Original Article

The effect of prehospital intravenous access in traumatic shock: a Japanese nationwide cohort study

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Aim: We aimed to evaluate effect of prehospital intravenous (IV) access on mortality in traumatic shock using a large nationwide dataset.

Methods: We used the Japan Trauma Data Bank to identify adults (≥18 years) with a systolic blood pressure <90 mm Hg at the trauma scene and were directly transported to the hospital between 2010 and 2019. We compared patients who had prehospital IV access (IV (+)) or not (IV (−)), using propensity score-matched analysis, and 1:1 nearest-neighbor matching without replacement. Standardized mean difference was used to evaluate the match balance between the two matched groups; a standardized mean difference >0.1 was considered a significant imbalance. Primary outcome was 72-h mortality.

Results: Propensity scores matching generated 479 pairs from 5,857 patients. No significant between group differences occurred in 72-h mortality (7.8 versus 8.8%; difference, −1.0%; 95% confidence interval [CI]: −2.5–4.5%), 28-day mortality (11.8 versus 11.3%; 95% CI: −4.6–3.6%), blood transfusion administration within 24 h (55.3 versus 49.1%; 95% CI: −0.1–12.6%), prehospital time (56.3 versus 53.0 min; 95% CI: −1.8–8.4 min), and cardiopulmonary arrest on hospital arrival (1.3 versus 1.3%; 95% CI: −1.4–1.4%). However, significantly higher systolic blood pressure on hospital arrival was found in the IV (+) than in the IV (−) group (104.6 versus 100.1 mm Hg; 95% CI: 0.3-8.7 mm Hg).

Conclusion: We found no significant effect of establishing IV access in the prehospital setting on survival outcomes of patients with traumatic shock.

Key words: Blood pressure, blood transfusion, intravenous access, prehospital care, traumatic shock

IINTRODUCTION

TRAUMA IS A major cause of death; improving its outcome is an urgent issue.[1,2] Prehospital medical care plays a critical role in improving outcomes of patients after severe trauma.[3] Although a potentially beneficial prehospital care measure is securing intravenous (IV) access, few studies exist on its effects in patients with trauma, and its effects on traumatic shock remain unclear. One study reported improved survival,[4] whereas others failed to detect a benefit,[5–7] or reported decreased survival.[8,9] Moreover, many previous studies were limited by insufficient adjustment for confounding factors, low external validity, and small sample size.

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In this study, we aimed to evaluate the effects of securing prehospital IV access in patients with traumatic shock using a large nationwide dataset. In addition, we hoped to minimize confounding bias using propensity score matching.

METHODS

Study design

THIS RETROSPECTIVE COHORT study used data of Japan Trauma Data Bank (JTDB) and was approved by the medical ethics committee of Juntendo University Shizuoka Hospital (Approval number 807). This was an observational study using anonymized data; hence, obtaining individual consent was exempted.

Prehospital care in Japan

The Japanese Emergency Medical System (EMS), supervised by the Fire and Disaster Management Agency, is operated by the municipal government. An EMS crew generally

includes at least one technician who is trained to insert an IV line. These technicians are authorized to administer crystalloid fluids intravenously to patients in or suspected of being in a state of shock under remote medical supervision. Although the prehospital care protocol is at the discretion of the municipal government, the Japan Prehospital Trauma Evaluation and Care program[10]—a standard prehospital trauma care program for paramedics that is being introduced nationwide—recommends administering 250–500 mL crystalloid to trauma patients with severe hypotension and imminent cardiac arrest. Japanese EMS providers are legally prohibited from administering any drugs, except in cases of cardiopulmonary arrest and providing blood transfusions; therefore, prehospital blood transfusions are uncommon, even when physicians are at the scene.[11]

Data collection

Data were obtained from the JTDB, a nationwide trauma registry established in 2003 by the Japanese Association for the Surgery of Trauma and the Japanese Association for Acute Medicine to improve and ensure the quality of trauma care in Japan.[12] The JTDB collects data from 280 hospitals, including 96% of tertiary emergency medical centers in Japan.[13] Altogether, 92 data variables[12] relating to patients were collected, including patient demographics, premorbid medical conditions, prehospital and in-hospital vital signs, prehospital care, abbreviated injury score (AIS), injury severity score (ISS), prehospital and in-hospital procedures, and in-hospital and emergency department mortality. Prehospital consciousness levels were evaluated using the Japan Coma Scale (JCS), which classifies the levels into one of four categories: alert, spontaneous eye opening, eye opening in response to a verbal or pain stimulus, and no eye opening, and each level is further divided into three subcategories. The JCS correlates well with in-hospital outcomes in trauma patients.[14]

We collected information on patients registered in the JTBD from January 2010 to March 2019. The inclusion criteria were adult (≥18 years) trauma patients who were directly transported to the hospital, had sustained blunt or penetrating injuries, and had systolic blood pressure (sBP) <90 mm Hg in the prehospital setting. Patients with cardiopulmonary arrest at the time of contact with the ambulance crew and missing survival status data on discharge were excluded.

