Effectiveness of Physician-Led Prehospital Management in Severe Trauma Patients: A Retrospective Analysis of the Japanese Nationwide Trauma Registry

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Abstract

Background: The comparative effectiveness of physician-led over paramedic-led prehospital trauma management has been inconclusive. Regarding this topic, in some previous studies, the impacts of physician-led prehospital management were affected by the advantage of shortened prehospital time by helicopter transportation. This study aimed to evaluate the effect of physician-led prehospital management independent of prehospital time.

Methods: This retrospective cohort study analyzed the data of severe trauma patients who were transported directly to a hospital during 2009–2018 using Japan's nationwide trauma registry. In-hospital mortality was compared between patients who received physician-led prehospital management and those who received paramedic-led management, using 1:4 propensity score-matched analysis. The propensity score was calculated using information on patient demographics, mechanism of injury, and vital signs at the scene of injury, as well as prehospital transport time. Subgroup analysis was performed to identify patients who were most likely to benefit from physician-led prehospital management.

Results: A total of 30,968 patients (physician-led: 3,032, paramedic-led: 27,936) were eligible for analysis, of whom 2,766 propensity score-matched pairs (i.e., physician-led: 2766, paramedic-led: 11,064) were generated and compared. Physician-led pre-hospital trauma management showed significant superiority over paramedic-led prehospital trauma management (in-hospital mortality: 395 [14.3%] and 1785 [16.1%], respectively; odds ratio [95% confidence interval] = 0.87 [0.77–0.97], $p = 0.017$). In subgroup analysis, cases characterized by patient age <65 years, Injury Severity Score ≥25, Abbreviated Injury Scale in pelvis and lower extremities ≥3, and prehospital transport time <60 min likely benefitted from physician-led prehospital management.

Conclusions: The result of a largescale registry-based cohort study showed that physician-led prehospital trauma management was significantly associated with survival benefit independent of prehospital transport time. The findings may provide a basis for future research to assess effective physician-provided treatments in prehospital-field.

Background

As the scope of medical interventions that paramedics can perform are generally limited compared to that of physicians, physician-led prehospital management is expected to improve survival outcomes in severe trauma patients. However, the effect of physician-led over paramedic-led prehospital management in severe trauma patients has been debatable. Although some randomized controlled trials[1, 2] and cohort studies[3–5] suggested beneficial effects of physician-led prehospital trauma management, a recent systematic review concluded that evidence of the superiority of physician-led over paramedic-led prehospital management in severe trauma patients is insufficient because of the limited number of studies with high methodological quality.[6] Notably, some studies evaluating this topic included helicopter emergency medical service (HEMS) with physicians, which had two major advantages:

prehospital physician-led management itself and the shortened prehospital transport time. Another systematic review[7] reported that, although physician-led prehospital trauma management was associated with lower mortality, the benefit disappeared after excluding helicopter transport as a confounder.

As longer prehospital transport time has been reported to be associated with higher mortality rates,[8] it would be important to evaluate the benefit of physician-led trauma management independent of prehospital transport time for establishing optimal dispatch criteria for prehospital physician teams. However, studies evaluating the independent effect of physician-led trauma management, in which prehospital transport time was considered, have been scarce.

The aim of the present study was to evaluate the effect of physician-led prehospital trauma management on patient mortality considering the effect of time requiring patient transport. In addition, in subgroup analyses, we examined the characteristics of patients who were most likely to benefit from physician-led prehospital management itself.

Methods

Study design and setting

We conducted a nationwide registry-based retrospective cohort study, wherein we analyzed data from the Japan Trauma Data Bank (JTDB) between fiscal years 2009 and 2018. The JTDB was established in 2003, and it is overseen and maintained by the Japanese Association for the Surgery of Trauma and Japanese Association for Acute Medicine. The details of all trauma patients who suffered a severe injury at any region of the body, with an abbreviated injury scale (AIS) score of ≥ 3, were registered in the JTDB. During the study period, the JTDB received records from approximately 280 hospitals, including almost all government-approved tertiary emergency hospitals in the country. The database includes information on injury mechanisms, prehospital time (including the paramedic dispatch time, physician contact time, and hospital arrival time), patient baseline characteristics (including vital signs at the scene of injury and upon arriving at an emergency department [ED]), procedures performed, and survival status at hospital discharge.

In Japan, the operation of prehospital physician teams, such as dispatch criteria and operating time), varies according to the medical control area. The coverage area also varies largely depending on whether it is an urban or rural area. The physicians are delivered in a car or a helicopter according to the system of the medical control area. They are not always trauma surgeons but are those usually working at an ED and trained to provide basic prehospital trauma management such as assessment with sonography, tracheal intubation, chest drainage, intraosseous infusion, and temporal hemostatic maneuver using a tourniquet. Regarding fluid resuscitation, prehospital blood transfusion is not common in Japan, and only the administration of the crystalloid solution is provided in many cases.

