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ORIGINAL ARTICLE

Difficult-to-transport cases and neurological outcomes of out-of-hospital cardiac arrest: A population-based nationwide study in Japan

Azusa Taguchi[1,2] | Shotaro Aso[3] | Hiroshi Yamagami[2] | Hideo Yasunaga[1]

[1]Department of Clinical Epidemiology and Health Economics, School of Public Health, The University of Tokyo, Tokyo, Japan

[2]Department of Emergency Medicine, Shonan Kamakura General Hospital, Kamakura, Kanagawa, Japan

[3]Department of Health Services Research, Graduate School of Medicine, The University of Tokyo, Tokyo, Japan

Correspondence
Azusa Taguchi, Department of Clinical Epidemiology and Health Economics, School of Public Health, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan.
Email: a-taguchi@g.ecc.u-tokyo.ac.jp

Abstract

Aim: In Japan, emergency medical service personnel often have difficulty obtaining hospitals' acceptance of emergency cases owing to congestion in the emergency unit; such cases are called difficult-to-transport cases. Increased difficult-to-transport cases at a regional level may be associated with the prognosis of out-of-hospital cardiac arrest (OHCA). This study aimed to investigate the association between the proportion of difficult-to-transport cases at a regional level and neurological outcomes in patients with OHCA, using the nationwide Utstein database linked to ambulance records in Japan.

Methods: In this retrospective cohort study from 2017 to 2021 in Japan, the proportion of difficult-to-transport cases was calculated as the number of difficult-to-transport cases divided by the number of emergency calls in each district on each day. Patients with OHCA were categorized into no, low, and high difficult-to-transport cases groups. The primary outcome was a Cerebral Performance Category 1 or 2 at 1 month. The secondary outcome was transportation time intervals. Multivariate regression analyses were conducted to assess the association between difficult-to-transport cases and patient outcomes.

Results: Among 592,021 eligible patients, the no, low, and high difficult-to-transport case groups included 282,747 (48%), 155,167 (26%), and 154,107 (26%) patients, respectively. The high difficult-to-transport cases group was associated with decreased favorable neurological outcomes (adjusted odds ratio, 0.91; 95% confidence interval, 0.86–0.95) and longer total transportation time (difference, 4.1 min; 95% confidence interval, 3.8–4.4).

Conclusion: A higher proportion of difficult-to-transport cases was associated with poorer neurological outcomes and longer total transportation times in patients with OHCA.

KEYWORDS
emergency medical services, out-of-hospital cardiac arrest, transportation interval

INTRODUCTION

Difficult-to-transport cases (DTC) occur frequently in Japan. It is often difficult for emergency medical service (EMS) personnel to obtain hospital acceptance of emergency cases. Hospitals can refuse a request call from EMS personnel because of a lack of available hospital beds or the absence of specialists for specific diseases.[1] Although DTC themselves arise from multifactorial causes, their frequent occurrence in a region may indicate systemic congestion and a relative insufficiency of medical resources.[2,3] Thus, high proportions of DTC in a region can be indicators of emergency medical system congestion and a relative lack of medical resources in that area.

Several previous studies have examined the association between a relative lack of medical resources and the outcomes of patients requiring emergency medical care. One Japanese study assumed that a relative lack of medical resources could occur during the coronavirus disease-2019 (COVID-19) pandemic and showed that the pandemic was associated with poorer neurological outcomes in out-of-hospital cardiac arrest (OHCA).[4] Another study assumed that a relative lack of medical resources could occur on the days when major US marathons were held, showing that road closure was associated with a longer total transportation time from the emergency call to hospital arrival and that the 30-day mortality was higher in patients with myocardial infarction and OHCA on the days of the events than on other days.[5] However, these studies have been conducted in specific areas and situations. To the best of our knowledge, no study has focused on DTC as an indicator of the relative lack of medical resources or investigated the association between DTC and the outcomes of emergency patients.

OHCA patients are less likely to be DTC. EMS personnel and tertiary hospitals attempt to prioritize prompt treatment for OHCA patients. In the present study, we hypothesized that a significant concentration of DTC in a district may indirectly affect the outcomes of patients with OHCA due to the lack of medical resources in public emergency services and hospitals. We investigated the association between DTC and favorable neurologic outcomes of OHCA using the nationwide Utstein and ambulance record databases in Japan.

