

# Hybrid emergency room reduces blood transfusion for patients with severe trauma

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## Research article

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## Abstract

**Background:** A hybrid emergency room (hybrid ER) is defined as an emergency unit with four functions: resuscitation, computed tomography (CT) scanning, performing operations, and angiography. The safety and efficacy of performing CT scans in a hybrid ER is not well known in the primary survey. The purpose of this study was to evaluate the safety and clinical effects of hybrid ERs.

**Methods:** This was a retrospective observational study using the Shimane University Hospital Trauma Databank from January 2016 to February 2019. Hospitalized patients with severe trauma and an injury severity score  $\geq 16$  were divided into two groups: the non-hybrid ER group ( $n=134$ ) and the hybrid ER group ( $n=145$ ). The time from arrival to CT scan and interventions, and number of in-hospital survivors, preventable trauma deaths (PTD), and unexpected survivors (US) were assessed between both groups. The amount of blood transfused was also compared between the groups.

**Results:** The time from arrival to CT scan and interventions was significantly reduced in the hybrid ER group compared with than in the non-hybrid ER group (25 vs. 6 minutes;  $p <0.0001$ , 101 vs. 41 minutes;  $p =0.0007$ ). There was no significant difference in the rate of in-hospital survivors (96.9 vs. 96.3%;  $p=0.770$ ), PTD (0 vs. 0%), and US (9.0 vs. 6.2%;  $p=0.497$ ) between the groups. The amount of blood transfused was significantly reduced in the hybrid ER group compared to the non-hybrid ER group (red blood cell: 6 vs. 2,  $p =0.012$ , fresh frozen plasma: 9 vs. 6,  $p =0.021$ ).

**Conclusions:** The results of our study suggest that trauma treatment in a hybrid ER is as safe as previous conventional treatment in a non-hybrid ER, and that hybrid ERs, which can reduce the time for trauma surveys and treatment and do not require patient transfer, can reduce the amount of blood transfusion required for resuscitation.

## Background

It is extremely important to stabilize the physiological status of patients with severe trauma during trauma treatment. Hemostasis is an essential element that can save the life of patients with severe trauma(1). The advanced trauma life support (ATLS) guidelines have been standard for trauma surveys and treatment in many countries. Primary surveys in ATLS show that a simple assessment, including a focused assessment with sonography for trauma (FAST) and radiography of the chest and pelvis, is recommended to achieve resuscitation in patients with severe trauma. Therefore, it has been said that computed tomography (CT) imaging requiring patient transfer should not be performed for hemodynamically unstable trauma patients. It had been a dogma that the CT examinations were not safe for those patients with life-threatening injuries. Advances in CT equipment have dramatically reduced the CT imaging time. With the progress in this, reports increasingly indicate that whole-body CT scans should be effectively used for trauma treatment (2-8). An important point is that whole-body CT scans with accurate diagnosis decrease the mortality of trauma patients (2, 6-8). Moreover, it has been shown that

whole-body CT in trauma patients has a high sensitivity and a low rate of missed injuries (4). These reports, thus, show that a whole-body CT scan, if possible, should be performed for trauma treatment.

Patients with hemodynamic instability require immediate resuscitative operations, including hemostasis. In particular, immediate surgery is necessary for critically unstable trauma patients with impending cardiac arrest. If the emergency room has an operating theater and interventional radiology (IVR) room, the surgeon can immediately start the resuscitative intervention without patient transfer.

Based on these reports, a hybrid emergency room (hybrid ER) has been developed to achieve both an accurate diagnosis and faster surgical and angiographic hemostasis. This emergency unit utilizes new concepts to perform immediate initial resuscitation in patients with life-threatening injuries and to perform a trauma whole-body CT scan to facilitate quick damage control surgery and transcatheter arterial embolization (TAE) using IVR. Therefore, this unit is defined as an integrated system that enables four functions to be performed in the same room without patient transfer: resuscitation, CT scan, surgery, and IVR (9, 10). It has been reported that trauma care using a hybrid ER is associated with improved patient survival in severe trauma(11). Furthermore, Kinoshita et al. reported that installation of a hybrid ER may significantly improve mortality in severe trauma patients due to the capability of immediate diagnosis by CT scan and rapid control of massive bleeding without the need for transferring the patients (12). Recently, the efficacy of hybrid ERs has been reported in patients with severe traumatic brain injury (13, 14). However, the safety of the primary survey using CT imaging remains unknown.

