A short decision time for transcatheter embolization can better predict mortality in patients with pelvic fracture

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Research Article

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Abstract

Purpose: Early use of hemostasis strategies, such as transcatheter arterial embolization (TAE), is critical in cases of pelvic injury because of the risk of hemorrhagic shock and other fatal injuries. We investigated the influence of delays in TAE administration on mortality.

Methods: This retrospective, observational study enrolled patients with pelvic injury who underwent acute TAE and were admitted to the Advanced Critical Care Center at Gifu University Hospital between January 2008 and December 2019. The time from when the doctor decided to administer TAE to the start of TAE (needling time) was defined as "decision-TAE time."

Results: We included 159 patients. The median decision-TAE time was 60 min. Twenty-four patients died. Kaplan–Meier curves for overall survival were compared between patients above and below the median cutoff value for decision-TAE time; survival was significantly better for patients below the median cutoff value ($p=0.02$). Multivariable Cox proportional hazards regression analysis revealed that the longer the decision-TAE time, the higher the risk of mortality ($p=0.037$). A short TAE duration (procedure time) with a short decision-TAE time was associated with the best survival (p for interaction=0.023).

Conclusions: Decision-TAE time may play a key role in establishing resuscitation in pelvic fracture patients, and efforts to shorten this time should be pursued.

Background

Pelvic injury is often associated with hemorrhagic shock and other fatal injuries [1]. The hemorrhage-related mortality rate may be as high as 40%, and overall mortality in these patients may be over 10–32%, even if they are hospitalized in a level 1 trauma center [2–5]. In the emergency department (ED), the definitive treatment options used to achieve timely hemodynamic stabilization in patients with pelvic injury include transcatheter arterial embolization (TAE) and pre-peritoneal packing (PPP) [1, 6, 7]. The other treatment options to address hemodynamic instability include arterial cross clamping and resuscitative endovascular occlusion of the aorta (REBOA) [8, 9].

The literature contains many reports on the relative advantages of TAE and PPP [10–13]. As indicated in these reports, TAE, a less invasive procedure, has become widely accepted as a safe and efficacious substitute for direct surgical intervention [10]. Conversely, considerable delays in performing embolization and lack of readily available experts in angiography have been highlighted [10, 12]. Some researchers report the mortality rates of patients treated with TAE to range from 16–50%, [14, 15], representing a higher mortality rate than that of patients treated with PPP [12].

More recent reports suggest that early administration of TAE results in low mortality rates [4, 16]. In these reports, the so-called "door-to-angioembolization time" should be shorter for better outcomes [4, 16]. Anecdotally, the time course of patients with pelvic injury varies according to their status. For some patients, there may be time to perform a computed tomography (CT) scan before TAE because their vital signs are relatively stable, and for other patients, this might not be possible [17]. The true effectiveness of shortening the delay before administration of TAE can be confirmed using “decision-TAE time,” which represents the time from the decision to administer TAE to the actual administration of TAE.

In this study, we aimed to investigate how “decision-TAE time” influenced the mortality of patients admitted to hospital with pelvic trauma.

Methods

Study design and ethics statement

This observational study used retrospectively collected data. The study adhered to the STrengthening the Reporting of OBservational Studies in Epidemiology (STROBE) statement and the study protocol is available. Ethics approval was obtained from the medical ethics committee of Gifu University (Institutional review board approval No. 2020-061). The need for informed consent from the patients was waived by the medical ethics committee of Gifu University because of the retrospective nature of the study. This study adhered to the ethical guidelines for medical and health research involving human subjects established by the Japanese government.

Study setting

Gifu University Hospital is the only advanced critical care center in this region. The region includes catchment areas populated by approximately 2 million people. Patients with pelvic injury who underwent acute TAE were included if they were admitted to the Advanced Critical Care Center (ACCC) at Gifu University Hospital between January 2008 and December 2019. The attending emergency physicians were responsible for the trauma survey and treatment of patients with pelvic injuries in the ED. Emergency physicians and interventional radiologists were involved in the decision-making process. In our institution, interventional radiologists and the equipment required for TAE are available 24 h a day, 365 days a year.

Selection criteria

Patients who received TAE for trauma-related pelvic fracture injury were enrolled in this study. Patients with out-of-hospital cardiac arrest (OHCA) that did not respond to resuscitation, with missing data on the time course of TAE, and who underwent PPP were excluded. We identified the patients using the diagnosis codes of the facility. The diagnoses were pelvic fracture, pelvic ring fracture, iliac fracture, pubic fracture, ischial fracture, sacral fracture, acetabular fracture, and hip fracture dislocation. Data regarding demographic and biological data on admissions, treatment process, and outcomes were all collected from medical records.

Treatment

At the ACCC at Gifu University Hospital, we established a treatment algorithm based on the EAST recommendations [6]. Patients who could not undergo CT scan due to hemodynamic instability were directly sent for TAE. Some of these patients could not be prepared for TAE because of the threat of death or PPP had just been performed; hence, TAE was added if needed. Other patients underwent a CT scan, and immediate TAE was initiated if necessary. If transferred patients had already undergone a CT and there was enough information to make a decision, additional examinations were bypassed and the patient was sent directly for TAE. REBOA was utilized in some cases based on decisions made by the treating emergency physicians.