METHODS

EMS in Japan

The EMS is a part of the emergency medical system and is managed by the local government.[1,6] A trained EMS personnel assess patients according to local protocols based on national protocols. After arriving at the scene, an EMS personnel triages the patient and makes a request call to the most appropriate hospital for the patient. A request call from an EMS personnel to a hospital is required for a patient to be transported by ambulance. The EMS personnel are required to make request calls until the hospital agrees to accept the patient.[7] Patients with lethal conditions (e.g., cardiac arrest, multiple trauma, stroke) are more likely to be transported to tertiary emergency hospitals.[6]

Study design and data sources

We conducted a retrospective cohort study from 2017 to 2021 in Japan. We used two databases of the Fire and Disaster Management Agency (FDMA) of Japan. The first is a prospective nationwide population-based observational database involving all patients with OHCA in Japan (the Utstein database).[8] In collaboration with the treating physicians, the EMS personnel at each site enter the data of patients with OHCA using an Utstein-style form.[9] The second is a prospective, nationwide, population-based observational database involving all patients transported by ambulance (EMS records). Anonymous data are sent electronically to the FDMA database servers at each local EMS site.

The Utstein database includes the following data: date; prefecture; sex; age; cause of arrest (cardiac or non-cardiac origin); bystander witness status; presence of bystander cardiopulmonary resuscitation (CPR); times of collapse, emergency call, EMS arrival at the scene, initiation of CPR, and first shock; initial rhythms, including ventricular fibrillation, pulseless electrical activity, and asystole; information on the EMS crew (physician-staffed or not); 1-month survival; and neurological outcome 1 month after cardiac arrest, defined as the Glasgow–Pittsburgh Cerebral Performance Category (CPC).[10]

The EMS database includes the following data: date, prefecture, district code, sex, age, type of accident, time of emergency call, EMS arrival at the scene, departure from the scene, hospital arrival, number of request calls, and procedure type by the EMS personnel. In the EMS data, Japan is divided into 729 districts.

Data linkage

Information on district codes in the EMS database was added to the Utstein database. We identified patients who received CPR in the EMS database. The cases were matched with those in the Utstein database based on the following criteria: age, sex, prefecture, and time of emergency call.

Patient selection

We enrolled all the patients with OHCA aged ≥18 years from January 1, 2017 to December 31, 2021. Data with obviously incorrect times (e.g., time of hospital arrival before the time of the emergency call) were excluded. Pediatric cases were excluded in accordance with previous studies.[4,5]

Exposure and covariates

The exposure in our study was the proportion of DTC in the region and on the specific day when each patient suffering from cardiac pulmonary arrest was identified. We defined DTC as cases in which the EMS made four or more request calls to the hospitals.[11] We calculated the proportion of DTC as the number of DTC divided by the number of emergency calls in each district on each day. The proportions of DTC were divided into three categories: (i) zero (no DTC group), (ii) >0 and <4.3% (low DTC group), and (iii) ≥4.3% (high DTC group). No prior studies have provided theoretical background for this categorization of DTC. We divided the cases into three groups based on median values, excluding the no DTC group. The median value excluding patients in the no DTC group was 4.3%.

The covariates were as follows: sex, age, bystander witness status, physician-staffed ambulance, bystander CPR, bystander rescue breathing, bystander automated external defibrillator (AED) use, initial shockable rhythm, airway devices used by EMS, AED use by EMS, establishment of venous access by EMS, adrenaline administration by EMS, cause of arrest (cardiac origin or not), year, mean daily number of ambulance dispatches in each district, weekends, and daytime (from 8:00 a.m. to 5:00 p.m.). The weekend and daytime variables were derived from the dates and times of emergency calls. There is a potential variation in the quality of EMS between urban and rural areas.[12,13] To adjust for the variation in EMS, the mean daily number of ambulance dispatches in each district was categorized into three groups: (i) ≤9, (ii) 10 to 99, (iii) ≥100. We classified areas as rural and urban based on the average daily ambulance transports, which serve as a proxy for population distribution.