Massive transfusion is required for trauma resuscitation, including damage control surgery (15). Damage control resuscitation (DCR) is an important strategy aimed at minimizing the amount of blood loss until definitive hemostasis is achieved (15, 16). Besides performing DCR, achieving hemostasis in patients with massive bleeding and additional life-threatening injuries is also essential. If a system that enables faster hemostasis can be established, it may be possible to reduce the amount of blood required for transfusion. The Hybrid ER can be considered a leading candidate for this kind of system. However, this has not yet been verified in practice.

We hypothesized that hybrid ER is as safe as conventional resuscitation and that the use of hybrid ER could reduce blood transfusions. In the present study, we evaluated the safety of using a hybrid ER system for primary survey in trauma care and assessed whether the use of hybrid ER can reduce the amount of blood transfused in patients with severe trauma.

## Methods

### Study Design and Patient Selection

This was a retrospective observational study using the Shimane University Hospital Trauma Database from January 2016 to February 2019. This study was approved by the Shimane University Institutional Committee on Ethics (#4083). The Shimane University Hospital Trauma Database consisted of data collected from the medical records of patients who needed hospitalization or were transported by

emergency ambulance or medical helicopter to Shimane University Hospital. Hospitalized patients with severe trauma (injury severity score [ISS ≥ 16]) were enrolled in this study. The patients were divided into two groups: the non-hybrid ER group (January 2016-July 2017) and the hybrid ER group (August 2017–February 2019) (Fig. 1).

### **Management in Non-Hybrid ERs**

Patients were transferred to the regular emergency room in our trauma center. The Japan Advanced Trauma Evaluation and Care (JATEC) guidelines(17) based on the ATLS guidelines were applied to all patients. FAST and radiography of the chest and pelvis for the assessment of circulation were performed in the primary survey. If patients needed resuscitation, it was performed immediately in the emergency room. Resuscitative thoracotomy was performed in the emergency room, but the patient underwent an emergency laparotomy and craniotomy after being transferred to the operating room. Whole-body CT imaging was performed after the secondary surveys according to the JATEC guidelines. If patients needed hemostasis using IVR, they were transferred to the angiographic room where TAE was performed. Blood transfusion was immediately started if needed because the transfusion products were permanently placed in our trauma center.

### **Management in Hybrid ERs**

The Shimane Advanced Trauma Center of Shimane University Hospital installed a rotation-type hybrid ER system in August 2018 (Fig. 2). (10) Our hybrid ER utilizes an operating table but not an angiographic table and has an air-conditioned room (class 10,000) (10). Therefore, all surgeries, including craniotomy, can be performed in this hybrid ER without transferring patients. Whole-body CT scan, damage control surgery, and TAE can be started quickly after transferring patients to our trauma center. We created a clinical protocol for this hybrid ER. The basic concept of the protocol conformed to the ABCDE approach as well as JATEC. After transferring to the hybrid ER, assessment of A (airway), B (breathing), and C (circulation) was performed. A whole-body CT scan was performed instead of the FAST, and radiography of the chest and pelvis. If patients had problems with their airway or breathing, resuscitation, including intubation, was prioritized. The team leader assessed only 10 cases with life-threatening injuries, including intracranial bleeding, cases requiring craniotomy, pericardial effusion, mediastinal hematoma and aortic injury, massive hemothorax, pneumothorax requiring a chest drain, massive lung contusion with desaturation, multiple rib fractures that could cause flail chests, abdominal bleeding (organ injury or mesenteric injury), retroperitoneal hematoma with pelvic fracture, and massive retroperitoneal bleeding in zone I or II. We called the assessment of these cases, using CT imaging in the hybrid ER, “mFACT: modified focused assessment with CT for trauma.” If even one qualifying case was found, it was defined as “mFACT positive.” If mFACT was positive, resuscitation, including resuscitative surgery or IVR, was immediately performed on the patient. An assessment of CNS dysfunction was performed after the whole-body CT scan. If it was determined that the patient might have a cardiac arrest soon (e.g., a systolic blood pressure of 60 mmHg or below), a resuscitative thoracotomy was performed instead of the whole-body CT scan. Damage control surgery, craniotomy, and TAE were performed immediately without

transferring the patients. The basic protocol for the primary survey in the hybrid ER takes the ABC"CT"DE approach.