Data definitions

Response time was defined as time from EMS call to EMS crew contact with the patient. Prehospital time was defined as time from EMS call to EMS arrival at the hospital. Prehospital respiratory rate was classified into: 0–5, 6–9, 10–29, and ≥30 breaths per minute (bpm).[15] Prehospital pulse rate was classified into: bradycardia (<60 bpm), normal (60–100 bpm), and tachycardia (>100 bpm). Cardiopulmonary arrest on hospital arrival (CPA-OA) was defined as sBP = 0 mm Hg at arrival.

Outcomes

The primary outcome was 72-h mortality. The secondary outcomes were 28-day mortality, sBP on hospital arrival, blood transfusion within 24-h, prehospital time, and CPA-OA.

Statistical analyses

We compared patients who received an intravenous route before hospital arrival (IV (+) group) and those who did not (IV (−) group) using propensity score-matched analysis. Logistic regression analysis was performed to estimate propensity score, and to predict establishment of IV access in a prehospital setting. Variables included in the model were: age; sex; and type (blunt or penetrating), mechanism (traffic-related, fall, or other), and cause (accident, assault, suicide, or other) of injuries. Transporter type (ambulance, ambulance with physician, helicopter, or other), prehospital vital signs (JCS, sBP, respiratory rate, pulse rate, and temperature), response time, maximum AIS in each body region, ISS, and comorbidities were included. Each IV (+) group patient was matched to an IV (−) group patient using nearest-neighbor matching without replacement. We used a caliper width equal to 0.2 of the standard deviation of the logit of the propensity score. The balance between these two groups was evaluated using the standardized mean difference (SMD), with SMD > 0.1 as a significant imbalance. Outcomes were compared in the matched cohort, and their differences with 95% confidence intervals (CIs) were reported. We performed a sensitivity analysis that considered the clustered structure of the dataset using the institute's identification number. Additionally, we conducted a separate sensitivity analysis that excluded "type of injury" and "ISS," which overlapped with "mechanism of injury" and "AIS."

Missing values were handled using the pair-wise method. All statistical analyses were performed using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria),[16] and results were considered statistically significant based on a P value of <0.05 or the range of the 95% CI.

Subgroup analysis

The matched cohort was grouped into those transported either by EMS crew only or with a physician, in subgroup analysis. We evaluated the effectiveness of the prehospital IV in each group. Additionally, we evaluated the interaction between securing prehospital IV access and prehospital physician intervention. Second, we extracted the group that received blood transfusion within 24 h after matching the cohort, to evaluate the effectiveness of securing prehospital IV.

RESULTS

OF 361,706 REGISTERED individuals in the JTDB, 9,835 met the inclusion criteria, and 1,445 were excluded, leaving 8,930 patients deemed eligible for the analysis. Using the propensity score estimated by a multivariate logistic regression analysis of 5,857 patients, we obtained 479 patients per group (Fig. 1). Table 1 shows the patients' baseline characteristics before and after propensity score matching. In the matched population, the baseline characteristics of patients were finely balanced between the two groups.

Table 2 shows the outcomes of the matched cohort. There was no significant difference in 72-h mortality between the IV (+) and IV (−) groups (7.8 versus 8.8%; difference, −1.0%; 95% CI: −2.5%–4.5%). The sBP on hospital arrival was significantly higher in the IV (+) than that in the IV (−) group (104.6 versus 100.1 mm Hg; difference, 4.5 mm Hg; 95% CI: 0.3–8.7 mm Hg), whereas there was no significant difference in 28-day mortality (11.8 versus 11.3%; 95% CI: −4.6%–3.6%), blood transfusion administration within 24 h (55.3 versus 49.1%; 95% CI: 0.1%–12.6%), prehospital time (56.3 versus 53.0 min; 95% CI: −1.8–8.4 min), and CPA-OA (1.3 versus 1.3%; 95% CI: −1.4%–1.4%) between the two groups.

Tables 3 and 4 show that for both sensitivity analyses, there were no significant difference in 72-h mortality between the IV (+) and IV (−) groups.

