients (27.6%). This finding is in line with Kim et al. (2019) regarding the characteristics of patients with brain injuries at a trauma center hospital in South Korea that a total of 322 patients experiencing brain trauma is dominated by male (72.4%).32 Besides, Guizzo et al. (2020) conducted a study in a university hospital in Brazil and found a total of 1354 recorded trauma patients consisting of 948 male patients (70%) and 406 female patients (30%) were women.33

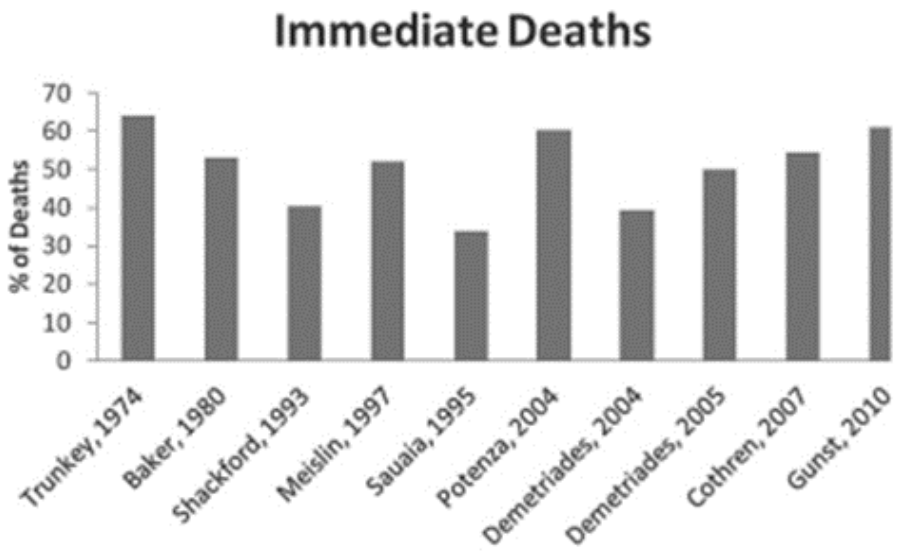
The largest age group experiencing trauma cases at UGM Academic Hospital is the 60-80 year age group with 23 patients (39.6%) and the 40-60 year age group with 20 patients (34.5%). Meanwhile, in the age group of 0-18 years and > 80 years, only 2 patients (3%) and 3 patients (5%) experience the trauma. Kim et al. (2019) calculated the mean age of patients experiencing trauma and found a mean age of 54.26 years,32 while Guizzo et al. (2020) found a mean age of 39.48 years.33 Both studies have slightly different conclusions from this present study, however, if categorized into age groups, the age that experiences the most trauma is the adult category.

Based on diagnosis, trauma patients treated at UGM Academic Hospital from 2018 to 2023 are dominated by brain injury (39 patients), subdural hemorrhage (SDH) (12 patients), spinal cord injury (12 patients), subarachnoid hemorrhage (SAH) (8 patients), intracranial hemorrhage (5 patients), epidural hemorrhage (EDH) (4 patients), and intraventricular hemorrhage (IVH) (1 patient). Based on the 2018 Global Status Report on Road Safety published by the World Health Organization (WHO), traffic accident cases are quite high and included in the top 10 causes of death. Moreover, traffic accident cases in developing countries, especially in Africa and Southeast Asia have a higher mortality compared to the global.13 A systemic review and meta-analysis study conducted in Ethiopia by Abate et al. (2020) involving data from 12 studies and 5 meta-analysis studies specifically conducted to examine the prevalence of brain injury cases found that traffic accidents are the main cause of brain injury in various cities in Ethiopia.35 This present study is in line with Baker et al. (2022) that brain and neck injuries have the highest prevalence, namely 47.9% of 2940 subjects. Of all these cases, 20.2% of patients experienced brain injuries (TBI) with various levels of severity.36 However, another study by Mariana et al. (2016) revealed that the most common injury caused by traffic accidents in Sleman District, DI Yogyakarta is injuries to the lower limbs. 17

Considering the risk factors for the presence or absence of alcohol consumption in trauma cases at UGM Academic Hospital, 55 patients (95%) do not consume alcohol and 3 patients (5%) consume alcohol. Lakmal et al. (2020) conducted a study in Sri Lanka and found that out of 222 motor vehicle drivers who experienced accidents