Outcomes

The primary outcome was a favorable neurological prognosis, defined as a CPC score of 1 or 2, 1 month after the event.[8,14] The Glasgow–Pittsburgh CPC is defined as: good performance, CPC1; moderate disability, CPC2; severe cerebral disability, CPC3; vegetative state, CPC4; or brain death, CPC5. Secondary outcomes were survival at 1 month, total transportation time (from the emergency call to hospital arrival), time from the emergency call to EMS arrival at the scene, and time from EMS arrival at the scene to hospital arrival.[8]

Statistical analyses

Data were presented as percentages, numbers, means, or standard deviations. To compare proportions between the groups, chi-squared tests were conducted for categorical variables and analysis of variance (ANOVA) for continuous variables. We performed multivariable logistic regression analyses to assess the association between DTC and binary outcomes (favorable neurological outcome and survival at 1 month) and multivariable linear regression analyses to assess the association between DTC and continuous outcomes. We conducted two subgroup analyses based on the presence of a shockable rhythm and bystander witnesses. We conducted a sensitivity analysis excluding patients transported by physician-staffed ambulances.

To evaluate the dose–response relationship between DTC proportions and outcomes, we used restricted cubic spline (RCS) functions. Conventional multivariate regression analyses require the categorization of the continuous variable of exposure when a linear association is not assumed between exposure and outcome. However, this categorization leads to a loss of information. RCS analysis uses all data points to evaluate the nonlinear association between exposure and outcomes.[15,16] We used four knots for the DTC proportions (0.01, 0.03, 0.06, and 0.15), with the reference point set at 0.01. In the RCS analyses, we excluded the no DTC group because of its large proportion.

A P-value of less than 0.05 was considered statistically significant. All statistical analyses were conducted using STATA (StataCorp LLC, College Station, TX, USA).

RESULTS

A total of 636,079 patients were included in the Utstein database between 2017 and 2021. We excluded 37,340 patients in the linkage process, 408 patients with incorrect time data, and 6310 patients aged <18 years. In total, 592,021 eligible patients were identified. There were 282,747, 155,167, and 154,107 patients in the no, low, and high DTC groups, respectively (Figure 1).

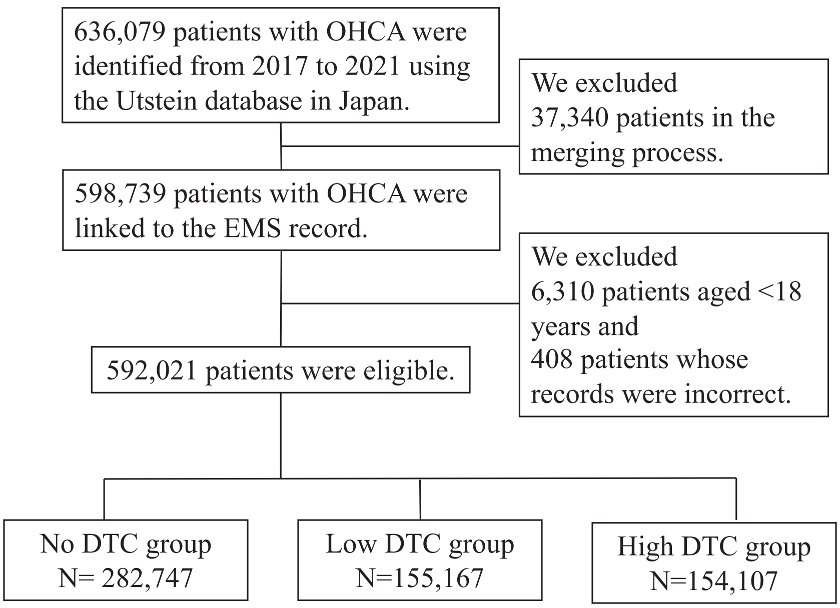

FIGURE 1 Patient selection. DTC, difficult-to-transport cases; OHCA, out-of-hospital cardiac arrest.

TABLE 1 Patient characteristics.