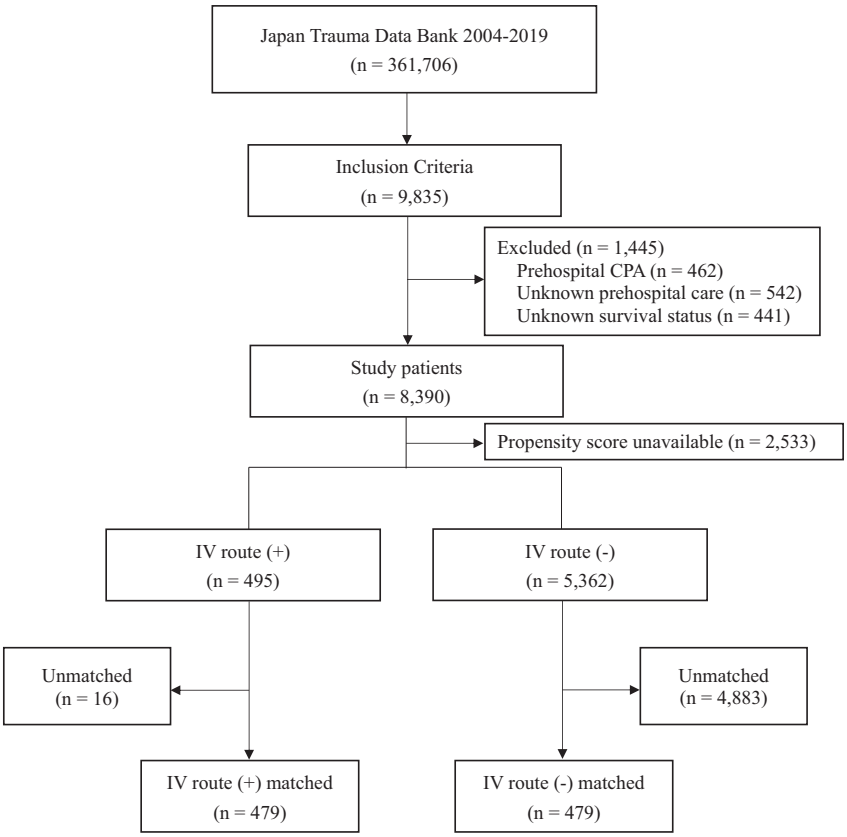

Fig. 1. Flowchart of this study. CPA, cardiopulmonary arrest; IV, intravenous.

Table 1. Characteristics of the study population

Variables	Before matching			After matching		
	IV (−) group *n* = 5362	IV (+) group *n* = 495	SMD	IV (−) group *n* = 479	IV (+) group *n* = 479	SMD
Age, year	56.96 [20.06]	56.52 [20.00]	0.022	55.35 [20.17]	56.51 [20.12]	0.057
Gender, male (%)	3569 (66.6)	351 (70.9)	0.094	349 (72.9)	340 (71.0)	0.042
Type of injury (%)						
Blunt injury	4728 (88.2)	429 (86.7)	0.046	411 (85.8)	416 (86.8)	0.030
Penetrating injury:	634 (11.8)	66 (13.3)		68 (14.2)	63 (13.2)	
Mechanism of injury (%)						
Traffic-related	2005 (37.4)	240 (48.5)	0.287	229 (47.8)	231 (48.2)	0.078
Fall	2374 (44.3)	152 (30.7)		138 (28.8)	150 (31.3)	
Other	983 (18.3)	103 (20.8)		112 (23.4)	98 (20.5)	
Cause of injury (%)						
Accidents	3973 (74.1)	352 (71.1)	0.176	336 (70.1)	344 (71.8)	0.042
Assault	144 (2.7)	10 (2.0)		12 (2.5)	10 (2.1)	
Suicide	925 (17.3)	80 (16.2)		81 (16.9)	77 (16.1)	
Other	320 (6.0)	53 (10.7)		50 (10.4)	48 (10.0)	
Transporter type (%)						
Ambulance	4899 (91.4)	260 (52.5)	0.968	269 (56.2)	260 (54.3)	0.060
Ambulance with physician	154 (2.9)	93 (18.8)		81 (16.9)	92 (19.2)	
Helicopter with physician	299 (5.6)	142 (28.7)		129 (26.9)	127 (26.5)	
Other	10 (0.2)	0 (0.0)		0 (0.0)	0 (0.0)	
Prehospital vital signs						
Japan Coma Scale (%)						
Clear	1444 (26.9)	92 (18.6)	0.247	85 (17.7)	91 (19.0)	0.071
1–3	2162 (40.3)	190 (38.4)		201 (42.0)	185 (38.6)	
10–30	861 (16.1)	100 (20.2)		94 (19.6)	96 (20.0)	
100–300	895 (16.7)	113 (22.8)		99 (20.7)	107 (22.3)	
Systolic blood pressure (mm Hg)	77.2 [8.7]	75.8 [9.4]	0.158	75.78 [9.56]	76.03 [9.26]	0.027
Respiratory rate (%)						
0–5	15 (0.3)	4 (0.8)	0.310	5 (1.0)	3 (0.6)	0.087
6–9	15 (0.3)	3 (0.6)		2 (0.4)	3 (0.6)	
10–29	4258 (79.4)	326 (65.9)		304 (63.5)	320 (66.8)	
≥30	1074 (20.0)	162 (32.7)		168 (35.1)	153 (31.9)	
Pulse rate (%)						
0–59	595 (11.1)	55 (11.1)	0.181	60 (12.5)	53 (11.1)	0.057
60–100	3368 (62.8)	271 (54.7)		256 (53.4)	268 (55.9)	
>100	1399 (26.1)	169 (34.1)		163 (34.0)	158 (33.0)	
Temperature (°C)	35.92 [1.20]	35.90 [1.22]	0.015	35.94 [1.13]	35.89 [1.23]	0.044
Response time (min)	8.63 [16.52]	10.16 [7.31]	0.120	9.73 [7.65]	9.99 [7.13]	0.036
Abbreviated Injury Scale						
Head	1.01 [1.62]	1.19 [1.77]	0.105	1.06 [1.62]	1.19 [1.77]	0.078
Face	0.28 [0.64]	0.28 [0.68]	0.003	0.25 [0.59]	0.28 [0.68]	0.056
Neck	0.08 [0.42]	0.12 [0.58]	0.092	0.11 [0.52]	0.12 [0.57]	0.023
Thorax	1.31 [1.77]	1.68 [1.92]	0.197	1.77 [1.92]	1.68 [1.92]	0.047
Abdomen and pelvis	0.62 [1.26]	0.94 [1.53]	0.229	0.92 [1.46]	0.89 [1.49]	0.023
Spine	1.11 [1.66]	1.11 [1.63]	0.001	1.08 [1.57]	1.10 [1.63]	0.014
Upper extremity	0.63 [1.02]	0.58 [0.99]	0.050	0.54 [0.96]	0.58 [0.99]	0.047
Lower extremity	1.22 [1.56]	1.49 [1.68]	0.170	1.46 [1.66]	1.46 [1.67]	0.003
Body surface	0.44 [0.22]	0.05 [0.22]	0.038	0.05 [0.25]	0.05 [0.22]	0.009

