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Effect of the number of request calls on the time from call to hospital arrival: a cross-sectional study of an ambulance record database in Nara prefecture, Japan

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ABSTRACT

Objectives: In Japan, ambulance staff sometimes must make request calls to find hospitals that can accept patients because of an inadequate information sharing system. This study aimed to quantify effects of the number of request calls on the time interval between an emergency call and hospital arrival.

Design and setting: A cross-sectional study of an ambulance records database in Nara prefecture, Japan.

Cases: A total of 43 663 patients (50% women; 31.2% aged 80 years and over): (1) transported by ambulance from April 2013 to March 2014, (2) aged 15 years and over, and (3) with suspected major illness.

Primary outcome measures: The time from call to hospital arrival, defined as the time interval from receipt of an emergency call to ambulance arrival at a hospital.

Results: The mean time interval from emergency call to hospital arrival was 44.5 min, and the mean number of requests was 1.8. Multilevel linear regression analysis showed that ~43.8% of variations in transportation times were explained by patient age, sex, season, day of the week, time, category of suspected illness, person calling for the ambulance, emergency status at request call, area and number of request calls. A higher number of request calls was associated with longer time intervals to hospital arrival (addition of 6.3 min per request call; p<0.001). In an analysis dividing areas into three groups, there were differences in transportation time for diseases needing cardiologists, neurologists, neurosurgeons and orthopaedists.

Conclusions: The study revealed 6.3 additional minutes needed in transportation time for every refusal of a request call, and also revealed disease-specific delays among specific areas. An effective system should be collaboratively established by policymakers and physicians to ensure the rapid identification of an available hospital for patient transportation in order to reduce the time from the initial emergency call to hospital arrival.

Strengths and limitations of this study

- A strength of this study is that it examined a large database of patients transported by ambulance that included detailed information about the number of request calls and the time for transportation in Nara prefecture, Japan.
- This study suggested that one refusal of a request call extended the time from call to hospital arrival by 6.3 min.
- This study revealed that there is a difference of up to ~30 min between areas in the time from call to arrival and specifically pointed out disease-specific delays among specific areas.
- Limitations of this study were that patient emergency status was decided by the ambulance crew and our data consisted of patients from one prefecture in Japan.

INTRODUCTION

A request for the delivery of an emergency patient is sometimes rejected, and this is a social problem in Japan.[1–4] In Japan, the emergency transport system is managed by local governments.[1 5 6] Each prefecture establishes a medical care system to provide care to several medical care zones, each of which consists of several districts. Patients who require ambulance transport to hospitals can call for emergency services by dialling '119'. The emergency call is directly received by the local fire defence headquarters, and the nearest available ambulance is dispatched to the patient.[6] Ambulance crews, who are trained paramedics belonging to the local fire departments, assess patients in accordance with local protocols that are based on national protocols.[4] After arriving on scene, an ambulance crew would first assess the patient and provide emergency medical treatment if required. Subsequently, the crew determines

the most appropriate hospitals for the patient, and places request calls to these hospitals while still at the scene.[4] The patient is then transported by ambulance for free to the nearest emergency hospital that agrees to treat the patient. Emergency hospitals in Japan are classified into three levels: primary, secondary and tertiary.[1] According to Article 19 of the Medical Practitioners' Law, physicians cannot refuse patients without good reason.

The national average of the time from calling an ambulance to hospital arrival was 39.4 min in 2014; it is increasing every year,[7] and is a known predictor of outcomes of acute heart failure[8] and head trauma.[9] Japan has the most rapidly ageing population in the world,[10] and it is estimated that there were 33 656 000 people aged 65 years and above (26.5% of the population) in 2015.[11] As the number of elderly people will reach a peak of 33.78 million in 2042, the percentage of elderly people will reach 39.9% in 2060.[12] The number of ambulance dispatches was nearly 6.0 million in 2014 and this reflected a trend of increases over the previous 6 years.[7] Owing to the rapidly ageing population and an increase in ambulance dispatches, the time from call to hospital arrival will invariably increase unless major changes are implemented in the emergency care and resource distribution systems.

One recent study showed that the number of request calls to hospitals had greater odds of an on-scene arrival time of over 30 min.[13] However, the direct effect of the number of request calls on the time from call to hospital arrival is unclear. The aim of this study was to evaluate factors affecting the time to hospital arrival of ambulances, especially the effect of the number of request calls.