	Total	No DTC group	Low DTC group	High DTC group	
	N = 592,021	*N* = 282,747	*N* = 155,167	*N* = 154,107	*p*-Value
Male, *n* (%)	339,685 (57)	161,652 (57)	89,009 (57)	89,024 (58)	<0.001
Age, years (SD)	76.4 (15)	77 (15)	75.6 (16)	76 (15)	<0.001
Advanced-level EMS provider in EMS team, *n* (%)	588,755 (99)	280,452 (99)	154,760 (100)	153,543 (100)	<0.001
Physician-staffed ambulance, *n* (%)	21,231 (4)	10,117 (4)	6557 (4)	4557 (3)	<0.001
Initial shockable rhythm, *n* (%)	36,584 (6)	17,331 (6)	9769 (6)	9484 (6)	0.082
Witnessed status, *n* (%)					
Not witnessed	349,181 (59)	169,003 (60)	90,145 (58)	90,033 (58)	<0.001
Witnessed by not EMS	196,211 (33)	91,449 (32)	52,936 (34)	51,826 (34)	
Witnessed by EMS	46,629 (8)	22,295 (8)	12,086 (8)	12,248 (8)	
Bystander chest compression, *n* (%)	291,795 (49)	149,399 (53)	75,018 (48)	67,378 (44)	<0.001
Bystander rescue breathing, *n* (%)	30,436 (5)	13,241 (5)	8770 (6)	8425 (6)	<0.001
Bystander AED use, *n* (%)	7475 (1)	3270 (1)	2199 (1)	2006 (1)	<0.001
AED use by EMS, *n* (%)	56,969 (10)	26,948 (10)	14,994 (10)	15,027 (10)	0.051
Airway devices used by EMS, *n* (%)					
No use	343,414 (58)	163,058 (58)	89,607 (58)	90,749 (59)	<0.001
Intubation	46,244 (8)	24,149 (9)	10,433 (7)	11,662 (8)	
Supraglottic devices	202,363 (34)	95,540 (34)	55,127 (36)	51,696 (34)	
Establishing venous access by EMS, *n* (%)	216,815 (37)	113,923 (40)	50,013 (32)	52,879 (34)	<0.001
Administration of adrenaline by EMS, *n* (%)	152,092 (26)	77,810 (28)	37,128 (24)	37,154 (24)	<0.001
Cardiogenic cardiac arrest, *n* (%)	68,264 (12)	33,074 (12)	18,543 (12)	16,647 (11)	<0.001
Year, *n* (%)					
2017	115,506 (20)	59,006 (21)	34,230 (22)	22,270 (15)	<0.001
2018	117,534 (20)	57,319 (20)	34,909 (23)	25,306 (16)	
2019	117,982 (20)	56,229 (20)	35,074 (23)	26,679 (17)	
2020	118,726 (20)	56,821 (20)	26,876 (17)	35,029 (23)	
2021	122,273 (21)	53,372 (19)	24,078 (16)	44,823 (29)	
Average number of daily emergency calls in a district, *n* (%)					
≤9	101,920 (17)	89,347 (32)	12 0	12,561 (8)	<0.001
10–99	320,858 (54)	184,107 (65)	60,948 (39)	75,803 (49)	
≥100	169,243 (29)	9293 (3)	94,207 (61)	65,743 (43)	
Weekends, *n* (%)	170,903 (29)	78,278 (28)	39,613 (26)	53,012 (34)	<0.001
Daytime (8:00 a.m. to 5:00 p.m.), *n* (%)	287,985 (49)	138,435 (49)	74,756 (48)	74,794 (49)	<0.001

Abbreviations: AED, automated external defibrillator; DTC, difficult-to-transport cases; EMS, emergency medical service; OHCA, out-of-hospital cardiac arrest; SD, standard deviation.

Table 1 presents the baseline patient characteristics. The mean age was 80 years, and 339,685 (57%) were male. Overall, OHCA of 242,840 patients (41%) was witnessed by bystanders, and 36,584 patients (6.2%) had an initial shockable rhythm.

The proportion of bystander chest compressions was lower in the high DTC group than in the no DTC group. The number of patients in the high DTC group increased from 2017 to 2021. The proportion of patients on weekends was higher in the high DTC group (34%) than in the no and low DTC groups (29% and 26%, respectively). The districts with 10–99 and ≥100 daily average emergency calls had a higher proportion of patients in the high DTC group (49% and 43%, respectively) than in the districts with ≤9 (8%).

Table 2 presents the unadjusted outcomes. Favorable neurological outcomes and survival at 1 month were higher in the low DTC group (3.0% and 5.8%, respectively) than in the no DTC group (2.6% and 2.7%, respectively) and the high DTC group (2.7% and 4.9%, respectively). The total transportation time was longer in the high DTC group (37.4 min) than in the no DTC and low DTC groups (34.1 and 33.3 min, respectively).