## Data Sources

Data were obtained from the Shimane University Hospital Trauma Database. Age, sex, mechanism of trauma, Abbreviated Injury Scale (AIS), maximum AIS, ISS, revised trauma score (RTS), probability of survival (Ps) calculated using the Trauma and Injury Severity Score (TRISS) (18, 19), cardiac pulmonary arrest on arrival (CPA-OA), blood transfusion, and procedure of resuscitative operation or IVR, were compared between the groups. Resuscitative thoracotomy, laparotomy, pelvic external fixation, craniotomy, and TAE were performed for resuscitative operations or IVR. Safety in hybrid ER was evaluated based on the comparison of outcomes between hybrid ER and non-hybrid ER. To estimate the safety of hybrid ER, the prognosis of patients, in-hospital survival of patients, death in Ps>0.5 (excluding patients with severe head injuries of Glasgow Coma Scale (GCS) score ≤ 5, and those 80 years or older), survivors with Ps<0.5, and complications were compared between both groups. Complications were assessed using adapted Clavien-Dindo in trauma (ACDiT) (20). CPA-OA cases were excluded in the evaluation of in-hospital survivors and complications. Finally, the amount of red blood cells (RBCs) and fresh frozen plasma (FFP) transfused in emergency room were compared between both groups. A transfusion protocol for damage control resuscitation by the Shimane Advanced Trauma Center was used for this purpose. Blood transfusion was initiated based on the assessment of blood consumption (ABC) score (21), but the final decision to start blood transfusion was made by the attending trauma surgeon. Complete blood count and coagulation tests were performed every 30 minutes, and the targeted goals for transfusion were hemoglobin 7-9g/dL and fibrinogen>150mg/dL.

## Statistical Analysis

Statistical analysis was performed using JMP® Pro 14.2.0 (SAS Institute Inc., Tokyo, Japan). Differences in baseline characteristics were analyzed using the Wilcoxon test for continuous variables and chi-square and Fisher's exact tests for categorical variables. Differences in time from arrival to CT scan, time from arrival to interventions, and amount of blood transfused between both groups were analyzed using the Wilcoxon test. All results were assessed at the  $p=0.05$  level of significance.

## Results

A total of 1,893 patients with trauma were identified in the Shimane University Hospital Trauma Database from January 2016 to February 2019 (Fig. 1). Of these, 1,271 patients were treated in the non-hybrid ER, and 134 patients required hospitalization with ISS ≥ 16. In contrast, 622 patients were treated in the hybrid ER, and 145 patients required hospitalization with ISS ≥ 16. The median age of all patients was 69 years (interquartile range [IQR], 52-80 years). Table 1 shows the comparison of patient baseline characteristics. There was no significant difference in the baseline characteristics between the non-hybrid ER and hybrid ER groups. There was also no significant difference in the number of patients requiring interventions (surgery or IVR) (24 vs. 39,  $p=0.086$ ) or blood transfusion (26 vs. 24,  $p=0.640$ ) between the

groups. Although the number of CPA-OA in the hybrid ER group was slightly higher than that in the non-hybrid ER group (4 vs. 11,  $p=0.113$ ), there was no significant difference noted between the groups.

### **Time from arrival to CT scan and interventions, including surgery and IVR**

To determine the efficacy of reducing the trauma care time by hybrid ER, the time from arrival to CT scan and interventions, including surgery and IVR, were compared between the non-hybrid ER and hybrid ER groups (Table. 2). The time from arrival to CT scan was significantly reduced in the hybrid ER group compared with that in the non-hybrid ER group (25 [IQR 17-35.5] vs. 6 [4-8] min,  $p<0.0001$ ). Furthermore, the time from arrival to interventions was also significantly reduced in the hybrid ER group (101 [43.8-152.5] vs. 41 [20-72] min,  $p=0.0007$ ).