Table 1. (Continued)

Variables	Before matching			After matching		
	IV (−) group *n* = 5362	IV (+) group *n* = 495	SMD	IV (−) group *n* = 479	IV (+) group *n* = 479	SMD
Injury Severity Score	19.40 [13.51]	23.77 [14.88]	0.307	22.76 [14.39]	23.42 [14.76]	0.045
Comorbidities (%)						
Asthma	131 (2.4)	17 (3.4)	0.059	18 (3.8)	16 (3.3)	0.023
COPD	46 (0.9)	2 (0.4)	0.057	1 (0.2)	1 (0.2)	<0.001
Other chronic lung disease	42 (0.8)	4 (0.8)	0.003	4 (0.8)	4 (0.8)	<0.001
Heart failure	88 (1.6)	4 (0.8)	0.076	5 (1.0)	4 (0.8)	0.022
Hypertension	1020 (19.0)	107 (21.6)	0.064	98 (20.5)	102 (21.3)	0.021
Ischemic heart disease	162 (3.0)	20 (4.0)	0.055	15 (3.1)	19 (4.0)	0.045
Liver cirrhosis	57 (1.1)	2 (0.4)	0.077	2 (0.4)	2 (0.4)	<0.001
Chronic hepatitis	85 (1.6)	12 (2.4)	0.060	10 (2.1)	12 (2.5)	0.028
Peptic ulcer	93 (1.7)	7 (1.4)	0.026	6 (1.3)	7 (1.5)	0.018
Inflammatory bowel disease	28 (0.5)	5 (1.0)	0.056	4 (0.8)	5 (1.0)	0.022
Diabetes mellitus	442 (8.2)	39 (7.9)	0.013	38 (7.9)	36 (7.5)	0.016
Stroke	204 (3.8)	12 (2.4)	0.080	10 (2.1)	12 (2.5)	0.028
Psychiatric disease	724 (13.5)	74 (14.9)	0.041	73 (15.2)	69 (14.4)	0.024
Dementia	204 (3.8)	23 (4.6)	0.042	27 (5.6)	21 (4.4)	0.057
Malignancies	155 (2.9)	8 (1.6)	0.086	11 (2.3)	7 (1.5)	0.062
Hematological diseases	12 (0.2)	1 (0.2)	0.005	0 (0.0)	1 (0.2)	0.065
Chronic renal failure or HD	62 (1.2)	7 (1.4)	0.023	6 (1.3)	6 (1.3)	<0.001
Immunosuppressant use	7 (0.1)	2 (0.4)	0.053	2 (0.4)	2 (0.4)	<0.001
Anticoagulant use	82 (1.5)	7 (1.4)	0.010	7 (1.5)	7 (1.5)	<0.001
Steroid use	15 (0.3)	1 (0.2)	0.016	1 (0.2)	1 (0.2)	<0.001
Pregnancy	5 (0.1)	1 (0.2)	0.028	2 (0.4)	1 (0.2)	0.037

Table 2. Comparisons of study outcomes in patients who had venous access at the prehospital setting and those who did not

Variables	IV (+) group	IV (−) group	Difference (95% CI)
72-h mortality, *n* (%)	37 (7.8%)	42 (8.8%)	−1.0 (−2.5–4.5)
28-day mortality, *n* (%)	56 (11.8%)	54 (11.3%)	0.5 (−4.6–3.6)
Systolic blood pressure on arrival, mean (mm Hg) [±SD]	104.6 [±34.3]	100.1 [±32.0]	4.5 (0.3–8.7)
Blood transfusion in 24-h, *n* (%)	265 (55.3%)	235 (49.1%)	6.2 (−0.1–12.6)
Prehospital time, mean (min) [±SD]	56.3 [±24.0]	53.0 [±51.3]	3.3 (−1.8–8.4)
Cardiopulmonary arrest on arrival, *n* (%)	6 (1.3%)	6 (1.3%)	0.0 (−1.4–1.4)

The subgroup analyses shown in Tables 5 and 6 revealed no significant difference in 72-h mortality between the two groups.