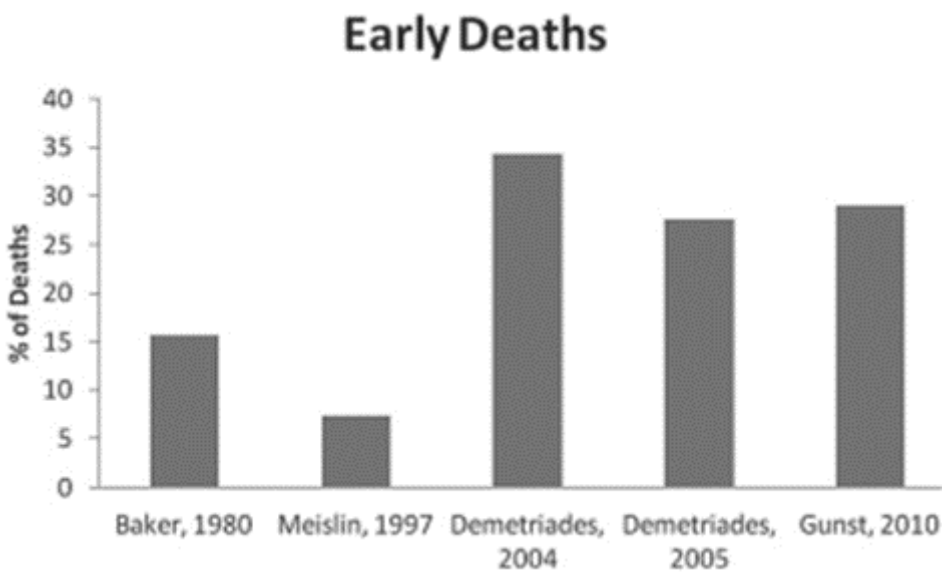
and were traumatized, 45 people (20.3%) consumed alcohol exceeding the legal limit.34 This is in line with the present study that most trauma cases treated at UGM Academic Hospital are not under the influence of alcohol.

In discussing deaths caused by trauma, Trunkey (1983) introduced a trimodal distribution of deaths due to trauma based on the time interval from injury to death. It covers immediate death, early death, and late death.37 Immediate death is death that occurs at the scene of the incident, or occurs 1 hour after arriving at the hospital, or occurs while the patient is still in the emergency room.38 Early death is deaths that occur <24 hours from the trauma, while late deaths are deaths that occur after 24 hours from the trauma.38 Based on the data obtained from UGM Academic Hospital from 2020 to 2023, the immediate death, early death, and late death were 9 patients (15.5%), 9 patients (15.5%), and 40 patients (69%) respectively. Some previous studies conducted from 1974 to 2010 showed that immediate death due to trauma did not experience a significant change, namely in the range of 50-60%. This occurs even though there have been improvements in the trauma management system, pre-hospital management, and better trauma prevention.38 Thus, immediate death due to trauma is included in the inevitable deaths caused by the severity of the trauma.



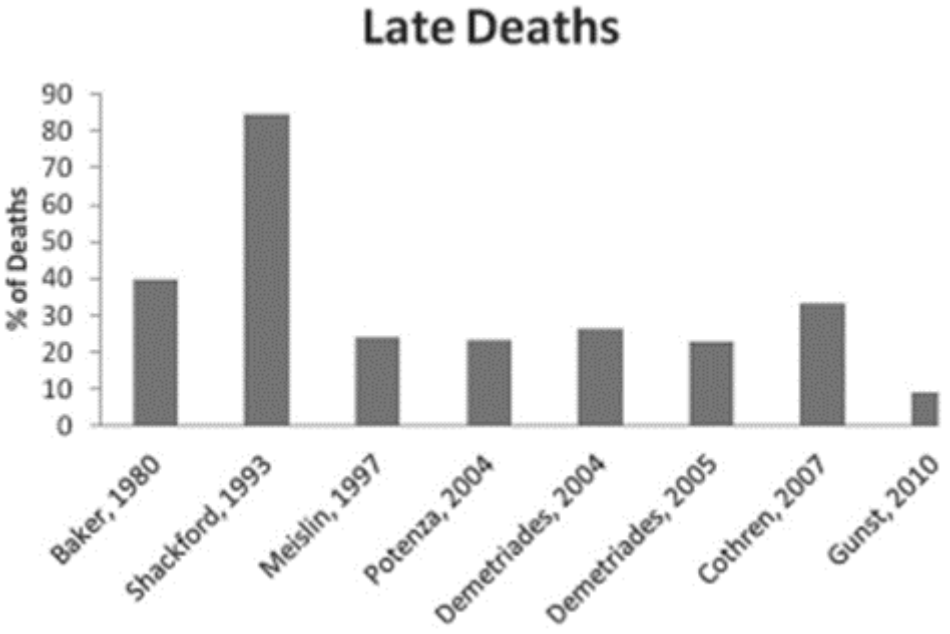
Graph 1. The percentage of immediate death rates due to trauma (Sobrino & Shafi. 2013).