Definition of parameters

Emergency physicians decided to administer TAE when: 1) the CT scan indicated massive hemorrhage from pelvic injury or 2) the patient was hemodynamically unstable and did not undergo a CT scan or was transferred from another hospital after the CT scan. We analyzed the time from the decision to administer TAE to the start of TAE (needling time) and named this time the "decision-TAE time." When the CT scan indicated massive hemorrhage, the "decision-TAE time" was defined as the time from starting the CT to TAE (CT-TAE group: CT group). When the patient did not undergo a CT scan or was transferred after the CT scan, the "decision-TAE time" was defined as the time from arrival at the ED to the administration of TAE (door-TAE group: DT group) (Fig. 5). Demographic and biological data on admission were collected from medical records. The injury severity score (ISS) and the Abbreviated Injury Score (AIS) by body area (head, chest, abdomen, pelvis, and extremities) were calculated for each patient and defined as "severe" if they were scored at 3 points or more.

Outcomes

The primary outcome of this study was the time from the end of the TAE to death. There were 10 secondary outcomes, including parameters associated with TAE (decision-TAE time, number of arteries involved in TAE, localizations, embolic materials, time of TAE administration, and number of secondary TAEs), treatment with REBOA, surgical management for pelvic fractures, hospital length of stay, and reasons for death.

Statistical analysis

The baseline characteristics of the patients and the continuous variables are expressed as median and interquartile range (IQR) and categorical variables as counts and percentages. The sample size in this study was calculated according to feasibility and to avoid overfitting of the statistical model, not according to power [18]. For the primary analysis, Cox proportional hazards regression analysis was performed to confirm the effect of decision-TAE time on the time from the end of TAE to death. Age and sex have been reported in various medical fields as the most important characteristics affecting mortality [19, 20]. Therefore, the Cox proportional hazards model was adjusted for age and sex to avoid confounding by the patients' baseline characteristics [19, 20]. Glasgow Coma Scale (GCS) and transfer were also incorporated into the model as covariates, as they are strongly related to outcome and decision-TAE time. Following a simple rule, the number of covariates had to be limited to two or three to avoid overfitting [21]. Therefore, we calculated the optimism parameter, and if it was less than 0.2, we considered that the model was not overfitting even with the above four variables as covariates. Kaplan–

Meier estimation was conducted to estimate the cumulative survival rate for each group divided by the median of the decision-TAE time. The difference in the cumulative survival rate between the two groups was confirmed using the log-rank test.

The effects of the end of TAE on death were analyzed using a model similar to that used for the primary analysis. In this secondary analysis, GCS and transfer were not included as covariates because they were not considered to be related to the end of TAE. In addition, an interaction term (decision-TAE time * TAE duration) was incorporated into the Cox proportional hazards model to test whether the effect of decision-TAE time on mortality was modified with the inclusion of TAE duration. The hazard ratio (HR) for the 75th percentile vs. the 25th percentile of decision-TAE time or TAE duration with a 95% confidence interval was reported in each Cox proportional hazards analysis. Parameters that could influence the decision-TAE time on arrival were summarized for each group by dividing decision-TAE time into quartiles, and comparisons between groups were conducted using a Fisher's exact test for categorical variables and a Kruskal–Wallis test for continuous variables. Imputation was not used for missing data because no data were missing for the primary outcome. A *p*-value (two-sided) of < 0.05 was considered statistically significant. No adjustment was made for multiple comparisons because all analyses were performed as exploratory. All statistical analyses were performed using the R version 4.0.3 (https://www.r-project.org/).

Results

Patient demographics

A total of 611 patients with pelvic fractures were included in this study. A flowchart of the inclusion process is shown in Fig. 1. Table 1 summarizes the patients' clinical characteristics.

Table 1
General demographics of the pelvic fracture patients who received acute angioembolization for pelvic injury

Factors	No. (%) or Median (25%, 75%) (N = 159)
Age (y/o)	74 (61, 81)
Sex	
Male	95 (59.8%)
Female	64 (40.3%)
Antiplatelet drug	26 (16.4%)
Anticoagulant drug	12 (7.6%)
Transferred, n(%)	81 (50.9%)
ISS (score)	25 (16, 34)
Severe anatomic injuries, n(%)	
Head AIS ≧ 3	42 (26.4%)
Chest AIS ≧ 3	55 (34.6%)
Abdomen AIS ≧ 3	26 (16.4%)
Pelvis AIS ≧ 3	125 (78.6%)
SBP upon ED arrival(mmHg)	109 (87.5, 132)
GCS upon ED arrival(total)	14 (13, 15)
Pelvic fracture type, n(%)	
Tile OTA classification	
A1	6 (3.7%)
A2	11 (6.8%)
A3	3 (1.9%)
B1	45 (28.3%) (including associated 5 acetabular fractures)
B2	26 (16.4%) (including associated 3 acetabular fractures)
B3	15 (9.4%) (including associated 1 acetabular fractures)
C1	23 (14.5%) (including associated 1 acetabular fractures)

ISS, injury severity score; AIS, Abbreviated injury score; TAE, transarterial catheter embolization; DT, door-to-TAE

Factors	No. (%) or Median (25%, 75%) (N = 159)
C2	7 (4.4%)
C3	5 (3.1%)
Unknown	1 (0.6%)
Sacral fracture	2 (1.3%)
Acetabular fracture	15 (9.4%)
Indications for TAE	
1. Contrast extravasation on CT scan	134 (84.3%)
2. Massive hematoma on CT scan	13 (8.2%)
3. Unstable hemodynamics	12 (7.6%)
DT group, n(%)	45 (28.3%)
CT group, n(%)	114 (71.7%)
ISS, injury severity score; AIS, Abbreviated injury score; TAE, transarterial catheter embolization; DT, door-to-TAE	