DISCUSSION

OUR ANALYSIS FOUND no significant effect of securing prehospital IV access on mortality in patients with traumatic shock. Sensitivity analysis showed that securing prehospital IV access did not increase sBP on arrival; however, there is little evidence to support the main result.

Few previous studies exist regarding prehospital IV fluid administration for traumatic shock,[4–9] and their conclusions are inconsistent; no study has solely focused on securing IV access. Although one study[4] suggested that prehospital IV fluid administration was beneficial to trauma patients; the

Table 3. The baseline characteristics of the matched patients in the sensitivity analysis using the institute's identification number

Variables	IV (−) group n = 350	IV (+) group n = 350	SMD
Age, year	57.09 [20.17]	56.45 [19.72]	0.032
Gender, male (%)	251 (71.7)	253 (72.3)	0.013
Type of injury (%)			
Blunt injury	305 (87.1)	306 (87.4)	0.009
Penetrate injury	35 (12.9)	34 (12.6)	
Mechanism of injury (%)			
Traffic-related	173 (49.4)	168 (48.0)	0.032
Fall	111 (31.7)	1116 (33.1)	
Other	66 (18.9)	166 (18.9)	
Cause of injury (%)			
Accidents	266 (76.0)	255 (72.9)	0.110
Assault	3 (0.9)	7 (2.0)	
Suicide	52 (14.9)	57 (16.3)	
Other	29 (8.3)	31 (8.9)	
Transporter type (%)			
Ambulance	249 (71.1)	246 (70.3)	0.049
Ambulance with physician	45 (12.9)	42 (12.0)	
Helicopter with physician	56 (16.0)	62 (17.7)	
Other	0 (0.0)	0 (0.0)	
Prehospital vital signs			
Japan Coma Scale (%)			
Clear	75 (21.4)	74 (21.1)	0.068
1–3	127 (36.3)	138 (39.4)	
10–30	69 (19.7)	64 (18.3)	
100–300	79 (22.6)	74 (21.1)	
Systolic blood pressure (mm Hg)	76.43 (9.19)	76.13 (9.18)	0.032
Respiratory rate (%)			
0–5	0 (0.0)	2 (0.6)	0.158
6–9	2 (0.6)	0 (0.0)	
10–29	237 (67.7)	244 (69.7)	
≥30	111 (31.7)	104 (29.7)	
Pulse rate (%)			
0–59	44 (12.6)	45 (12.9)	0.009
60–100	188 (53.7)	188 (53.7)	
>100	118 (33.7)	117 (33.4)	
Temperature (°C)	35.83 [1.33]	35.91 [1.26]	0.066
Response time (min)	8.72 [8.58]	9.63 [6.21]	0.121
Abbreviated Injury Scale			
Head	1.16 [1.73]	1.09 [1.71]	0.040
Face	0.26 [0.64]	0.27 [0.65]	0.022
Neck	0.13 [0.56]	0.10 [0.49]	0.054
Thorax	1.59 [1.90]	1.66 [1.90]	0.036
Abdomen and pelvis	0.84 [1.48]	0.88 [1.50]	0.027
Spine	1.07 [1.66]	1.11 [1.65]	0.022
Upper extremity	0.69 [1.06]	0.60 [1.01]	0.083
Lower extremity	1.23 [1.54]	1.39 [1.63]	0.099
Body surface	0.06 [0.24]	0.05 [0.21]	0.076
Injury Severity Score	22.48 [15.01]	22.47 [14.78]	<0.001
Comorbidities (%)			

Table 3. (Continued)