The multivariable logistic regression analyses showed that the high DTC group was less likely to have favorable

TABLE 2 Crude outcomes among the three groups.

	Total	No DTC group	Low DTC group	High DTC group	*p*-Value
Favorable neurological outcome, *n* (%)	16,032 (2.7)	7287 (2.6)	4651 (3.0)	4094 (2.7)	<0.001
Survival at 1 month, *n* (%)	30,777 (5.2)	14,110 (5.0)	9073 (5.8)	7594 (4.9)	<0.001
Total transportation time, min (SD)	34.8 (25.2)	34.1 (14.7)	33.3 (13.0)	37.4 (43.1)	<0.001
Call to EMS arrival at the scene, min (SD)	7.7 (3.9)	8.1 (4.1)	7.2 (3.2)	7.6 (3.9)	<0.001
Scene to hospital arrival, min (SD)	26.5 (24.4)	25.4 (13.0)	25.6 (12.1)	29.2 (42.7)	<0.001

Abbreviations: DTC, difficult-to-transport cases; EMS, emergency medical service; SD, standard deviation.

TABLE 3 Outcomes compared with the no difficult-to-transport cases group.

	Low DTC group			High DTC group		
	aOR	95% CI	*p*-Value	aOR	95% CI	*p*-value
Favorable neurological outcome	0.95	0.90 to 1.01	0.086	0.91	0.86 to 0.95	<0.001
Survival at 1 month	1.01	0.97 to 1.05	0.722	0.88	0.85 to 0.91	<0.001
	Minutes	95% CI	*p*-Value	Minutes	95% CI	*p*-Value
Total transportation time	0.56	0.44 to 0.67	<0.001	4.07	3.79 to 4.35	<0.001
Call to EMS arrival at the scene	−0.11	−0.14 to −0.07	<0.001	−0.06	−0.10 to −0.03	0.001
Scene to hospital arrival	0.66	0.56 to 0.76	<0.001	4.13	3.86 to 4.41	<0.001

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; DTC, difficult-to-transport; EMS, emergency medical service.

neurological outcomes than the no DTC group (odds ratio [OR], 0.91; 95% confidence interval [CI], 0.86–0.95) (Table 3). In the multivariable linear regression analyses, the total transportation time was longer in the low DTC group (difference, 0.6 min; 95% CI, 0.4–0.7) and the high DTC group (difference, 4.1 min; 95% CI, 3.8–4.4) than in the no DTC group.

In the subgroup analysis with initial shockable rhythm, the proportion of favorable neurological outcomes in the high DTC group was lower than in the no DTC group (OR, 0.87; 95% CI, 0.81–0.94) (Table 4). In patients whose OHCA was witnessed by bystanders, the proportion of favorable neurological outcomes in the high DTC group was lower than in the no DTC group (OR, 0.92; 95% CI, 0.87–0.97) (Table 5). Moreover, in the sensitivity analysis, the proportion of favorable neurological outcomes in the high DTC group was lower than that in the no DTC group (OR, 0.90; 95% CI, 0.86–0.95) (Table S1).

Figure 2 shows the dose–response relationship between the proportions of DTC and the OR for favorable neurological outcomes in all patients with OHCA. Figure 3 shows the dose–response relationship between the proportions of DTC and the OR for favorable neurological outcomes, stratified by the groups with initial shockable or nonshockable rhythms and those whose OHCA was witnessed by bystanders or not. No dose–response relationship between the proportion of DTC and favorable neurological outcomes was observed in patients with nonshockable rhythms or those whose OHCA was witnessed by bystanders.

DISCUSSION

We examined the relationship between DTC and outcomes in patients with OHCA using the nationwide Utstein database in Japan. Higher DTC proportions were associated with poorer neurological outcomes and longer total transportation times.