METHODS
Data and setting
This was a cross-sectional study. The data sources were ambulance transportation records database (transportation database) and ambulance request call records database (request call database) in the Nara prefecture, Japan. The location and map of Nara prefecture are shown in online supplementary figure S1. The prefectural population was 1.36 million in 2015, with a population density of 369 persons per square kilometer.[14] Most of the prefecture is covered by mountains and forests, with the exception of the northwest area. Nara prefecture consists of five medical areas; there are almost 70 hospitals within the prefecture, three of which are tertiary hospitals.[15][16] All hospitals are requested to indicate admission acceptability according to patient severity and category of suspected illnesses by displaying this information in a web system.

The transportation database consists of information about patient characteristics, date and time of each call and hospital arrival, and time for each component of transportation (except for the time from the end of a request call to leaving the scene and the time from entering a hospital to delivering a patient to hospital staff (hospital arrival)). The request call database consists of information about patient characteristics, date and time of call for the suspected illness, name of the hospital accepting request calls, whether or not the hospital indicated the admission acceptability of patients and the result of the request call. In Nara prefecture, ambulance crews have a tablet-type portable computer for searching hospital statuses with regard to admission acceptability. Using these computers, the crew members input the date and time of each action for transportation and the assessment results (such as each patient's emergency situation and suspected illnesses).

Nara prefecture has established a medical cooperation system for these 10 important illnesses through the formation of a medical institution network in order to provide coordinated care for patients. Under this system, patient emergency situations are categorised into 5 levels and suspected illnesses are categorised into 10 important illnesses and other categories. These categories are assessed by ambulance crews based on designated criteria and protocols. The 10 important illnesses are categorised as follows: cardiopulmonary arrest (CPA), stroke, disturbance of consciousness (DOC), acute coronary syndrome (ACS), abdominal pain, trauma, severe burns, perinatal problem, paediatrics and psychiatric illness. The other categories are classified according to medical specialties, including internal medicine, neurosurgery except for stroke or DOC, surgery except for abdominal pain, orthopaedics except for trauma and cardiology except for ACS. Patients were categorised into the 'other category' if they were not categorised into one of these important illnesses.

Inclusion and exclusion criteria
Our inclusion criteria were transportation and request calls made by patients (1) transported from 1 April 2013 to 31 March 2014, (2) aged 15 years and older and (3) with suspected illness related to internal medicine, trauma, orthopaedics, neurosurgery, abdominal pain, surgery, cardiology, CPA, stroke, ACS and DOC. Patients' suspected illnesses were categorised into 10 important illnesses and other categories after assessment by emergency medical services (EMS) staff. The 10 important illnesses were categorised as the following patient situations: CPA, stroke, DOC, ACS, abdominal pain, trauma, perinatal problem, paediatrics and psychiatric illness. We excluded patients with suspected illness related to perinatal problems, paediatrics and psychiatric illness because the number of hospitals that accepted these kinds of patients was very small. We also excluded patients with suspected illnesses, except for those concerning internal medicine, orthopaedics, neurosurgery, surgery and cardiology, due to the low number of patients with these illnesses.

We excluded transportation and request calls from hospital to hospital and from clinic to hospital. We decided on these inclusion criteria because these

illnesses are important in terms of health policy and affect many patients. We excluded patients who took longer than 1000 min for finding hospitals, driving to a hospital, or transportation as outliers. We also excluded children because the number of hospitals allowing transportation of children is very small, and we would have needed to conduct a separate study for children as distinct from adults. We treated missing data as null values, while the cases were retained in the analysis.

Variables

Date and time of hospital arrival, time from arrival on scene to the beginning of request calls, time from the beginning of request calls to the ending of the calls, time from the ending of the calls to hospital arrival, time from leaving the scene to hospital arrival, patient characteristics (age and sex), person calling ambulance, registered district of the EMS and patient's emergency status and category of suspected illness as recorded by on-scene EMS staff or operational staff at the local fire defence headquarters. We divided patients into three groups according to age: (1) 15 to ≤59 years, (2) 60–79 years and (3) 80 years or more; the cut-off at 60 years was selected as it is the official retirement age in Japan. We defined the seasons as spring from March to May, summer from June to August, autumn from September to November and winter from December to February. We also defined noon from 8:00 to 15:00, early night from 16:00 to 23:00, and late night from 12:00 to 7:00. We defined on-scene time as the sum of the time from arriving on the scene to leaving the scene.