Another study conducted in the period 1980 to 2010 showed that there was no significant change in early deaths due to trauma ranging from 25-30%38 It can be said that early deaths due to trauma are more caused by the severity of the trauma so adequate treatment cannot prevent this death.



Graph 2. The percentage of early death rates due to trauma (Sobrino & Shafi. 2013).

A study conducted from the period 1980 to 2010 showed a significant reduction in late death due to trauma whereas the latest study by Gunst et al. (2010) shows a mortality rate of 9%.38 At this stage, the mortality is influenced by improvements in the trauma management system in hospitals, including improvements in the pre-hospital phase of treatment.



Graph 3. The percentage of late death rates due to trauma (Sobrino & Shafi. 2013).

Based on the data obtained from UGM Academic Hospital, late deaths due to trauma have a higher percentage than early deaths. This can be due to better handling at the resuscitation stage and no delay in taking the patient to the hospital. Moreover, the study also found that only 1 patient was taken to the hospital late due to delays in finding the victim. Meanwhile, other delays cover delays in obtaining definitive treatment, but not too late in obtaining access to temporary treatment. This means that patients in this condition still receive treatment even though

it is not optimal, for example, delays in surgery due to the unavailability of the ICU and ventilator (1 patient), delays due to waiting for family approval for further action (2 patients), delays because the patient was sent home from another hospital without being referred to the other hospital (1 patient), delays due to the need to refer from another health facility to UGM Academic Hospital (6 patients), and delays due to the patient's critical condition and not suitable for surgery (47 patients). These data show that if patients continue to receive temporary treatment even though there is a delay in definitive therapy, it will still reduce early deaths (<24 hours).

The high number of cases of late death at UGM Academic Hospital is also caused by the high number of trauma due to brain injuries. A total of 37 cases or 63% of all deaths due to trauma at this hospital are caused by brain injuries. This is in line with Meislin et al. (1997) that found patients who died due to trauma within 24-48 hours due to nervous system injury (45%), collapse of the circulatory system or bleeding (35%), and multi-organ failure (9%).[39] Moreover, patients who died due to trauma lasting 2 days to 3 weeks are due to nervous system injury (48%), collapse of the circulatory system or bleeding (35%), and multi-organ failure (16%).[39] This study shows that nervous system injury, including brain injury, becomes the main cause of death in patients who survive more than 24 hours after the trauma, whether in early death or late death, although the number of multi-organ failures increases over time.