### **Prognosis of Patients with Severe Trauma**

To determine the safety of a novel trauma workflow using a hybrid ER, the number of in-hospital survivors, complications, death in  $Ps>0.5$ , and survivors in  $Ps<0.5$ , were compared between the groups (Table 3). There was no significant difference in the number of in-hospital survivors between the two groups (126 [96.9%] vs. 129 [96.3%],  $p=0.770$ ). There was no significant difference in the incidence of complications between the two groups (Table 3). There was no death in  $Ps>0.5$ , except in patients with severe brain injuries with a GCS of 5 or lower, and those 80 years or older in both groups. Moreover, there was no significant difference in survivors with  $Ps<0.5$  between both groups (12 vs. 9;  $p=0.497$ ) (Table 4).

### **Amount of Blood Transfusion**

Next, to assess the effect of hybrid ERs on trauma resuscitation, the amount of transfused blood (RBC and FFP) from arrival to the end of the resuscitative interventions was assessed in both groups (Fig. 3). The total dose of RBC was significantly lower in the hybrid ER group than in the non-hybrid ER group (6 [4-16] vs. 2[2-8],  $p=0.012$ ). In point estimation, the non-hybrid ER group had higher RBC levels (9.81, 95% CI, 7.19-12.44) than the hybrid ER (4.42, 95% CI, 1.63-7.20) group. Furthermore, the amount of FFP was also significantly lower in the hybrid ER group relative to the non-hybrid ER group (9 [6-17] vs. 6 [4-6],  $p=0.021$ ). In point estimation, the non-hybrid ER group also had a higher level of FFP (11.74, 95% CI, 8.30-15.18) than the non-hybrid ER (7.00, 95% CI, 3.35-10.65). Our results indicate that the use of a hybrid ER, which shortens the time between arrival and interventions, including surgery, reduces the need for transfusion for resuscitation.

## **Discussion**

In the present study, we demonstrated two major findings: 1) trauma treatment in hybrid ERs does not increase the mortality of patients with severe trauma compared with previous conventional treatment in non-hybrid ERs; and 2) trauma resuscitation in a hybrid ER reduces the amount of blood transfusion required in the resuscitation.

The hybrid ER system is a new treatment concept, and the clinical effects of hybrid ERs in trauma treatment have not been clearly defined. In particular, the safety of using hybrid ERs for trauma treatment has not been reported. Therefore, this study was necessary to clarify the safety of hybrid ERs for trauma management. Previous reports showed that the time to CT initiation, time to definitive therapy (including thoracotomy or laparotomy), and time to TAE in trauma workflows in hybrid ERs were significantly reduced compared with those in non-hybrid ERs (12, 22). Reduction in time to CT scan and intervention is one of the greatest advantages of hybrid ER. However, the safety of the new trauma workflow for performing a CT scan during the primary survey has not been evaluated. In this study, we demonstrated that a hybrid ER is as safe as conventional treatment. This result suggests that it may be reasonable to actively use the hybrid ER system in patients with severe trauma.

In our trauma protocol for hybrid ERs, a CT scan is performed instead of FAST and radiography of the chest and pelvis. It has been emphasized in trauma surveys that this three-point examination is simple and can be performed without transferring the patient. At this point, CT imaging in hybrid ER is similar to FAST and radiography of the chest and pelvis, as in conventional imaging surveys. Additionally, the whole-body CT scan can reveal findings unknown in the primary survey, including intracranial bleeding, mediastinal hematoma, and retroperitoneal hematoma around the aorta or kidney. This provides advantages over conventional methods; if this information is available during the primary survey, it can guide the appropriate management strategy. Moreover, patients can immediately undergo resuscitative surgery, including hemostasis, without transfer. In fact, our results revealed that the time from arrival to CT scan and resuscitative interventions was significantly reduced with hybrid ER use. This may benefit patients requiring the shortest possible time from hemostasis to surgery or IVR. Moreover, if a CT scan in the hybrid ER reveals an intracranial hematoma with concurrent massive abdominal bleeding, simultaneous craniotomy and resuscitative laparotomy can be performed in the emergency department without patient transfer. The hybrid ER has another advantage in that two or more surgeries can simultaneously be performed in the emergency department.