This study complied with the principles of the 1964 Helsinki Declaration and its later amendments. The Ethics Committee of Tokyo Medical and Dental University approved this study (#2192). The requirement for informed consent from each patient was waived because of the study's retrospective design and the use of anonymized patient data.

Study population

Patients who met all of the following criteria were included: (1) patients who suffered injuries of Injury Severity Score (ISS) ≥ 16, (2) patients who were transferred directly from the scene of injury, and (3) patients whose specific information regarding times of injury, physician contact, and hospital arrival were available. We excluded patients from the analysis if they met at least one of the following criteria: (1) cardiac arrest at the scene of injury, (2) unsalvageable injury defined as AIS = 6, (3) missing data required for analyses, and (4) unrealistic or outlier values on prehospital time course. Outlier values on prehospital time course were determined using robust regression analysis in which time of injury, physician contact time, and hospital arrival time were accounted for.

Data collection

We collected information on the following items from the JTDB: age; sex; mechanism of injury; type of injury (i.e., blunt or penetrating); year, season, and time of injury; time of physician contact; time of hospital arrival; systolic blood pressure, heart rate, and respiratory rate at the scene of injury, consciousness level at the scene of injury (recorded using the Japan Coma Scale[9]); The highest score of AIS values for each region of the body; ISS; and patient survival status at hospital discharge.

Definition and outcome

We identified patients with physician-led prehospital management by comparing time of physician contact and time of hospital arrival. Eligible patients were divided into the physician-led prehospital management group (physician-led group) and the paramedic-led prehospital management group (paramedic-led group). Season of injury was divided into four categories by quarter, beginning in January. Time of injury was divided into four zones every 6 hours, beginning at 0:00. The study outcome was in-hospital mortality.

Statistical analysis

Considering the heterogeneity of trauma patients between the physician-led group and the paramedic-led group, we used a propensity score matching analysis[10] to compare the outcome between the two groups. In this analysis, a logistic regression model was applied to estimate the propensity score for each patient, predicting physician-led prehospital management based on age, sex, mechanism of injury, type of injury, year of injury, systolic blood pressure and respiratory rate at the scene of injury, consciousness level at the scene of injury, and ISS, in addition to prehospital transport time (from injury onset to hospital arrival). Considering the differences in staffing according to working hours and in road conditions according to season, both time and season categories of injury were incorporated into the model. These variables were chosen based on the clinical perspective, and the predictive accuracy of these variables for in-hospital mortality was assessed using C-statistics. Propensity score matching extracted 1:4 matched pairs from the physician-led and paramedic-led groups; this ratio was determined based on the feasibility of match balance and maximum use of patient data. Match balance between the groups was assessed by the absolute standardized mean difference (ASMD); values < 0.1 were considered acceptable. The caliper width was set as the standard deviation of the logit-transformed propensity score multiplied by 0.1 to achieve well-matched balance between the two groups. The chi-square test was used for intergroup comparison in the propensity score-matched cohort. The effectiveness of physician-led prehospital management was also evaluated in a sensitivity analysis in an overall study cohort (i.e., not the propensity score-matched cohort) using a multivariate logistic regression model. In this model, the aforementioned variables used in the propensity score calculation were used as the covariates. Multicollinearity was assessed by the variance inflation factor, with the tolerance value set at < 2.

Subgroup analysis was performed in the propensity score–matched cohort to assess potential candidates who would benefit from physician-led prehospital management. We evaluated the *p* values for the interaction of the following dichotomized categories for the study outcome: age (< 65 *vs.* ≥65); sex (male *vs.* female); type of injury (blunt *vs.* penetrating); blood pressure at the scene of injury (< 90 mmHg *vs.* ≥90 mmHg); shock index defined by the heart rate/systolic blood pressure ratio (< 1 *vs.* ≥1); presence or absence of coma (defined by Japan Coma Scale > 30 at the scene of injury); the highest AIS scores on the head, chest, abdomen, and pelvis and lower extremities (< 3 *vs.* ≥3); ISS (< 25 *vs.* ≥25); and the time lapse between the time of injury and the time of hospital arrival (< 60 min vs. ≥60 min).

Descriptive statistics were reported as counts and percentages for categorical variables and medians and the 25th – 75th percentiles for numeric or ordered variables. Predictive statistics were reported as odds ratios (ORs) and 95% confidence intervals (CIs). The level of significance was defined as two-sided $p < 0.05$ for all statistical analyses. All analyses were performed using R 3.5.3 (R Foundation for Statistical Computing, Vienna, Austria).