Variables	IV (−) group $n = 350$	IV (+) group $n = 350$	SMD
Asthma	16 (4.6)	16 (4.6)	0.058
COPD	1 (0.3)	1 (0.3)	<0.001
Other chronic lung diseases	4 (1.1)	2 (0.6)	0.062
Heart failure	4 (1.1)	4 (1.1)	<0.001
Hypertension	82 (23.4)	68 (19.4)	0.098
Ischemic heart disease	12 (3.4)	11 (3.1)	0.016
Liver cirrhosis	1 (0.3)	2 (0.6)	0.044
Chronic hepatitis	6 (1.7)	7 (2.0)	0.021
Peptic ulcer	5 (1.4)	5 (1.4)	<0.001
Inflammatory bowel disease	3 (0.9)	1 (0.3)	0.076
Diabetes mellitus	29 (8.3)	26 (7.4)	0.032
Stroke	7 (2.0)	7 (2.0)	<0.001
Psychiatric disease	43 (12.3)	53 (15.1)	0.083
Dementia	15 (4.3)	16 (4.6)	0.014
Malignancies	6 (1.7)	7 (2.0)	0.021
Hematological diseases	0 (0.0)	0 (0.0)	<0.001
Chronic renal failure or HD	7 (2.0)	6 (1.7)	0.021
Immunosuppressant use	2 (0.6)	2 (0.6)	<0.001
Anticoagulant use	6 (1.7)	4 (1.1)	0.048
Steroid use	0 (0.0)	1 (0.3)	0.076
Pregnancy	0 (0.0)	0 (0.0)	<0.001

authors did not account for prehospital sBP because of considerable missing data. Some studies[5–7] have reported that prehospital IV fluid administration did not affect the outcomes. In contrast, other studies[8,9] indicated that prehospital IV fluid administration worsened trauma patients' outcomes. A possible explanation of the infusion at prehospital scene resulting in an adverse effect could be the unadjusted baseline characteristics of the patients.

Sub-analysis of ambulance without physician group was performed to eliminate bias of administering other treatments because of physicians' intervention. Subgroup analysis of population transported by helicopter or ambulance with physician suggested that mortality was not affected by prehospital IV access, and securing prehospital IV did not prolong prehospital time (Table 5). From this sub-analysis, securing prehospital IV route might delay hospital arrival when transported by EMS crew only because of some factors (skill levels or lack of human resources). Furthermore, some effects of physician intervention, other than prehospital IV access, might increase sBP on arrival.

Securing IV access in a prehospital setting has some potential benefits. First, it enables prehospital fluid administration to increase blood pressure by increasing the circulating blood volume and preload to help maintain appropriate tissue perfusion. In this study, securing prehospital IV route tended to increase sBP on arrival in the main analysis and in patients with suspected hemorrhagic shock. Second, securing IV access provides an avenue to administer drugs in the early phase after injury. Administering drugs (e.g., tranexamic acid) in the prehospital setting was shown as beneficial.[17,18] It might have resulted in sBP increase on arrival in those transported with a physician. Third, the prehospital IV route enables prehospital blood transfusions and was reported as beneficial.[19–22] Contrariwise, securing IV access requires time and may lead to delayed hospital arrival.[5,23] This study also showed that prehospital IV access by only EMS crew or in patients with hemorrhagic shock prolonged prehospital time in IV (+) group than in IV (−) group.

Considering the potential benefits and tolerable risk profile of prehospital IV access, the benefits of prehospital IV access should be explored further, albeit our analysis failed to show significant benefit on outcomes. Given the new resuscitation guidelines for trauma patients, permissive hypotension and restricted fluid resuscitation were proposed.[24–26] Further studies to identify optimal prehospital fluid resuscitation protocols are warranted.

Table 4. Baseline characteristics of matched patients in the sensitivity analysis using the dataset without overlapped variables