Six patients with OHCA and two patients with missing data were excluded. Acute TAE was performed in 172 patients, and 13 patients were excluded because they had undergone PPP with TAE and this may have influenced the effects of TAE on hemostasis. In previous reports, PPP and TAE have been reported as “complementary procedures” performed to stop bleeding [22, 23]. Although they are complementary [22, 24], PPP and TAE could be effective as single or combined strategies, depending on the situation. A total of 159 (26.0%) patients met the inclusion criteria. The median patient age was 74 (interquartile range [IQR]: 61–81) years, and 95 patients were male (59.8%) while 64 were female (40.3%). Eighty-one patients (50.9%) were transferred from other hospitals. The median ISS was 25 (IQR: 16–34). The proportions of severe anatomic injuries with an AIS of ≥ 3 were as follows: head, 26%; chest, 35%; abdomen, 16%; and pelvis, 79%. The median systolic blood pressure on arrival was 109 (IQR: 87.5–132) mmHg and the median GCS score was 14 (IQR: 13–15). The Tile Orthopaedic Trauma Association (OTA) classification was A1 in six patients (3.7%); A2 in 11 patients (6.8%); A3 in three patients (1.9%); B1 in 45 patients (28.3%) (including five associated acetabular fractures); B2 in 26 patients (16.4%) (including three acetabular fractures); B3 in 15 patients (9.4%) (including one acetabular fracture); C1 in 23 patients (14.5%) (including one acetabular fracture); C2 in seven patients (4.4%); and C3 in five patients (3.1%). There was an unknown fracture type in one patient (0.6%) because of the lack of a CT scan, sacral fractures in two patients (1.3%), and acetabular fractures in 15 patients (9.4%). The door-to-TAE (DT) group (the patients who did not undergo a CT scan before TAE) comprised 45 patients (28.3%) and the CT group comprised 114 patients (71.7%). The indication for TAE was contrast extravasation on the CT scan for 134 patients (84.3%), massive hematoma for 13 patients (8.2%), and unstable hemodynamics for 12 patients (7.6%).

Relationship between mortality and decision-TAE time

The median decision-TAE time was 60 min (IQR: 40–87 min). Twenty-four patients died, and the mortality rate was 15.1%. A decision-TAE time of < 60 min was associated with a significantly higher survival rate than that of ≥ 60 min ($p = 0.02$), as per the Kaplan–Meier curves (Fig. 2). The multivariable Cox proportional hazards regression model adjusted for age, sex, GCS and transfer revealed that the longer the decision-TAE time, the higher the risk of mortality (hazard ratio [HR] for IQR: 40–87: 1.45, 95% confidence interval [CI]: 1.02–2.07, $p = 0.037$) (Table 2). The optimism parameter was 0.168, indicating that the model was not overfitting. After adjustment for age and sex, TAE duration was not significantly associated with mortality ($p = 0.737$) (Table 2).

Although the interaction between TAE duration and decision-TAE time was statistically significant ($p = 0.023$), it indicated that TAE duration modified the effect of decision-TAE time on mortality (Fig. 3).

Patient outcomes

The total number of arteries involved during TAE was 466 with a median of three (IQR: 2–4). The locations of the arteries and embolic materials are summarized in Supplementary Tables 1 and 2, respectively. There were 7 (4.4%) cases of REBOA. Two patients (1.3%) underwent secondary TAE for hemostasis. Sixty-six patients (41.5%) underwent surgical management for pelvic fractures, including external fixation in 15 patients (9.4%) and internal fixation in 59 patients (37.1%). The median hospital length of stay was 24 (IQR: 11–41) days. The reason for death was unstable hemodynamics in five patients (3.1%), severe head trauma in nine patients (5.7%), unstable hemodynamics and severe head trauma in three patients (1.9%), and other reasons including sepsis or respiratory failure in seven patients (4.4%). Patient outcomes are summarized in Table 3.

Table 3
Outcomes of the pelvic fracture patients who received acute angioembolization for pelvic injury (N = 159)

Factors	N	No. (%) or Median (25%, 75%)
Surgical management	159	66 (41.5%)
External fixation	159	15 (9.4%)
Internal fixation	159	59 (37.1%)
Combined REBOA	159	7 (4.4%)
REBOA 2008–2013	58	3 (5.2%)
REBOA 2014–2019	101	4 (2.5%)
Secondary TAE for hemostasis	159	2 (1.3%)
Mortality, n (%)	159	24 (15.1%)
Mean hospital length of stay (day)		26 (11, 41)
Reasons for death		
1) Unstable hemodynamics, n (%)	159	5 (3.1%)
2) Severe head trauma, n (%)	159	9 (5.7%)
3) 1) + 2), n (%)	159	3 (1.9%)
4) Other reasons, n(%)	159	7 (4.4%)

REBOA, resuscitative endovascular occlusion of the aorta; TAE, transarterial catheter embolization

Age, sex, and parameters that could influence the decision-TAE time on arrival and mortality were aggregated in every IQR and statistically tested; these are presented in Table 4.

Table 4
Age, sex, and parameters that could influence the decision-TAE time on arrival