Results

A flow diagram of the patient selection process is presented in Fig. 1. A total of 30,968 patients were eligible for analysis based on the inclusion and exclusion criteria. Of them, 3,032 patients (9.8%) received physician-led prehospital management. Physician-led prehospital management was more likely to be provided during daytime (between 6:00 and 17:59) than during nighttime. Median ISS (25th, 75th percentiles) was 25 (18, 32) in the physician-led group and 21 (17, 27) in the paramedic-led group, suggesting that patients in the physician-led group suffered more severe injuries than those in the paramedic-led group. The time lapse from the time of injury to physician contact was shorter in the physician-led group than in the paramedic-led group (median [25th, 75th percentiles] = 40 [30, 55] min and 46 [35, 61] min, respectively); however, the delay between the time of injury and hospital arrival was greater in the physician-led group than in the paramedic-led group (median [25th, 75th percentiles] = 56 [42, 73] min and 44 [34, 58] min, respectively). In-hospital mortality was observed in 460 (15.2%) patients in the physician-led group and in 3,417 (12.2%) patients in the paramedic-led group. Baseline characteristics of the overall study cohort are summarized in Table 1.

Table 1
Baseline characteristics of the overall study cohort

Variables	Physician-led group (n = 3,032)	Paramedic-led group (n = 27,936)	ASMD
Age, years, median (IQR)	62 (42, 74)	63 (43, 75)	0.012
Females, n (%)	876 (28.9)	8,194 (29.3)	0.010
Year of injury, n (%)			0.135
2009	121 (4.0)	1,357 (4.9)	
2010	163 (5.4)	1,659 (5.9)	
2011	199 (6.6)	2,193 (7.9)	
2012	303 (10.0)	2,672 (9.6)	
2013	322 (10.6)	3,054 (10.9)	
2014	388 (12.8)	3,216 (11.5)	
2015	396 (13.1)	3,525 (12.6)	
2016	422 (13.9)	3,111 (11.1)	
2017	370 (12.2)	3,228 (11.6)	
2018	348 (11.5)	3,921 (12.5)	
Season of injury, n (%)			0.050
January–March	662 (21.8)	6,463 (23.1)	
April–June	746 (24.6)	6,583 (23.6)	
July–September	794 (26.2)	6,922 (24.8)	
October–December	830 (27.4)	7,968 (28.5)	
Time of injury, n (%)			0.334
0:00–5:59	253 (8.3)	4,117 (14.7)	
6:00–11:59	1,164 (38.4)	8,466 (30.3)	
12:00–17:59	1,163 (38.4)	8,747 (31.3)	
18:00–23:59	452 (14.9)	6,606 (23.6)	
Mechanism of injury, n (%)			0.305
Traffic accident (driver)	806 (26.6)	6,619 (23.7)	

Variables	Physician-led group (n = 3,032)	Paramedic-led group (n = 27,936)	ASMD
Traffic accident (passenger)	151 (5.0)	1,052 (3.8)	
Traffic accident (pedestrian or bicycle)	688 (22.7)	6,493 (23.2)	
Fall from height	526 (17.3)	3,479 (12.5)	
Ground-level falls	557 (18.4)	8,385 (30.0)	
Others	304 (10.0)	1,908 (6.8)	
Type of injury, n (%)			0.047
Blunt	2,976 (98.2)	27,583 (98.7)	
Penetrating	56 (1.8)	353 (1.3)	
Vital signs at the scene of injury, median (IQR)			
Systolic blood pressure, mmHg	132 [110, 159]	135 [112, 160]	0.056
Heart rate, beats/min	84 [72, 100]	84 [72, 98]	0.071
Respiratory rate, breaths/min	24 [19, 28]	20 [18, 24]	0.167
Japan Coma Scale at the scene of injury, n (%)			0.224
0 (alert)	790 (26.1)	7,973 (28.5)	
1	538 (17.7)	5,477 (19.6)	
2	250 (8.2)	3,501 (12.5)	
3	232 (7.7)	2,312 (8.3)	
10	302 (10.0)	2,025 (7.2)	
20	63 (2.1)	595 (2.1)	
30	102 (3.4)	685 (2.5)	
100	179 (5.9)	1,381 (4.9)	
200	197 (6.5)	1,478 (5.3)	
300 (deep coma)	379 (12.5)	2,509 (9.0)	
The highest score of AIS, median (IQR)			
Head	3 [0, 4]	3 [0, 4]	0.013

Variables	Physician-led group (n = 3,032)	Paramedic-led group (n = 27,936)	ASMD
Face	0 [0, 0]	0 [0, 0]	0.04
Neck	0 [0, 0]	0 [0, 0]	0.026
Chest	3 [0, 4]	0 [0, 3]	0.248
Abdomen	0 [0, 0]	0 [0, 0]	0.125
Spine	0 [0, 2]	0 [0, 2]	0.023
Upper extremities	0 [0, 2]	0 [0, 1]	0.121
Pelvis and lower extremities	0 [0, 2]	0 [0, 2]	0.163
Surface	0 [0, 0]	0 [0, 0]	0.017
ISS, median (IQR)	25 [18, 32]	21 [17, 27]	0.274
Prehospital time-course, min, median (IQR)			
Injury to physician contact	40 [30, 55]	46 [35, 61]	0.331
Injury to ED arrival	56 [42, 73]	44 [34, 58]	0.471
Transporter			1.742
Air ambulance	979 (32.3)	1,451 (5.2)	
Ground ambulance	2,053 (67.7)	26,453 (94.7)	
Others	0 (0)	32 (0.1)	
Intubation in the prehospital settings, n (%)	249 (8.3)	253 (0.9)	0.357
Abbreviations: ASMD, absolute standardized mean difference; IQR, interquartile range; AIS, abbreviated injury scale; ISS, injury severity score; ED, emergency department.			