However, a whole-body CT scan in the primary survey may increase radiation exposure. In fact, the radiation exposure dose of whole-body CT scans is higher than that of regular X-rays. Therefore, we must make an effort to reduce the radiation exposure when using the hybrid ER. Only patients with high-intensity injuries or critical illness are transferred to the hybrid ER in our trauma center, and other patients are treated in the regular emergency room. Whole-body CT scans in the hybrid ER should only be performed in patients for whom it is essential. We also usually used X-ray machines in hybrid ERs for patients with rib fractures to reduce radiation exposure. Many of these patients in the hybrid ER group needed CT examination after the secondary survey; therefore, they underwent CT even if they were treated in a regular emergency room (non-hybrid ER). The radiation exposure in a hybrid ER is similar to that of a regular CT scan. Consequently, it was estimated that there would be no difference in the total radiation exposure in the emergency department between the two groups, although there was no data to support this finding. The hybrid ER can be a useful system, as described above, when used effectively in patients with life-threatening conditions.

We had initially believed that hybrid ER, where the C-arm was easily available, appeared to be suitable for REBOA (resuscitative endovascular balloon occlusion of the aorta). However, this was proved wrong when we actually used a hybrid ER. Laparotomy or pelvic packing can be performed quickly without patient transfer in a hybrid ER to control bleeding in patients who need REBOA because a hybrid ER also includes an operating room. If possible, definitive hemostasis should be performed earlier than temporary hemostasis by REBOA. Patients requiring resuscitative thoracotomy are likely to develop cardiac arrest, and REBOA is no longer indicated. In this study, none of the patients needed REBOA in the hybrid ER. We believe that intraoperative bleeding control can be achieved in the hybrid ER during the induction of REBOA.

Various specialties are required to make effective use of hybrid ERs. Without an interventionalist, the hybrid ER cannot fully demonstrate its capabilities. In our trauma center, trauma surgeons resuscitate the patient and perform open surgeries in the hybrid ER. Interventionalists are available every day in our trauma center, so there is minimal waiting time for IVR. Some trauma surgeons have even mastered emergency IVR techniques in our trauma center. If the interventionalist is not available, the trauma surgeon may perform IVR. In addition, the role of a radiologist is also extremely pivotal in hybrid ER. At our trauma center, the radiologist arrives at the emergency department before the patient arrives to prepare for the hybrid ER, and thus is a part of the team. Teamwork is also extremely important for the effective use of hybrid ER.

A previous report showed that trauma workflow using the hybrid ER system decreased the mortality of patients with severe trauma (12). This was the first clinical effect of the hybrid ER system. However, our results showed that there was no difference in the survival of hybrid ER patients compared with those of patients in the non-hybrid ER. We also assessed the survival benefit (survival and unexpected survival rate) at <50, 50-64, 65-79, and 80 ≤ years of age between the two groups. Unfortunately, there were no significant differences in survival and unexpected survival rates between the non-hybrid ER and hybrid ER groups in the four age groups. Thus, it may be difficult to improve survival using hybrid ER, as the survival rate in the conventional group (non-hybrid ER) was high. Another report indicated that more severely injured patients can survive in a hybrid ER (23). This report showed that the TRISS Ps of survival patients treated in the hybrid ER were lower than that of those in non-hybrid ER. This suggests that hybrid ERs may contribute to survival in more severe trauma patients with a high ISS (e.g., ISS ≥ 36).

We also focused on the amount of blood transfused because massive transfusion plays an important role in resuscitation during trauma treatment. Massive transfusion is a concept that forms the basis of DCR, as evidence for the efficacy of DCR has been reported extensively in the literature (15, 16). To determine the effect of blood transfusion in the hybrid ER, we compared the amount of blood transfused between the two groups. Our results revealed that the hybrid ER significantly reduced the amount of blood transfused to patients. This is the first report of the effectiveness of blood transfusion in hybrid ER. A hybrid ER can provide accurate injury information and reduce the time until hemostasis. This result suggests that faster hemostasis using a hybrid ER may have reduced blood transfusion in trauma resuscitation. The hybrid ER may thus make a medical contribution by reducing blood transfusions.