To the best of our knowledge, no previous study has demonstrated the impact of regional emergency medical system congestion on patient outcomes using nationwide databases. Previous studies have shown an indirect negative influence of the COVID-19 pandemic on OHCA outcomes.[4,17–19] Our results may also have been negatively influenced by the COVID-19 pandemic, as a previous study showed that the number of patients newly diagnosed with COVID-19 was positively correlated with the number of DTC.[20] However, the present study adjusted for bystander CPR, AED use, and airway device use by EMS, which were reported to decrease during the COVID-19 pandemic.[4,20] Because DTC had already occurred before the COVID-19 pandemic, the present study suggests a negative influence of regional crowding on OHCA outcomes, regardless of the COVID-19 pandemic.

TABLE 4 Outcomes in patients with an initial shockable rhythm compared with the no DTC group.

	Low DTC group			High DTC group		
	aOR	95% CI	*p*-Value	aOR	95% CI	*p*-Value
Favorable neurological outcome						
Shockable	0.95	0.88 to 1.04	0.26	0.87	0.81 to 0.94	<0.001
Nonshockable	0.95	0.89 to 1.02	0.17	0.92	0.86 to 0.98	0.02
Survival at 1 month						
Shockable	1.05	0.98 to 1.13	0.17	0.86	0.81 to 0.92	<0.001
Nonshockable	0.99	0.95 to 1.03	0.62	0.89	0.85 to 0.92	<0.001
	Min	95% CI	*p*-Value	Min	95% CI	*p*-Value
Total transportation time						
Shockable	0.26	−0.14 to 0.67	0.20	4.12	3.69 to 4.55	<0.001
Nonshockable	0.69	0.58 to 0.79	<0.001	4.13	3.84 to 4.43	<0.001
Call to EMS arrival at the scene						
Shockable	−0.06	−0.16 to 0.04	0.25	0.06	−0.04 to 0.16	0.28
Nonshockable	−0.11	−0.15 to −0.07	<0.001	−0.07	−0.11 to −0.03	<0.001
Scene to hospital arrival						
Shockable	0.33	−0.05 to 0.70	0.09	4.07	3.67 to 4.47	<0.001
Nonshockable	0.69	0.58 to 0.79	<0.001	4.13	3.84 to 4.43	<0.001

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; DTC, difficult-to-transport; EMS, emergency medical service.

TABLE 5 Outcomes in witnessed patients compared with the no DTC group.

	Low DTC group			High DTC group		
	aOR	95% CI	*p*-Value	aOR	95% CI	*p*-Value
Favorable neurological outcome						
Witnessed	0.94	0.89 to 1.00	0.05	0.92	0.87 to 0.97	0.003
Unwitnessed	1.03	0.97 to 1.09	0.35	0.86	0.81 to 0.90	<0.001
Survival at 1 month						
Witnessed	1.01	0.97 to 1.06	0.56	0.90	0.87 to 0.94	<0.001
Unwitnessed	1.03	0.97 to 1.09	0.35	0.86	0.81 to 0.90	<0.001
	Minutes	95% CI	*p*-Value	Minutes	95% CI	*p*-Value
Total transportation time						
Witnessed	0.60	0.39 to 0.82	<0.001	4.53	3.87 to 5.19	<0.001
Unwitnessed	0.64	0.50 to 0.78	<0.001	4.25	3.85 to 4.66	<0.001
Call to EMS arrival at the scene						
Witnessed	−0.14	−0.20 to −0.09	<0.001	−0.03	−0.08 to 0.03	0.34
Unwitnessed	−0.07	−0.12 to −0.02	0.004	−0.06	−0.11 to −0.01	0.01
Scene to hospital arrival						
Witnessed	0.74	0.54 to 0.95	<0.001	4.56	3.90 to 5.22	<0.001
Unwitnessed	0.71	0.59 to 0.84	<0.001	4.32	3.92 to 4.72	<0.001

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; DTC, difficult-to-transport; EMS, emergency medical service.

In terms of poorer neurological outcomes or survival of patients with OHCA, our results were consistent with those of several previous studies dealing with a lack of medical resources in a region or during the COVID-19 pandemic.[4,5,21] However, contrary to our findings, a previous single-center observational study showed that crowding in emergency departments was not associated with the outcomes of OHCA.[18] The difference between the findings of our study and those of the previous study may be attributed to the lack of a coordinating role at the regional level. In a single hospital, the lead physician can easily manage the available resources and optimize treatment. In most areas of Japan, several emergency hospitals are assumed to share the responsibility of accepting emergency patients. However, no comprehensive system or authority is capable of coordinating or optimizing resource allocation across these hospitals. This lack of centralized coordination may hinder the efficiency of patient transportation and resource utilization, particularly during periods of regional congestion.