The variables used for propensity score estimation had high accuracy for predicting in-hospital mortality with C-statistics of 0.87. Via the matching process, a total of 2,766 propensity score-matched pairs (2,766 and 11,064 patients per physician-led group and paramedic-led group, respectively) were generated. All the ASMD values of the adjusted variables for the severity adjustment were < 0.1, indicating a well-matched balance (Table 2). Time lapse from the time of injury to physician contact was shorter in the physician-led group than in the paramedic-led group (median [25th, 75th percentiles] = 39 [30, 53] min and 53 [39, 73] min, respectively). In-hospital mortality was observed in 395 (14.3%) patients in the physician-led group and in 1,785 (16.1%) patients in the paramedic-led group. A significantly reduced in-hospital mortality rate was observed in the physician-led group in the propensity score-matched population (OR =

0.87, 95% CI, 0.77–0.97; $p = 0.017$). In the sensitivity analysis conducted with the overall study population using logistic regression analysis, the variance inflation factors for all the variables were less than 2, which eliminated the issue of multicollinearity in the model. The result also showed the significant association between physician-led prehospital treatment and reduced in-hospital mortality (adjusted OR = 0.86, 95% CI, 0.75–0.98; $p = 0.021$).

Table 2
Baseline characteristics of the propensity score-matched cohort

Variables	Physician-led group (n = 2,766)	Paramedic-led group (n = 11,064)	ASMD
Age, years old, median (IQR)	62 (41, 74)	62 (42, 75)	0.011
Females, n (%)	794 (28.7)	3,271 (29.6)	0.019
Year of injury, n (%)			0.095
2009	121 (4.4)	444 (4.0)	
2010	162 (5.9)	595 (5.4)	
2011	199 (7.2)	738 (6.7)	
2012	303 (11.0)	1,115 (10.1)	
2013	320 (11.6)	1,217 (11.0)	
2014	376 (13.6)	1,385 (12.5)	
2015	367 (13.3)	1,433 (13.0)	
2016	340 (12.3)	1,469 (13.3)	
2017	291 (10.5)	1,333 (12.0)	
2018	287 (10.3)	1,335 (12.0)	
Season of injury, n (%)			0.008
January–March	610 (22.1)	2,459 (22.2)	
April–June	671 (24.3)	2,693 (24.3)	
July–September	725 (26.2)	2,911 (26.3)	
October–December	760 (27.5)	3,001 (27.1)	
Time of injury, n (%)			0.013
0:00–5:59	248 (9.0)	1,018 (9.2)	
6:00–11:59	1,037 (37.5)	4,106 (37.1)	
12:00–17:59	1,040 (37.6)	4,144 (37.5)	
18:00–23:59	441 (15.9)	1,796 (16.2)	
Mechanism of injury, n (%)			0.037
Traffic accident (driver)	721 (26.1)	2,867 (25.9)	

Variables	Physician-led group (n = 2,766)	Paramedic-led group (n = 11,064)	ASMD
Traffic accident (passenger)	129 (4.7)	549 (5.0)	
Traffic accident (pedestrian or bicycle)	640 (23.1)	2,532 (22.9)	
Fall from height	460 (16.6)	1,890 (17.1)	
Ground-level falls	546 (19.7)	2,246 (20.3)	
Others	270 (9.8)	980 (8.9)	
Type of injury, n (%)			0.016
Blunt	2,715 (98.2)	10,883 (98.4)	
Penetrating	51 (1.8)	181 (1.6)	
Vital signs at the scene of injury, median (IQR)			
Systolic blood pressure, mmHg	133 [111, 159]	134 [110, 158]	0.008
Heart rate, beats/min	84 [71, 100]	84 [72, 100]	0.006
Respiratory rate, breaths/min	24 [18, 27]	24 [18, 26]	0.006
Japan Coma Scale at the scene of injury, n (%)			0.025
0 (alert)	740 (26.8)	2,906 (26.3)	
1	505 (18.3)	1,987 (18.0)	
2	242 (8.7)	976 (8.8)	
3	220 (8.0)	895 (8.1)	
10	263 (9.5)	1,031 (9.3)	
20	58 (2.1)	249 (2.3)	
30	88 (3.2)	342 (3.1)	
100	159 (5.7)	655 (5.9)	
200	181 (6.5)	723 (6.5)	
300 (deep coma)	310 (11.2)	1,300 (11.7)	
The highest score of AIS, median (IQR)			
Head*	3 (0, 4)	3 (0, 4)	0.044