There are however, some important limitations to our results. First, this was a retrospective study conducted at a single institution. Since there may be several biases in such a study, these results should be verified in a prospective, multicenter study. Second, this study cannot identify whether a suitable criteria for admission to a hybrid ER is trauma resuscitation. Although severe trauma patients with ISS  $\geq$  16 were analyzed in our study, suitable clinical criteria for a hybrid ER should be assessed in the future. Third, it is said that a significant barrier to the installation of a hybrid ER is cost. We did not assess the costs and benefits of using a hybrid ER in trauma treatment. We usually use a hybrid ER as a CT scan room in an emergency room. Even if surgery is not performed on all patients, it may be possible to pay for a hybrid ER by performing CT examination a certain number of times in a day. In Japan, a dual-room-type hybrid ER has recently been released in consideration of cost merit (24). The cost-effectiveness of the hybrid ER should be estimated accordingly. Finally, the radiation exposure dose for whole-body CT scans in both groups was not assessed in this study. Radiation exposure should be reduced for medical examination; therefore, an accurate dose of radiation in both the groups should be assessed in the future.

## Conclusions

The new trauma workflow using a whole-body CT scan in a hybrid ER is as safe as the conventional trauma protocol. The use of this protocol in the hybrid ER did not adversely affect the prognosis of patients, including survival and PTDs. Moreover, a hybrid ER can reduce the amount of blood transfusion during resuscitation, although the hybrid ER does not contribute to improved survival in patients with severe trauma with ISS  $\geq$  16. Importantly, the hybrid ER, which does not require patient transfer, has a great advantage of reduced time to interventions. If the hybrid ER is used appropriately, early hemostasis can be achieved, and reduced transfusion will benefit patients with severe trauma.

## List Of Abbreviations

ER: emergency room; ATLS: advanced trauma life support; FAST: focused assessment with sonography for trauma; CT: computed tomography; IVR: interventional radiology; TAE: transcatheter arterial embolization; DCR: Damage control resuscitation; JATEC: Japan Advanced Trauma Evaluation and Care; mFACT: modified focused assessment with CT for trauma; AIS: Abbreviated Injury Scale; ISS: injury severity score; RTS: revised trauma score; Ps: probability of survival; Trauma and Injury Severity Score (TRISS); CPA-OA: cardiac pulmonary arrest on arrival; GCS: Glasgow Coma Scale; ACDiT: adapted Clavien-Dindo in trauma; RBC: red blood cells; FFP: fresh frozen plasma; ABC score: assessment of blood consumption score; IQR: interquartile range; CI: confidence interval; REBOA: resuscitative endovascular balloon occlusion of the aorta.

## Declarations

### Ethics approval and consent to participate

This study was approved by the Shimane University Institutional Committee on Ethics (#4083).

## **Consent for publication**

Not applicable

## **Competing interests**

Hiroaki Watanabe received lecture fees and travel expenses from Canon Medical Systems for educational lectures in Japan.

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We have no funding for this study.

## **Authors' contributions**

H.W. conceived and designed the study. H.W., R.M., S. K, T.M., K.O., Y.S., A. K., and E.H. participated in data collection and analysis. H.W. participated in writing. T.K. was in charge of the statistical analysis.

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## Tables

**TABLE 1. Baseline Characteristics**

	Non-hybrid ER (n=134)	Hybrid ER (n=145)	p value
Age in years (median)	68(55-79)	70 (52-81)	0.531
Male	93 (69.4%)	100 (68.9%)	1.000
Brunt	133 (99.3%)	143 (98.6%)	1.000
AIS $\geq$ 3			
AIS (head)	69 (51.5%)	87 (60.0%)	0.106
AIS (face)	3 (2.2%)	4 (2.8%)	0.598
AIS (chest)	85 (63.4%)	91 (62.8%)	0.229
AIS (abdomen)	24 (17.9%)	20 (13.8%)	0.200
AIS (extremity)	31 (23.1%)	34 (23.4%)	0.827
AIS (External)	1 (0.7%)	0 (0%)	0.170
Maximal AIS	4 (4-4)	4 (4-5)	0.124
ISS (median)	22 (18-33)	26 (18-35)	0.254
RTS	7.24 (range 0-7.84)	6.76 (range 0-7.84)	0.156
TRIIS Ps	0.798 (0.773-0.940)	0.769 (0.758-0.939)	0.303
CPA-OA	4 (3.0%)	11 (7.6%)	0.113
Intervention	24 (17.9%)	39 (26.9%)	0.086
Blood transfusion	26 (19.4%)	24 (16.6%)	0.640

ER: emergency room, AIS: abbreviated injury scale, ISS: injury severity score, RTS: revised trauma score, TRISS: Trauma and Injury Severity Score, Ps: probability of survival, CPA-OA: cardiac pulmonary arrest.