Decision-TAE time	**N**	**~ 40, N = 38**[1]	**40 ~ 60, N = 40**[1]	**60 ~ 87, N = 40**[1]	**87~, N = 41**[1]	**p-value**[2]
Age(y/o)	159	72.5 (59.2, 80.5)	72.5 (60.5, 81.0)	74.0 (63.8, 83.0)	77.0 (63.0, 81.0)	0.792
Sex	159					0.374
Female		11 (28.9%)	19 (47.5%)	16 (40.0%)	18 (43.9%)	
Male		27 (71.1%)	21 (52.5%)	24 (60.0%)	23 (56.1%)	
Transfer	159	29 (76.3%)	27 (67.5%)	11 (27.5%)	14 (34.1%)	< 0.001
ISS	159	20.5 (16.0, 31.2)	24.0 (12.0, 28.2)	28.0 (16.0, 34.5)	29.0 (17.0, 38.0)	0.242
GCS	159	15.0 (14.0, 15.0)	14.0 (12.8, 15.0)	14.0 (12.0, 15.0)	14.0 (13.0, 15.0)	0.031
SBP on admission	157	102.5 (82.0, 124.2)	107.0 (88.2, 121.2)	113.0 (85.0, 143.0)	114.0 (94.0, 132.2)	0.404
HR on admission	158	90.5 (75.2, 104.8)	90.5 (80.0, 105.0)	85.5 (73.5, 104.0)	89.5 (72.0, 110.0)	0.839
RR on admission	156	22.5 (18.0, 27.8)	20.0 (17.0, 24.0)	21.0 (18.0, 25.0)	22.5 (18.0, 26.5)	0.216
Antiplatelet drug	159	10 (26.3%)	8 (20.0%)	5 (12.5%)	3 (7.3%)	0.111
Anticoagulant drug	159	10 (26.3%)	8 (20.0%)	5 (12.5%)	3 (7.3%)	0.111
Indications for TAE						
Contrast extravasation	159	35 (92.1%)	30 (75.0%)	33 (82.5%)	36 (87.8%)	0.200
Massive hematoma	159	1 (2.6%)	7 (17.5%)	3 (7.5%)	2 (4.9%)	0.123
Unstable hemodynamics	159	2 (5.3%)	3 (7.5%)	4 (10.0%)	3 (7.3%)	0.956
Head AIS ≧ 3	159	7 (18.9%)	9 (22.5%)	11 (28.2%)	15 (36.6%)	0.322
Chest AIS ≧ 3	159	10 (26.3%)	10 (25.0%)	17 (42.5%)	18 (43.9%)	0.149
Abdomen AIS ≧ 3	159	7 (18.4%)	8 (20.0%)	6 (15.0%)	5 (12.2%)	0.787

Age, sex, and parameters that could influence the decision-TAE time on arrival were aggregated in every interquartile range and statistically tested.

Decision-TAE time	N	~ 40, N = 38[1]	40 ~ 60, N = 40[1]	60 ~ 87, N = 40[1]	87~, N = 41[1]	p-value[2]
Pelvis AIS ≧ 3	159	32 (84.2%)	32 (80.0%)	31 (77.5%)	30 (73.2%)	0.694
Mortality						
Death	159	3 (7.9%)	3 (7.5%)	6 (15.0%)	12 (29.3%)	0.030
[1]n (%); Median (IQR)						
[2]Fisher's exact test; Kruskal–Wallis rank sum test						
ISS, injury severity score; GCS, Glasgow coma scale; SBP, systolic blood pressure; HR, heart rate; RR, respiratory rate; TAE, transarterial catheter embolization						
Age, sex, and parameters that could influence the decision-TAE time on arrival were aggregated in every interquartile range and statistically tested.						

Discussion

The primary finding of this research was that a long decision-TAE time resulted in a high risk of mortality. Moreover, although the actual TAE duration did not have a statistically significant influence on decision-TAE time, the interaction between TAE duration and decision-TAE time was statistically significant, indicating that TAE duration modified the effect of decision-TAE time on mortality.

Some reports have suggested the importance of early TAE for improving mortality [4, 15, 16, 25]. In clinical settings, there are many variations in the circumstances surrounding patient delivery to the ER, and the condition of the patient upon delivery [26, 27]. These variables include the presence of associated injuries, severity of said injuries, and differences in vital signs [28]. Moreover, they may or may not have been transferred from another hospital and they may have received previous treatment by prehospital medical professionals [29, 30]. Physicians must decide upon a treatment plan for these patients taking these factors into consideration [31]. Hence, the actual effectiveness of shortening the delay from decision making to actual TAE administration can be confirmed by analyzing the time from when the decision to administer TAE is made to when the TAE is performed and its effect on the outcomes [28].

Several studies have reported that the time to angioembolization is longer than the time to PPP, which may be in part due to the high availability of orthopedic surgeons as compared with that of interventional radiologists [7, 12, 32], and TAE may be delayed at night or on weekends based on reports of other catheter-based interventions [16, 33, 34]. In our institution, interventional radiologists and the equipment required for TAE are available 24 h a day, 365 days a year. Therefore, the availability of staff and/or equipment was not an issue in the present study. The overall decision-TAE time was 60 min, even after performing other resuscitation procedures. Although PPP may have advantages over TAE, namely that of early start time [7, 12], most patients with pelvic fracture, even if they are unstable, can be managed with primary TAE strategies at centers that have 24-h availability of interventional radiologists [35].

Other studies have reported the effectiveness of REBOA for patients with unstable pelvic fractures [8, 9]. In this study, there were seven (4.4%) cases of REBOA; however, there were no clear indications for REBOA in pelvic fracture patients. Moreover, the consensus on REBOA indications, ideal patient populations, and outcomes has not been decided even among trauma specialties [36]; therefore, further studies are needed. In our facility, we aim to complete TAE, including treatment of other bleeding injuries, within 60 min. Although we could not directly clarify the relationship between TAE duration and mortality, our intervention analysis showed that TAE duration modified the effect of decision-TAE time on mortality. Based on these results, it appears that patients with a decision-TAE time of 105 min or longer benefited from a long TAE duration, whereas patients with a decision-TAE time of < 105 min benefitted from a short TAE duration. When the decision-TAE time increased by 10 min from 105 to 115 min, the risk increased by 1.15, 1.1, and 1.08 times, respectively, for cases with TAE duration times of 40, 55, and 75 min. If the decision TAE time extended by an additional 10 min to 125 min, the risk increased by 1.3, 1.23, and 1.15 times, respectively. Conversely, when the decision-TAE time reduced by 10 min from 105 min to 95 min, the risk was 0.88, 0.9, and 0.93 times, respectively. If the TAE time was reduced from 105 min to 20 min, the risk increased by 0.77, 0.81, and 0.86 times, respectively. This suggests that a short decision-TAE time with a short procedure time could lead to improved mortality outcomes. To our knowledge, this is the first study to discuss the relationship between TAE duration and mortality, as there is only speculation in previous reports. Further studies need to be undertaken.