Variables	Before Matching			After Matching		
	IV (−) group *n* = 5454	IV (+) group *n* = 503	SMD	IV (−) group *n* = 491	IV (+) group *n* = 491	SMD
Age, year	56.96 [20.03]	56.47 [19.94]	0.024	56.21 [20.17]	56.44 [20.00]	0.011
Gender, male (%)	3634 (66.6)	359 (71.4)	0.103	343 (69.9)	350 (71.3)	0.021
Mechanism of injury (%)						
Traffic-related	2037 (37.3)	246 (48.9)	0.295	251 (51.1)	240 (48.9)	0.067
Fall	2416 (44.3)	153 (30.4)		136 (27.7)	151 (30.8)	
Other	1001 (18.4)	104 (20.7)		104 (21.2)	100 (20.4)	
Cause of injury (%)						
Accidents	4042 (74.1)	359 (71.4)	0.179	357 (72.7)	352 (71.7)	0.055
Assault	148 (2.7)	10 (2.0)		13 (2.6)	10 (2.0)	
Suicide	939 (17.2)	80 (15.9)		76 (15.5)	79 (16.1)	
Other	325 (6.0)	54 (10.7)		45 (9.2)	50 (10.2)	
Transporter type (%)						
Ambulance	4988 (91.5)	264 (52.5)	0.972	266 (54.2)	264 (53.8)	0.021
Ambulance with physician	155 (2.8)	96 (19.1)		91 (18.5)	95 (19.3)	
Helicopter with physician	301 (5.5)	143 (28.4)		134 (27.3)	132 (26.9)	
Other	10 (0.2)	0 (0.0)		0 (0.0)	0 (0.0)	
Prehospital vital signs						
Japan Coma Scale (%)						
Clear	1475 (27.0)	93 (18.5)	0.255	77 (15.7)	92 (18.7)	0.096
1–3	2196 (40.3)	192 (38.2)		199 (40.5)	187 (38.1)	
10–30	871 (16.0)	101 (20.1)		94 (19.1)	100 (20.4)	
100–300	912 (16.7)	117 (23.3)		121 (24.6)	112 (22.8)	
Systolic blood pressure (mm Hg)	77.23 [8.71]	75.78 [9.40]	0.159	75.45 [9.37]	75.85 [9.37]	0.043
Respiratory rate (%)						
0–5	15 (0.3)	4 (0.8)	0.302	2 (0.4)	3 (0.6)	0.057
6–9	15 (0.3)	3 (0.6)		3 (0.6)	3 (0.6)	
10–29	4330 (79.4)	333 (66.2)		337 (68.6)	325 (66.2)	
≥30	1094 (20.0)	163 (32.4)		149 (30.3)	160 (32.6)	
Pulse rate (%)						
0–59	607 (11.1)	56 (11.1)	0.181	56 (11.4)	54 (11.0)	0.015
60–100	3420 (62.7)	275 (54.7)		269 (54.8)	272 (55.4)	
>100	1427 (26.2)	172 (34.2)		166 (33.8)	165 (33.6)	
Temperature (°C)	35.92 [1.19]	35.89 [1.22]	0.022	35.87 [1.30]	35.89 [1.23]	0.015
Response time (min)	8.61 [16.38]	10.15 [7.27]	0.121	9.48 [11.37]	10.03 [7.14]	0.058
Abbreviated Injury Scale						
Head	0.99 [1.62]	1.17 [1.76]	0.102	1.23 [1.73]	1.18 [1.76]	0.030
Face	0.28 [0.66]	0.28 [0.68]	0.003	0.28 [0.67]	0.28 [0.68]	0.015
Neck	0.08 [0.42]	0.12 [0.57]	0.092	0.09 [0.47]	0.12 [0.58]	0.058
Thorax	1.30 [1.78]	1.66 [1.91]	0.193	1.65 [1.93]	1.67 [1.92]	0.013
Abdomen and pelvis	0.62 [1.26]	0.96 [1.60]	0.241	0.95 [1.53]	0.91 [1.54]	0.024
Spine	1.10 [1.66]	1.09 [1.62]	0.003	0.96 [1.51]	1.08 [1.61]	0.077
Upper extremity	0.62 [1.02]	0.57 [0.99]	0.050	0.63 [1.03]	0.59 [1.00]	0.040
Lower extremity	1.20 [1.55]	1.47 [1.68]	0.168	1.42 [1.63]	1.45 [1.67]	0.021
Body surface	0.04 [0.21]	0.05 [0.22]	0.038	0.07 [0.27]	0.05 [0.22]	0.058
Comorbidities (%)						
Asthma	131 (2.4)	17 (3.4)	0.058	17 (3.5)	16 (3.3)	0.011
COPD	46 (0.8)	2 (0.4)	0.057	2 (0.4)	2 (0.4)	<0.001
Other chronic lung disease	43 (0.8)	4 (0.8)	0.001	3 (0.6)	4 (0.8)	0.024

Table 4. (Continued)

Variables	Before Matching			After Matching		
	IV (−) group *n* = 5454	IV (+) group *n* = 503	SMD	IV (−) group *n* = 491	IV (+) group *n* = 491	SMD
Heart failure	91 (1.7)	5 (1.0)	0.059	4 (0.8)	4 (0.8)	<0.001
Hypertension	1041 (19.1)	108 (21.5)	0.059	114 (23.2)	104 (21.2)	0.049
Ischemic heart disease	165 (3.0)	20 (4.0)	0.052	15 (3.1)	19 (3.9)	0.045
Liver cirrhosis	57 (1.0)	3 (0.6)	0.050	6 (1.2)	3 (0.6)	0.064
Chronic hepatitis	86 (1.6)	12 (2.4)	0.058	11 (2.2)	10 (2.0)	0.014
Peptic ulcer	94 (1.7)	7 (1.4)	0.027	6 (1.2)	7 (1.4)	0.018
Inflammatory bowel disease	28 (0.5)	5 (1.0)	0.056	6 (1.2)	4 (0.8)	0.041
Diabetes mellitus	451 (8.3)	40 (8.0)	0.012	43 (8.8)	39 (7.9)	0.029
Stroke	208 (3.8)	12 (2.4)	0.082	19 (3.9)	12 (2.4)	0.082
Psychiatric disease	737 (13.5)	75 (14.9)	0.040	72 (14.7)	73 (14.9)	0.006
Dementia	206 (3.8)	23 (4.6)	0.040	28 (5.7)	22 (4.5)	0.056
Malignancies	158 (2.9)	8 (1.6)	0.088	12 (2.4)	7 (1.4)	0.074
Hematological diseases	13 (0.2)	1 (0.2)	0.008	0 (0.0)	1 (0.2)	0.064
Chronic renal failure or HD	62 (1.1)	7 (1.4)	0.023	7 (1.4)	6 (1.3)	0.018
Immunosuppressant use	8 (0.1)	3 (0.6)	0.074	2 (0.4)	2 (0.4)	<0.001
Anticoagulant use	86 (1.6)	7 (1.4)	0.015	6 (1.2)	7 (1.4)	0.018
Steroid use	15 (0.3)	1 (0.2)	0.016	1 (0.2)	1 (0.2)	<0.001
Pregnancy	5 (0.1)	1 (0.2)	0.028	0 (0.0)	1 (0.2)	0.064