Variables	Physician-led group (n = 2,766)	Paramedic-led group (n = 11,064)	ASMD
Face*	0 (0, 0)	0 (0, 0)	0.016
Neck*	0 (0, 0)	0 (0, 0)	0.019
Chest*	3 (0, 4)	2 (0, 4)	0.056
Abdomen*	0 (0, 0)	0 (0, 0)	0.034
Spine*	0 (0, 2)	0 (0, 2)	0.009
Upper extremities*	0 (0, 2)	0 (0, 2)	0.046
Pelvis and lower extremities*	0 (0, 2)	0 (0, 2)	0.043
Surface*	0 (0, 0)	0 (0, 0)	0.004
ISS, median (IQR)	24 [17, 29]	25 [17, 29]	0.021
Prehospital time-course, min, median (IQR)			
Injury to physician contact*	39 [30, 53]	53 [39, 73]	0.714
Injury to ED arrival	54 [41, 69]	51 [38, 70]	< 0.001
Transporter			1.502
Air ambulance*	847 (30.6)	1,059 (9.6)	
Ground ambulance*	1,919 (69.4)	9,989 (90.3)	
Others*	0 (0)	16 (0.1)	
Intubation in the prehospital settings*, n (%)	199 (7.3)	192 (1.8)	0.267

*These variables were not included in the model for propensity score estimation.

Abbreviations: ASMD, absolute standardized mean difference; IQR, interquartile range; AIS, abbreviated injury scale; ISS, injury severity score; ED, emergency department.

The results of subgroup analysis are summarized in Fig. 2. Patient who had age < 65 years, severe injuries with ISS ≥ 25, injury with AIS ≥ 3 in the pelvis or lower extremities, and total transportation time < 60 min likely benefited from physician-led prehospital management.

Discussion

The present study evaluated the independent effect of physician-led prehospital trauma care by including a larger number of patients than that included in previous studies and by considering prehospital time.

The results demonstrated the independent survival benefit of physician-led prehospital trauma care. Furthermore, subgroup analysis revealed the specific subpopulations that might be likely to benefit from physician-led prehospital management. These findings could provide additional insights into the topic of prehospital trauma care, because some previous studies showing the superiority of physician-led prehospital trauma management would have been largely benefitted by the advantages of shortened prehospital transport time by HEMS[11, 12] in addition to the independent effect of physician-led prehospital care.

Several theoretical advantages of physician-led over paramedic-led prehospital management of severe trauma cases should be considered. First, physicians can provide a broader scope of surgical and medical interventions. Although medical interventions that paramedics are permitted vary depending on the country or area, the scope of their role tends to be limited compared to that of physicians. In Japan, paramedics responding to trauma patients without cardiac arrest are limited to performing spinal motion restriction, external fixation of bone fractures, oxygen administration using a mask, and administration of Ringer's solution (only to patients with shock). Second, physicians' interventions were reported to have a higher rate of success than those performed by paramedics; for example, a previous study showed a higher rate of achieving successful advanced airway management,[13–15] which prevents secondary brain injury, in physicians than in paramedics.[16] Third, physicians can make precise and flexible clinical decisions following the latest trauma management strategy rather than uniform simplified management, such as introduction of restrictive fluid management based on strategic permissive hypotension.[17]

Because the JTDB lacks detailed information on the treatments provided by physicians in prehospital settings, specific interventions contributing to survival benefit could not be mentioned in the present study. However, the results of the subgroup analysis in the present study suggested the candidates who were more likely to benefit from physician-led prehospital management. Patients younger than 65 years old were likely to receive survival benefit than patients aged ≥ 65 years. A previous study assessing the characteristics of geriatric trauma patients reported a positive linear relationship between age and mortality risk,[18] suggesting that the effects of any treatment might be smaller in older patients. Furthermore, similar to the previous study showing the effectiveness of physician-led prehospital management especially in severe trauma patients,[19, 20] our data suggested that patients with ISS ≥ 25 were likely to benefit from physician-led prehospital management than patients with ISS < 25. Interestingly, patients who suffered severe injury in the pelvis or lower extremities were more likely to benefit from physician-led prehospital management than those without severe injury in these regions; however, such an association was not observed in the head, chest, and abdominal trauma. This could be partially explained by the nature of the procedures performed at the scene of injury or during transportation. Interventions that can be provided in the prehospital setting are generally limited to simple procedures; although physicians often can temporarily improve deteriorated vital signs by some effective procedures, including the use of a tourniquet or resuscitative endovascular balloon occlusion of the aorta, they cannot repair multiple and complicated organ injuries anatomically in the prehospital settings. Thus, treatments in prehospital settings might have been provided as bridging therapies until definitive care that can be provided after ED arrival. This hypothesis also could explain the result that total prehospital time had significant interaction in the effectiveness of physician-led prehospital management. That is, prolonged prehospital time might have reduced the effect of physician-led prehospital treatments because of the nature of the bridging therapy. These findings from subgroup analyses would serve as a basis for establishing optimal indication for dispatching physician-led teams to the scene of injury.