We could not confirm the factors that influenced the decision-TAE time, except for hospital transfer (Table 4). Based on these results, the expected parameters that could influence the severity of the patient's condition, such as ISS, vital signs, and even associated injuries, were not related to decision-TAE time. In addition, the transferred patients underwent TAE within a short duration. These results indicate that fast CT scanning can reduce the decision-TAE time; hence, the development of fast imaging strategies is essential. Recently, there have been reports on the effectiveness of hybrid emergency room systems [37, 38], hybrid operation rooms [39], and mobile angiography systems [40] for treating trauma patients. These systems consist of an angiography-computed tomography (CT) machine in a trauma resuscitation room and thus have the potential to provide new evidence in this field.

This study has several limitations. First, the performance of the CT scan was dependent on the patient's mode of admission. This meant that we could not determine the severity of the patient's condition based on the CT/DT stratification. Second, we could not clarify the actual durations of "decision time," which means that other decision-TAE times could be established, and if this happens, the results would be changed. In fact, it is difficult to retrospectively ascertain the exact time when the decision to administer TAE is made, and we believe that the definition of decision-TAE time requires further discussion. Third, the result of this study cannot be generalized to other facilities that do not have the same interventional radiology coverage and equipment. Fourth, as the decision on treatment with REBOA was made by physicians, we could not analyze the impacts of REBOA in this study.

Conclusions

Overall survival was statistically different between the patients above and below the median cutoff value for decision-TAE time, and the longer the decision-TAE time, the higher the risk of mortality. Our results suggest that decision-TAE time plays a key role in establishing resuscitation in pelvic fracture patients, and efforts to shorten the time should be made.

Declarations

Consent to participate: The need for informed consent from the patients was waived by the medical ethics committee of Gifu University Graduate School of Medicine because of the retrospective nature of the study.

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Ethics approval: Ethics approval was obtained from the medical ethics committee of Gifu University Graduate School of Medicine, Gifu, Japan (Institutional review board approval No. 2020-061). This study adhered to the ethical guidelines for medical and health research involving human subjects established by the Japanese government.

Data and/or code availabilty: The data that support the findings of this study are available from the corresponding author, [HO], upon reasonable request.

Author Contributions:T.M. wrote the manuscript. N.K., Y.M., M.I., T.F., T.Y., H.K., and S.Y. treated the patients. T.I. performed the statistical analysis. M.M. and S.O. supervised the study. H.O. revised and edited the manuscript. All authors read and approved the final manuscript.