Concerning the cause of death, brain injury is the most common cause of death in trauma cases at UGM Academic Hospital with 37 cases (63%), followed by spinal cord injury in 8 cases (13.7%), multi-organ failure and sepsis in 5 cases (8, 6%), cardiac and respiratory arrest in 4 cases (6.8%), and comorbidities in 4 cases (6.8%). Brain injuries are the most common cause of death in trauma cases. Advance Life Trauma Support (ATLS) data in 2004 showed that the incidence of brain injuries was estimated to reach 500,000/year of all cases in the United States. Around 10% of these cases die before the patient reaches the hospital. Of the cases that arrive at the hospital, 80% are considered into the mild brain injury category, while moderate and severe brain injuries account for 10% each.[40] Persistent high intracranial pressure is a mechanism causing death in patients with severe traumatic brain injuries. Monitoring and management of high intracranial pressure (TTIK) has become routine and must be carried out by trauma centers. Conservative and surgical management can be carried out to minimize the occurrence of secondary brain injury.[41] Some studies report that primary decompressive craniectomy is still effective and safe in the management of life-saving surgery in patients with TTIK accompanied by brain edema after severe brain injury. In a prospective randomized study conducted in 2011, 309 patients who were managed conservatively failed to control intracranial pressure with a threshold of 25 mmHg > 1-12 hours after injury.[42-43] On the other hand, Mori et al. (2004) showed that decompressive craniectomy is proven to increase cerebral perfusion pressure (CPP) and cerebral blood flow (CBF) in brain injury patients.[44] Moreover, Ziai et al. (2003) found that decompressive craniectomy reduces mortality, increases recovery, reduces duration of stay in the ICU, and improves outcomes based on the Barthel Index Score, especially in primary decompressive craniectomy.[45] A previous study conducted in 1999 reported that almost 65% of patients with persistent brain edema who underwent decompressive craniectomy experienced good recovery after 1 year.[45-46] Other studies proposed some factors influencing the outcome of decompressive craniectomy in patients with severe traumatic brain injuries as presented in the following table:

Table 6. Some factors influencing the outcome of decompressive craniectomy in patients with severe traumatic brain injuries

Failed conservative management	Persistent intracranial hypertension and not response to conservative therapy result in poor outcomes with mortality rates exceeding 80%. Decompressive craniectomy is often performed as a last option.[45-48]

Time	Primary decompressive craniectomy (within 48 hours of injury) provides better outcomes than patients undergoing delayed surgery.[49-50]
Brain herniation	Decompressive craniectomy must be performed if there are neurological signs of brain herniation, although this procedure provides better results if performed before brain herniation occurs.[45,51]
Glasgow Coma Scale (GCS)	Studies show an increase in mortality in patients who have a GCS of 4-6 when decompressive craniectomy is performed, while the majority of survivors have a GCS of >8. [44-48, 51-52]
Patient's Age	Patients in the younger age group have better outcomes than those in the older age group of over 50 years. Thus, age is one of the considerations when carrying out a decompressive craniectomy procedure. [45-48,51-52]
Primary brain stem injury	The occurrence of primary brain stem injury is one of the contraindications for decompressive craniectomy as the chances of survival are relatively low. [44-48,52]
Abnormal pupil findings	The absence of the pupillary reflex has been proven to indicate very poor outcomes. [43-48]
Intracranial pressure	The intracranial pressure must be less than 40 mmHg when decompressive craniectomy is performed as ICP> 40 produces quite poor outcomes. [52]
Midline shift	Midline shift on preoperative head CT scan >1 cm is a significant predictor of poor outcome. [43-45]

Based on the results of the study conducted at UGM Academic Hospital, a total of 15 15 trauma cases underwent surgery, while 43 cases were treated non-operatively. Of the 15 surgeries performed, nine of them were decompressive craniectomies. The number of cases treated non-surgically is higher compared to those treated surgically because not all trauma cases require surgery. On the other hand, in some trauma cases that can be operated on, clinical considerations also become a determining factor in whether to take action. Considering the Emergency Severity Index (ESI) level as a triage parameter for emergency room patients at this hospital, the number of ESI 1 patients, ESI 2 patients, and ESI 3 patients are 29 patients, 18 patients, and 11 patients respectively. This means that the majority of trauma patients who died who were admitted to the emergency room were at ESI levels 1 and 2 (emergency category). Most of these patients entered a clinically unfavorable initial condition. This becomes a consideration for clinicians to determine the appropriateness of surgery in operable trauma cases. Thus, it can be attributed to the high number of cases of delay in definitive therapy as 47 patients were inoperable. This condition causes the clinician to choose conservative therapy which is not as good as definitive therapy in curative efforts. Therefore, patients can survive for more than 24 hours, but over time the natural course of the disease is not resolved adequately, resulting in late death.

5. CONCLUSION

The majority of trauma patients who died at UGM Academic Hospital are male, aged 40-80 years, and have brain injuries. Based on the trimodal distribution of time of death, most trauma patients at this hospital died in the final stages (late death). This can be caused by some factors such as the type of trauma, the patient's age, delays, the initial condition of the patient entering the ER based on the ESI score, and the presence or absence of comorbidities.

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