There were several limitations to this study that should be acknowledged. Because of the retrospective nature of this study, residual confounding was unavoidable. The number of patients with penetrating injury was limited. Physician dispatch criteria did not follow standardized protocols. Furthermore, detailed information on the treatments delivered by a physician was not available in the JTDB. As medical interventions that paramedics can provide vary depending on countries, the results are not always applicable in some countries. Despite these limitations, to the best of our knowledge, this was the first largescale retrospective cohort study that showed the independent survival benefit of physician-led prehospital trauma management. The results would serve as the basis for further developments to the effective prehospital trauma care system.

Conclusions

This large-scale retrospective cohort study showed a significant association between patient survival and physician-led prehospital trauma management independent of prehospital transport time. Further studies to identify effective interventions in prehospital-field care are necessary.

List Of Abbreviations

AIS, abbreviated injury scale

ASMD, absolute standardized mean difference

CI, confidence interval

ED, emergency department

HEMS, helicopter emergency medical service

ISS, injury severity score

JTDB, Japan Trauma Data Bank

OR, odds ratio

Declarations

Ethics approval and consent to participate

The Ethics Committee of Tokyo Medical and Dental University approved this study (#2192). The requirement for informed consent from each patient was waived because of the study’s retrospective design and the use of anonymized patient data.

Consent for publication

The manuscript does not include individual patient’s data. Therefore, consent is not applicable for this study.

Availability of data and materials

An overview of the Japan Trauma Data Bank (JTDB) is available at http://www.jtcr-jatec.org/traumabank/index.htm. The detailed data in the JTDB that support the findings of this study are available from Japan Trauma Care and Research but restrictions apply to the availability of these data, which were used under license for the current study, and hence are not publicly available.

Competing interests

The authors declare that they have no competing interests.

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Authors’ contributions

AE drafted and revised the manuscript, prepared the study concept and design, and performed statistical analysis and data interpretation as well as accepts responsibility for conduct of research, final approval, and study supervision; MK revised the manuscript, prepared the study concept and design, and performed data interpretation as well as accepts responsibility for conduct of research and final approval; AS performed data acquisition and revised the manuscript as well as accepts responsibility for conduct of research and final approval; YO revised the manuscript and performed data interpretation as well as accepts responsibility for conduct of research and final approval.

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References

1. Baxt WG, Moody P. The impact of a physician as part of the aeromedical prehospital team in patients with blunt trauma. JAMA. 1987;257:3246-50.
2. Garner AA, Mann KP, Fearnside M, Poynter E, Gebski V. The Head Injury Retrieval Trial (HIRT): a single-centre randomised controlled trial of physician prehospital management of severe blunt head injury

compared with management by paramedics only. Emerg Med J. 2015;32:869-75.

3. Pakkanen T, Kämäräinen A, Huhtala H, Silfvast T, Nurmi J, Virkkunen I, et al. Physician-staffed helicopter emergency medical service has a beneficial impact on the incidence of prehospital hypoxia and secured airways on patients with severe traumatic brain injury. Scand J Trauma Resusc Emerg Med. 2017;25:94.
4. Yeguiayan JM, Garrigue D, Binquet C, Jacquot C, Duranteau J, Martin C, et al. Medical pre-hospital management reduces mortality in severe blunt trauma: a prospective epidemiological study. Crit Care. 2011;15:R34.
5. Hirano Y, Abe T, Tanaka H. Efficacy of the presence of an emergency physician in prehospital major trauma care: a nationwide cohort study in Japan. J Emerg Med. 2019;37:1605-10.
6. Wilson SL, Gangathimmaiah V. Does prehospital management by doctors affect outcome in major trauma? A systematic review. J Trauma Acute Care Surg. 2017;83:965-74.
7. Knapp J, Häske D, Böttiger BW, Limacher A, Stalder O, Schmid A, et al. Influence of prehospital physician presence on survival after severe trauma: systematic review and meta-analysis. J Trauma Acute Care Surg. 2019;87:978-89.
8. Gauss T, Ageron FX, Devaud ML, Debaty G, Travers S, Garrigue D, et al. Association of prehospital time to in-hospital trauma mortality in a physician-staffed emergency medicine system. JAMA Surg. 2019;154:1117-24.
9. Shigematsu K, Nakano H, Watanabe Y. The eye response test alone is sufficient to predict stroke outcome – reintroduction of Japan Coma Scale: a cohort study. BMJ Open. 2013;3:e002736.
10. D'Agostino RB Jr. Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. Stat Med. 1998;17:2265-81.
11. Frankema SP, Ringburg AN, Steyerberg EW, Edwards MJR, Schipper IB, van Vugt AB. Beneficial effect of helicopter emergency medical services on survival of severely injured patients. Br J Surg. 2004;91:1520-6.
12. Tsuchiya A, Tsutsumi Y, Yasunaga H. Outcomes after helicopter versus ground emergency medical services for major trauma–propensity score and instrumental variable analyses: a retrospective nationwide cohort study. Scand J Trauma Resusc Emerg Med. 2016;24:140.
13. Bieler D, Franke A, Lefering R, Hentsch S, Willms A, Kulla M, et al. Does the presence of an emergency physician influence pre-hospital time, pre-hospital interventions and the mortality of severely injured patients? A matched-pair analysis based on the trauma registry of the German Trauma Society (TraumaRegister DGU®). Injury. 2017;48:32-40.
14. Franschman G, Verburg N, Brens-Heldens V, Andriessen TMJC, Van der Naalt J, Peerdeman SM, et al. Effects of physician-based emergency medical service dispatch in severe traumatic brain injury on prehospital run time. Injury. 2012;43:1838-42.
15. Pakkanen T, Virkkunen I, Kämäräinen A, Huhtala H, Silfvast T, Virta J, et al. Pre-hospital severe traumatic brain injury –comparison of outcome in paramedic versus physician staffed emergency medical services. Scand J Trauma Resusc Emerg Med. 2016;24:62.