**TABLE 2. Time from arrival to CT scan and interventions**

	Non-hybrid ER (n=134)	Hybrid ER (n=145)	p value
CT scan (minutes)	25 (17-35.5)	6 (4-8)	<0.0001
Interventions (minutes)	101 (43.8-152.5)	41 (20-72)	0.0007

ER: emergency room, CT: computed tomography

**TABLE 3. In-hospital survivors and complications**

	Non-hybrid ER (n=130)	Hybrid ER (n=134)	p value
In-hospital survivors	126 (96.9%)	129 (96.3%)	0.770
Complications (ACDiT)			
0	109 (83.8%)	116 (86.6%)	0.880
I	1 (0.8%)	0	0.480
II	15 (11.5%)	11 (8.2%)	0.312
III-a	0	0	
III-b	1 (0.8%)	2 (1.5%)	1.000
IV-a	1 (0.8%)	0	0.480
IV-b	0	0	
V-a	0	0	
V-b	3 (2.3%)	5 (3.7%)	0.724

ER: emergency room, ACDiT: adapted Clavien-Dindo in trauma

**TABLE 4. Prognosis of both groups (preventable death and unexpected survivors)**

	Non-hybrid ER (n=134)	Hybrid ER (n=145)	p value
Death in Ps>0.5	0	0	
Survivor in Ps<0.5	12 (9.0%)	9 (6.2%)	0.497