Table 5. The outcomes of the sub-analyses according to the groups divided by the cohort's transportation approach

Variables	IV (+) group	IV (−) group	Difference (95% CI)
Transported by ambulance without physician (*n* = 529)	260	269	
72-h mortality, *n* (%)	13 (5.1%)	21 (7.9%)	−2.8 (−7.0–1.5)
28-day mortality, *n* (%)	22 (8.6%)	29 (10.9%)	−2.3 (−7.4–2.8)
Systolic blood pressure on arrival, mean (mm Hg) [±SD]	100.3 [±30.9]	98.6 [±32.2]	1.7 (−3.7–7.1)
Blood transfusion within 24 h, *n* (%)	131 (50.4%)	115 (42.8%)	7.6 (−0.9–16.1)
Prehospital time, mean (min) [±SD]	51.7 [±22.8]	44.4 [±21.8]	7.3 (3.5–11.1)
Cardiopulmonary arrest on arrival, *n* (%)	4 (1.5%)	4 (1.5%)	0.0 (−2.0–2.0)
Transported by helicopter or ambulance with physician (*n* = 429)	219	210	
72-h mortality, *n* (%)	24 (11.1%)	21 (10.0%)	1.0 (−4.9–6.9)
28-day mortality, *n* (%)	34 (15.7%)	25 (12.0%)	3.7 (−2.9–10.3)
Systolic blood pressure on arrival, mean (mm Hg) [±SD]	109.9 [±37.5]	102.2 [±31.9]	7.7 (1.0–14.3)
Blood transfusion within 24 h, *n* (%)	134 (61.2%)	120 (57.1%)	4.0 (−5.3–13.4)
Prehospital time, mean (min) [±SD]	61.8 [±24.2]	64.5 [±72.8]	-2.6 (−13.0–7.6)
Cardiopulmonary arrest on arrival, *n* (%)	2 (0.9)	2 (1.0)	0.0 (−1.9–1.8)

The strengths of our study were the use of a comprehensive nationwide dataset and propensity score-matched analysis. Our well-balanced matched cohorts minimized the potential for bias. The sensitivity analysis results were consistent with those of the main analysis, indicating the robustness of our results.

Table 6. The outcomes of the sub-analysis according to the group that received blood transfusion within 24 h (n = 500)

Variables *n*	IV (+) group 265	IV (−) group 235	Difference (95% CI)
72-h mortality, *n* (%)	26 (10.0%)	28 (11.9%)	−2.0 (−7.5–3.6)
28-day mortality, *n* (%)	40 (15.3%)	37 (15.7%)	−0.4 (−6.8–6.0)
Systolic blood pressure on arrival, mean (mm Hg) [±SD]	101.1 [±36.3]	93.0 [±31.1]	8.1 (2.1–14.1)
Prehospital time, mean (min) [±SD]	57.2 [±24.7]	51.5 [±26.2]	5.7 (1.2–10.2)
Cardiopulmonary arrest on arrival, *n* (%)	2 (0.8%)	1 (0.4%)	0.3 (−1.0–1.7)

Limitations

This study has several limitations. First, data regarding amount of fluid administered, history of prehospital administration of any drugs, and cause of shock, are unavailable in JTDB. Therefore, we could not identify how securing the IV route in prehospital setting affected outcomes. Although we mentioned that administering tranexamic acid and blood transfusion are the potential benefits of securing early IV access, details of these are unavailable in JTDB; therefore, a major limitation of this study. Second, we rigorously adjusted for potential confounders using propensity score matching; however, residual confounders may remain to still bias our results. Third, the sample size may be a reason for the insignificant results of our study.

CONCLUSIONS

WE DID NOT find a significant effect of securing IV access in patients with traumatic shock on their outcome.

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DISCLOSURES

APPROVAL OF THE Research Protocol: The protocol for this research project has been approved by the medical ethics committee of Juntendo University Shizuoka Hospital, and it conforms to the provisions of the Declaration of Helsinki. (No. 807).

Informed Consent: The need for informed consent was waived by the ethics committee because the data were collected from existing patient records and were anonymized to protect the confidentiality of patients' information.

Conflict of Interest: None declared.

DATA AVAILABILITY STATEMENT

THE AUTHORS ARE not authorized to distribute datasets used in the current study.

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