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Figures

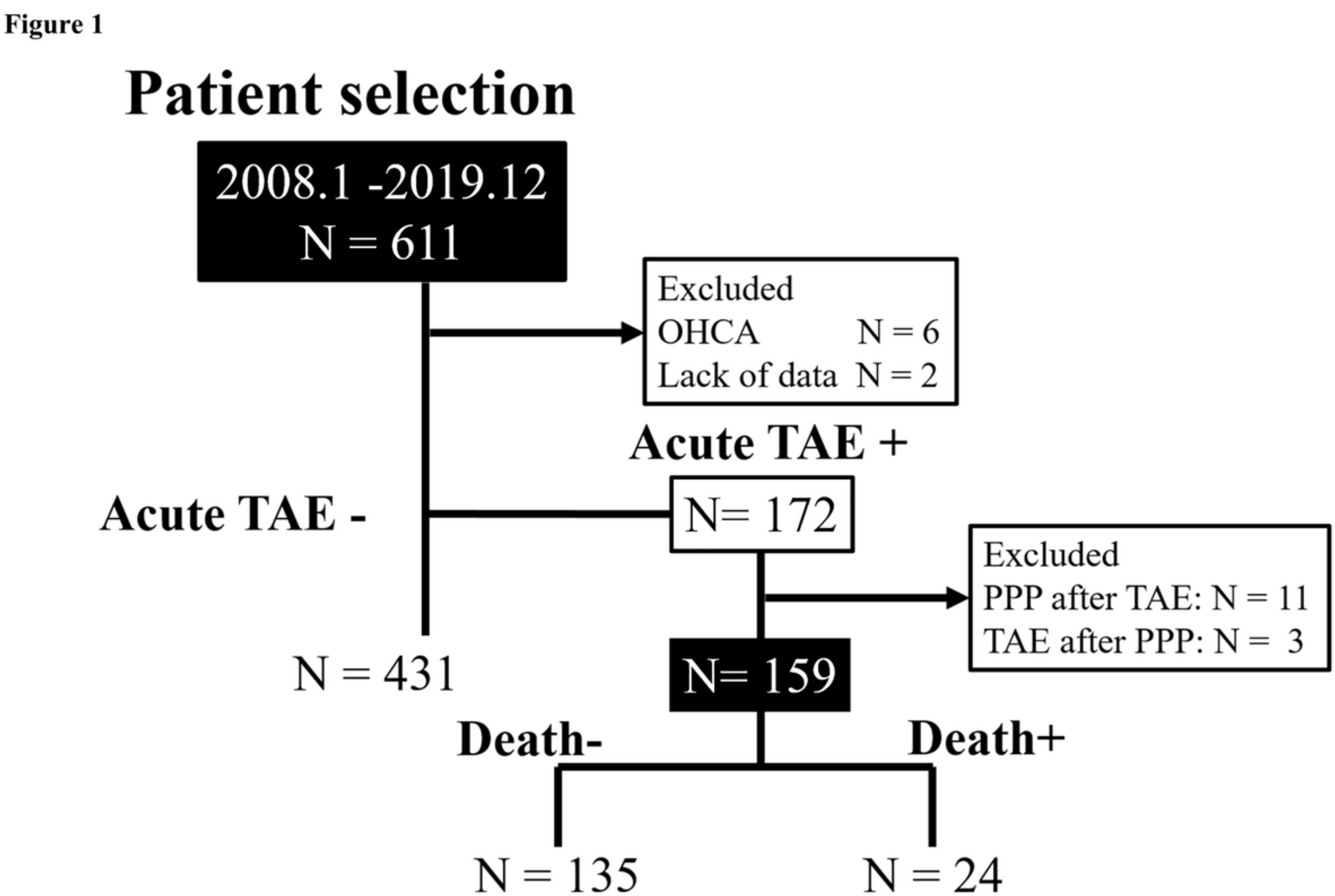

Figure 1

Patient selection

Flowchart diagram of eligible patients and excluded patients.

OHCA, out-of-hospital cardiac arrest; TAE, transarterial catheter embolization; PPP, pre-peritoneal packing

Figure 2

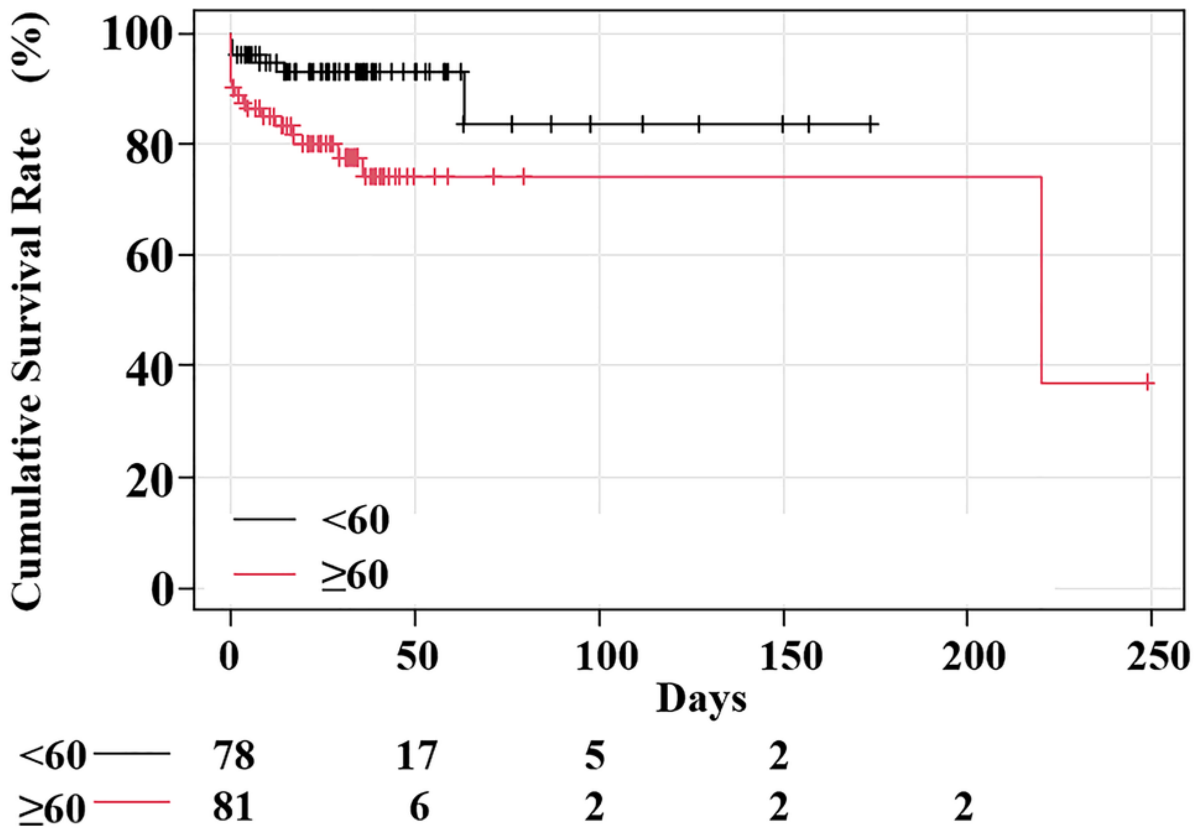

Figure 2

The Kaplan–Meier curves of overall survival

Patients with decision-TAE time of <60 min had significantly higher survival rates than those with a decision-TAE time of ≥60 min (p=0.02) from the analysis of Kaplan–Meier curves (Fig. 2). The hazard ratio was plotted when the reference was fixed at 105 min.