ER: emergency room, Ps: probability of survival

## Figures

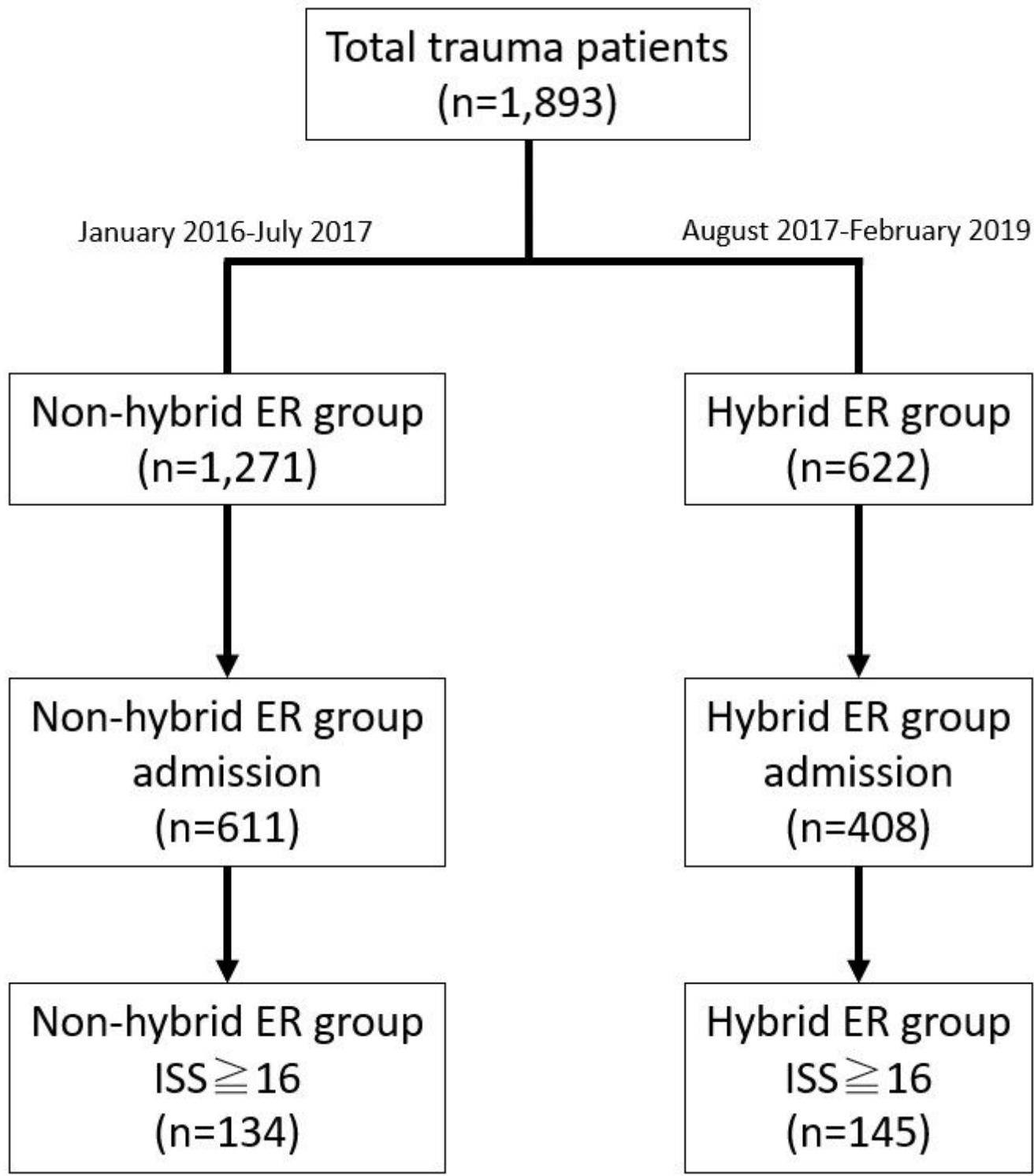


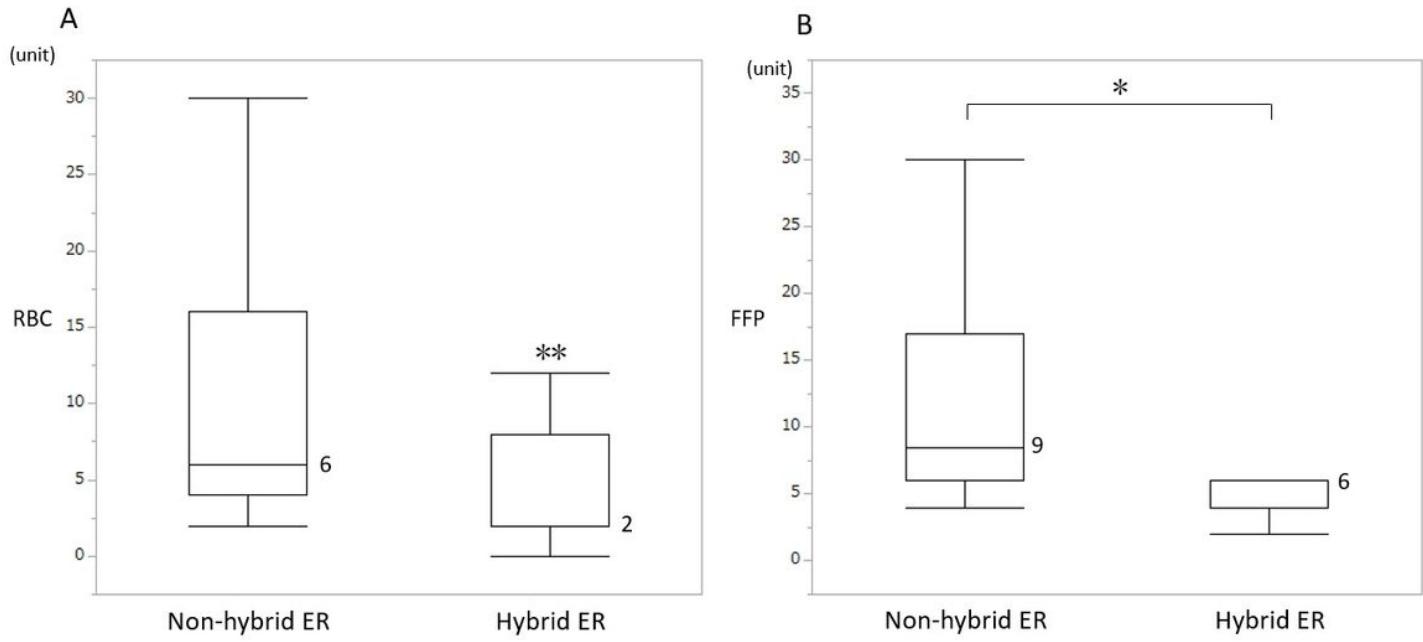
Figure 1

Flowchart of patient inclusion in the study



**Figure 2**

Hybrid emergency room (ER) used in this study



**Figure 3**

The amount of blood transfusion between both groups. A: red blood cell (RBC), B: fresh frozen plasma (FFP).