16. Chi JH, Knudson MM, Vassar MJ, McCarthy MC, Shapiro MB, Mallet S, et al. Prehospital hypoxia affects outcome in patients with traumatic brain injury: a prospective multicenter study. J Trauma. 2006;61:1134-41.
17. Garner A, Rashford S, Lee A, Bartolacci R. Addition of physicians to paramedic helicopter services decreases blunt trauma mortality. Aust N Z J Surg. 1999;69:697-701.
18. Kojima M, Endo A, Shiraishi A, Otomo Y. Age-related characteristics and outcomes for patients with severe trauma: Analysis of Japan's Nationwide Trauma Registry. Ann Emerg Med. 2019;73:281-90.
19. Nicholl JP, Brazier JE, Snooks HA. Effects of London helicopter emergency medical service on survival after trauma. BMJ. 1995;311:217-22.
20. Oppe S, De Charro FT. The effect of medical care by a helicopter trauma team on the probability of survival and the quality of life of hospitalised victims. Accid Anal Prev. 2001;33:129-38.

Figures

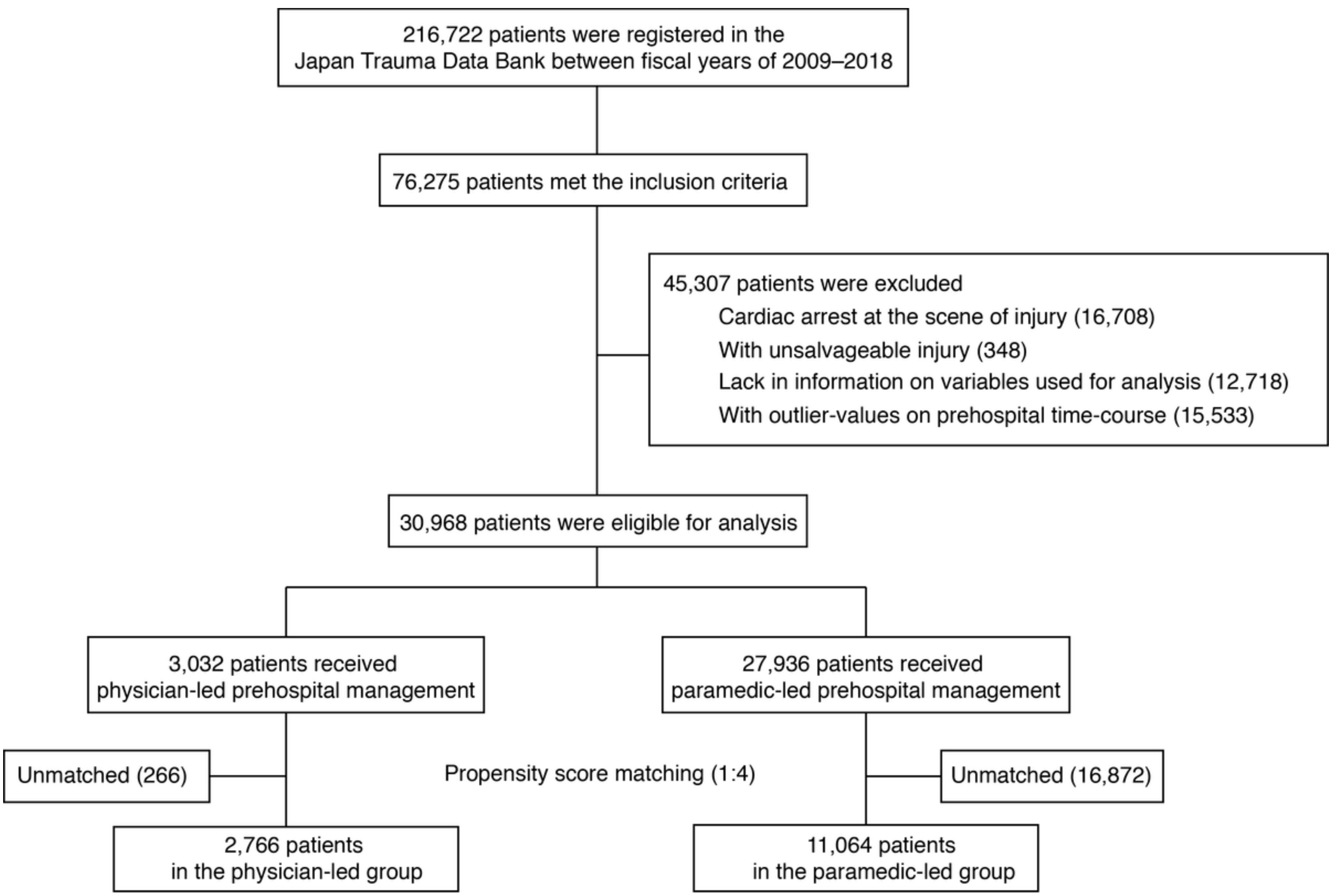

Figure 1

Flow diagram of the process of patient selection

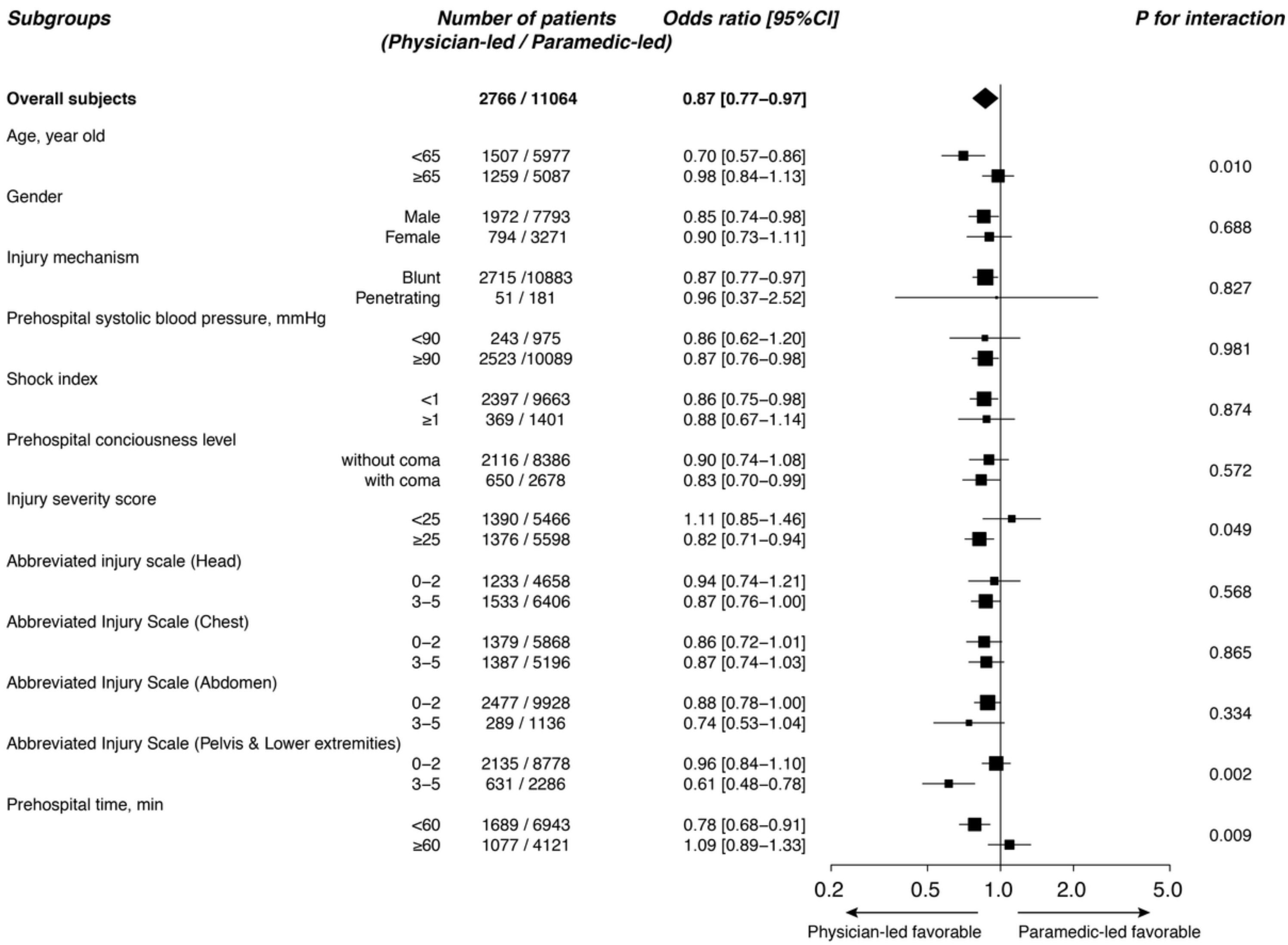

Figure 2

Subgroup analysis for the effect of physician-led prehospital trauma management on in-hospital mortality