TAE, transarterial catheter embolization

Figure 3

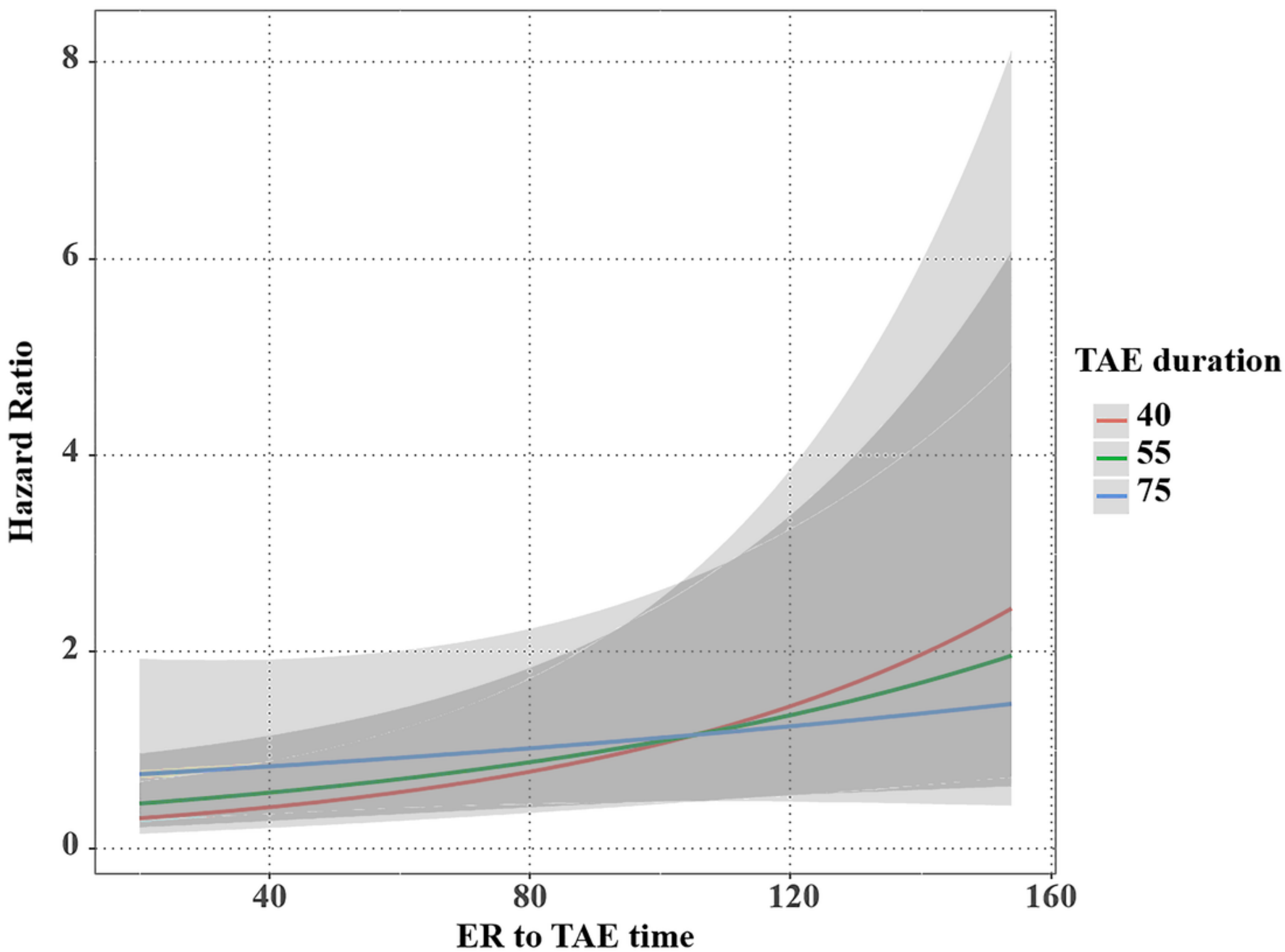

Figure 3

The interaction between TAE duration and decision-TAE time

Although the interaction between TAE duration and decision-TAE time is statistically significant (p=0.123), it indicated that TAE duration modifies the effect of decision-TAE time on mortality.