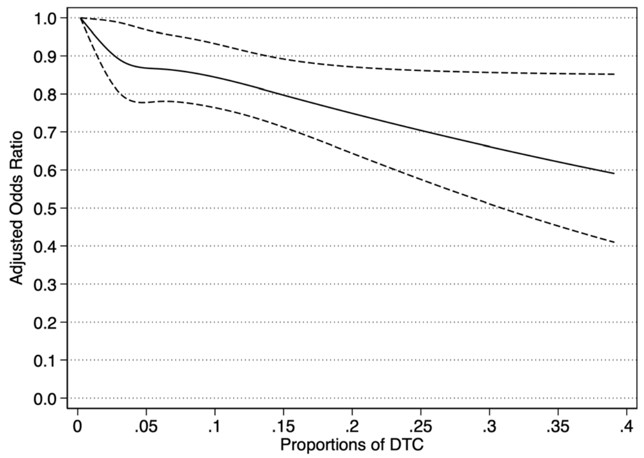

FIGURE 2 Association between favorable neurological outcomes and proportions of DTC. The solid line indicates the estimated values, and the dashed lines represent the 95% confidence intervals. DTC, difficult-to-transport cases.

We also observed a delay in the total transportation time per day due to regional emergency service congestion. The slight differences in the time from emergency call to EMS arrival at the scene in the low and high DTC groups were statistically significant but not clinically important. Delays in total transportation time during the COVID-19 pandemic have been observed in other countries.[22–24] However, our findings showed that higher proportions of DTC were associated with longer time from EMS arrival at the scene to hospital arrival, but not with longer time from emergency call to EMS arrival at the scene. This delay after EMS arrival occurred when EMS personnel had to make extra request calls or transport patients to a more distant hospital because the neighborhood hospital had rejected patients.[7] This result suggests that EMS personnel successfully prioritized the ambulance dispatch of patients with OHCA, even in regional congestion. However, hospitals could not preferentially accept the patients with OHCA whom EMS personnel requested for acceptance.