TAE, transarterial catheter embolization

Figure 4

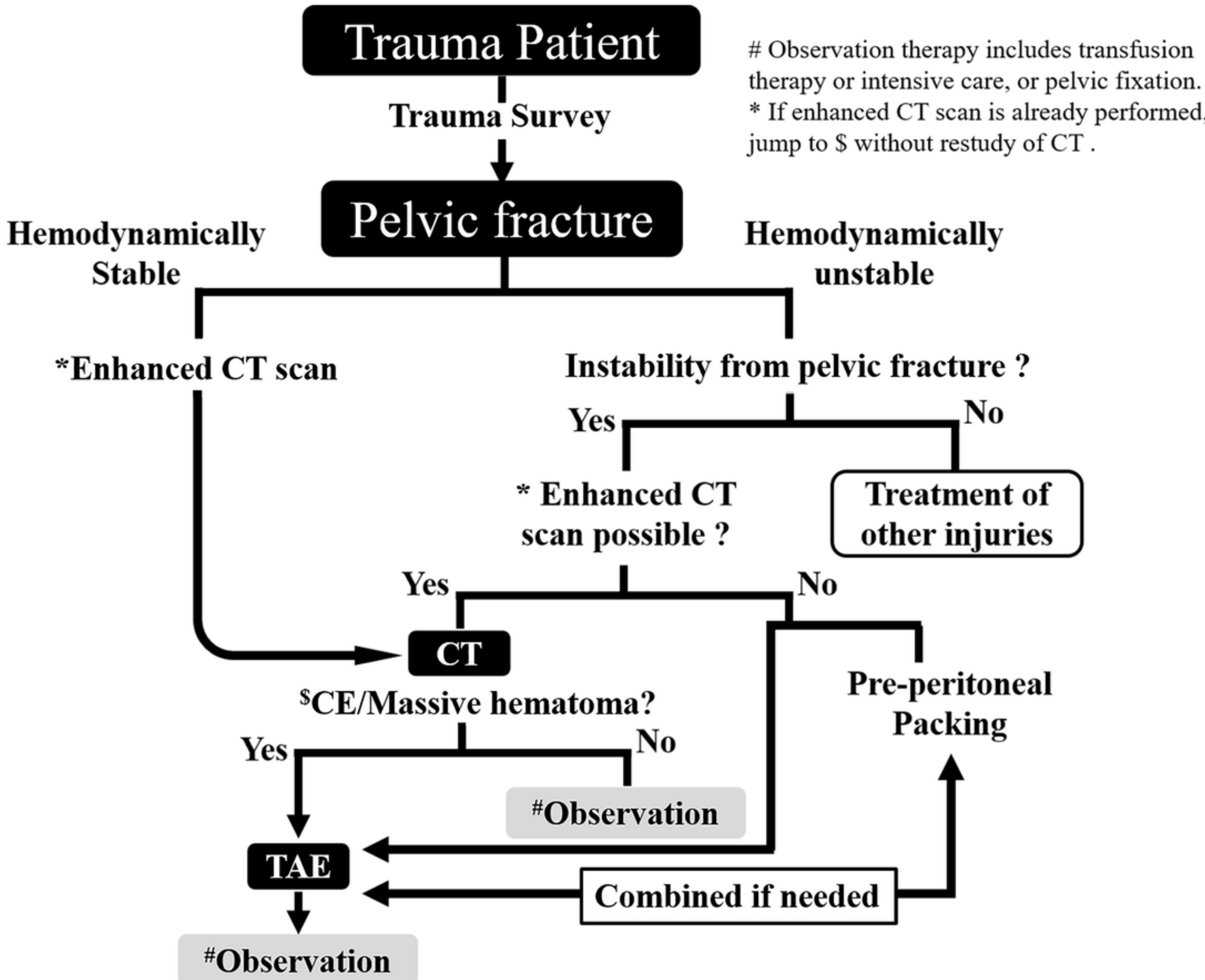

Figure 4

Treatment algorithm for pelvic injury

CT, computed tomography; TAE, transarterial catheter embolization

Figure 5

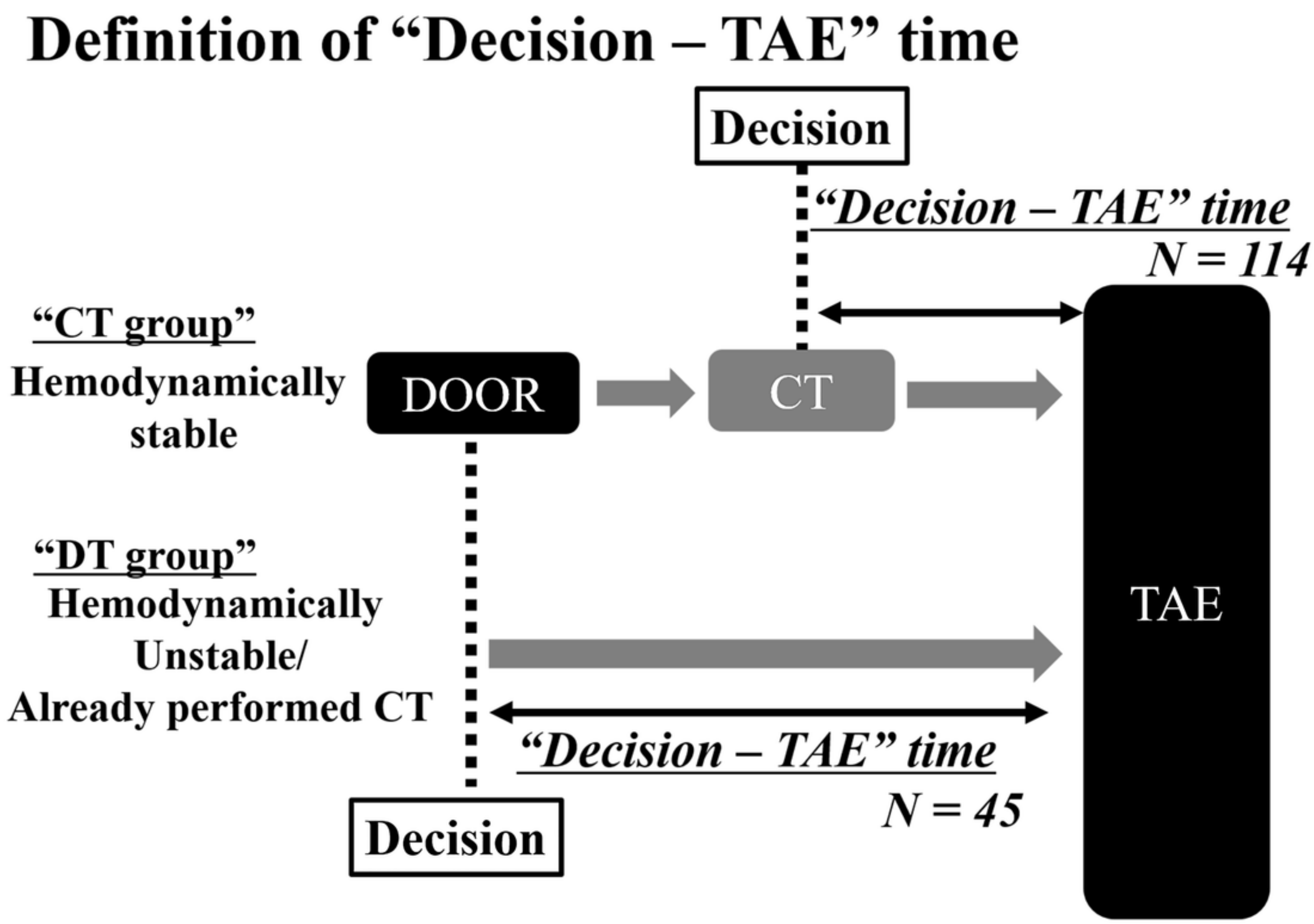

Figure 5

Definition of "decision-TAE" time

In the CT (CT-TAE) group, the decision-TAE time is defined as the time from the start of CT to the administration of TAE. In the door-TAE group, the decision-TAE time is defined as the time from arrival to administration of TAE.

TAE, transarterial catheter embolization

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementTable1.docx
- SupplementTable2.docx