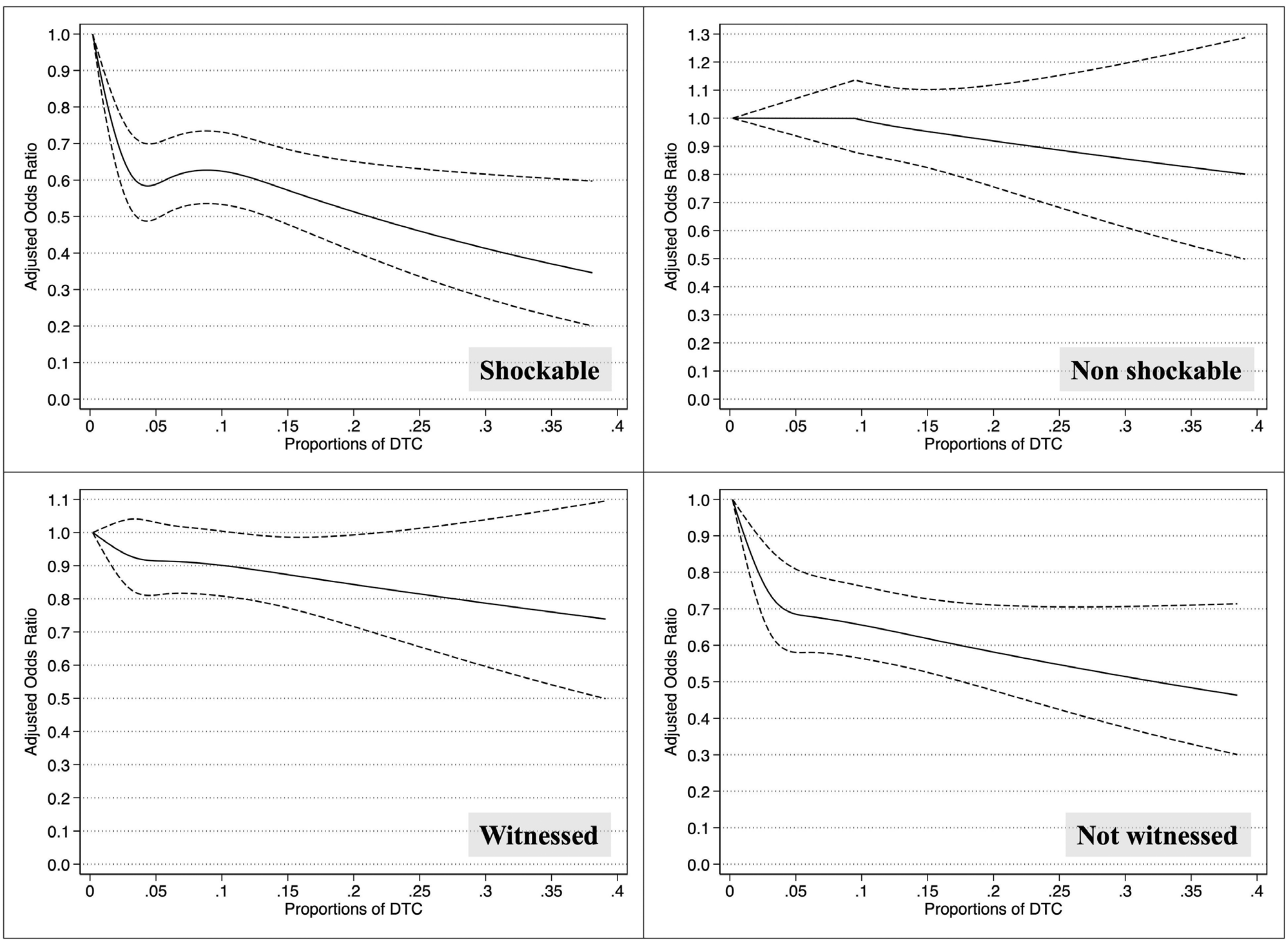

FIGURE 3 Associations between favorable neurological outcomes and proportions of DTC stratified by initial rhythm and witness status. The solid line indicates the estimated values, and the dashed lines represent the 95% confidence intervals. DTC, difficult-to-transport cases.

The neurological outcomes of OHCA can be appropriate surrogates for assessing the effects of an emergency medical system.[4] This study demonstrated that during periods of congestion at a regional level, poorer outcomes and longer transportation times were observed. While the specific mechanisms underlying these associations remain unclear, longer transportation times may be a contributing factor to the poorer outcomes observed in the high DTC group. Previous studies have suggested potential strategies to shorten transportation times and improve hospital acceptance. For example, the single-specialty staffing emergency department model[6,25] and information and communication technology[26–28] have been explored. These methods may provide valuable insights for constructing a more robust and efficient emergency medical system capable of adapting to periods of high demand.

Limitations

The strength of this study was its nationwide nature. However, this observational study had several limitations. First, we could not adjust for the shortage of in-hospital medical resources. During the COVID-19 pandemic after 2019, there was a surge in medical demand, coinciding with strained extracorporeal membrane oxygenation and intensive care unit capacity. Second, we were not able to obtain detailed patient information, such as medical history, activities of daily living, preexisting conditions, socioenvironmental factors, and hospital information (secondary or tertiary hospital). Moreover, we lacked data on population density, total population, older adult population, the number of ambulances per capita, and the number of secondary and tertiary emergency hospitals per capita to adjust for rural and urban areas. Third, we could not adjust the number of paramedics in the ambulance due to a lack of data. Finally, it remains unknown whether the findings of this study can be applied to different healthcare systems in other countries where ambulance services do not require permission to transport patients to hospitals.

CONCLUSIONS

A higher proportion of DTC was associated with poorer neurological outcomes and longer total transportation times for OHCA.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The databases used in this study are only available for use when authorized by the FDMA of Japan.

ETHICS STATEMENT

Approval of the research protocol: This study was approved by the Ethics Committee of Shonan Kamakura General Hospital (approval number: TGE02414-024; approval date: February 1, 2024).

Informed Consent: The requirement for informed consent was waived because of the anonymous nature of the data.

Registry and the Registration No. of the study/trial: N/A.

Animal Studies: N/A.

ORCID

Azusa Taguchi https://orcid.org/0000-0003-0137-279X

Shotaro Aso https://orcid.org/0000-0002-7804-2433

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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