With regard to ambulance administration, Nara prefecture is divided into 13 districts that were used to identify the places where ambulance calls were made. Thirteen districts were divided into the following three groups depending on the level of urbanisation and location of the registered district of the EMS: (1) urban area, which encompasses seven districts that are more urbanised than other areas in Nara prefecture (population was 1.08 million and the population density was 1578 per square kilometer in 2015), (2) the eastern rural area, which consists of three districts located in the east side of Nara prefecture (population was 0.21 million and the population density was 319 per square kilometer in 2015) and (3) the southern rural area, which consists of three districts located in the south side of Nara prefecture (population was 0.07 million and the population density was 30.9 per square kilometer in 2015).

Primary outcome measure

The primary outcome measure was the time from the initial emergency call by the patients to hospital arrival, that is, the time from the call for an ambulance to hospital arrival.

Statistical methods

The main results were calculated as means and SDs, and the baseline patient characteristics were compared using

Student's t-test or the Kruskal-Wallis test. First quartile and third quartile were calculated to show the distribution of data.

First, to estimate the effect of increasing the number of request calls on the time from call to hospital arrival, we conducted the Jonckheere-Terpstra trend test.

Second, in order to estimate the time from request call to hospital arrival after excluding unsuccessful request calls, we defined unsuccessful request calls as (1) request calls to hospitals indicated as 'Accepting patients' that resulted in failure and (2) request calls to hospitals indicated as 'Not accepting patients' that resulted in failure. To conduct this estimation, we merged the transportation database and the request call database. When the time for a request call was longer than the time from call to hospital in request call database, we decided these were entered incorrectly and then excluded them from calculations.

Third, to evaluate the effect of the number of request calls on time from call to hospital arrival, we conducted a multilevel linear regression analysis with a random intercept model that allowed different intercepts with 13 districts. The predictive variables were selected on the basis of previous research.[17–23] To evaluate the differences of time from call to hospital arrival between the three areas, we conducted a multilevel linear regression analysis with a random intercept model that allowed different intercepts with the three areas. We also conducted a subgroup analysis for on-scene time and time from leaving the scene to hospital arrival.

Finally, to evaluate the differences of time from call to hospital arrival between the three areas, we conducted a multilevel linear regression analysis with a random intercept model that allowed different intercepts with the three areas. To evaluate differences in the time from request call to hospital arrival among the three areas, we also conducted another multilevel linear regression analysis with a random intercept model to correct for patient clustering in the districts where patients were divided into three areas.

Data analysis was conducted using the statistical software package R, V.3.2.2.

RESULTS
Cases

From April 2013 to March 2014, the number of transportations by ambulance was 43 663. The mean (SD) of time from request call to hospital on arrival was 44.5 (SD: 20.9) minutes. The distribution of risk factors and their association with transportation time are shown in table 1. Slightly < one-third of patients were 80 years old or older, and 50% were women. The percentage of patients transported during the noon time period was 44.8%, which was a greater proportion than during other time categories. The number of patients in each area ranged from 723 to 11 223, and the mean (SD) was 3358.7 (SD: 3046.3) (the first and third quartile were

Table 1 Risk factors distribution and association with transportation time

	n N=43 663	Per cent	Time from call to hospital arrival		
			Mean (SD)	1st Qu–3rd Qu	p Value
Age, years					
≥15, <60	14 125	32.4	45.1 (22.7)	31.0–53.0	
≥60, <80	15 915	36.4	44.4 (20.2)	31.0–52.0	
≥80	13 623	31.2	43.9 (19.8)	31.0–51.0	<0.001*
Sex					
Male	21 833	50.0	45.1 (21.7)	31.0–51.0	
Female	21 830	50.0	43.8 (20.1)	31.0–53.0	<0.001†
Season					
Spring (March–May)	10 406	23.8	44.2 (20.1)	31.0–52.0	
Summer (June–August)	11 187	25.6	43.5 (20.2)	31.0–51.0	
Autumn (September–November)	10 741	24.6	44.5 (20.8)	32.0–53.0	
Winter (December–February)	11 329	25.9	45.7 (22.4)	32.0–53.0	<0.001*
Day of the week					
Monday	6627	15.2	43.5 (20.1)	30.0–51.0	
Tuesday	6133	14.0	43.8 (20.8)	31.0–51.0	
Wednesday	5838	13.4	43.9 (20.1)	31.0–52.0	
Thursday	5899	13.5	44.0 (20.8)	31.0–52.0	
Friday	6134	14.0	43.7 (20.0)	31.0–51.0	
Saturday	6436	14.7	45.8 (21.4)	32.0–54.0	
Sunday	6596	15.1	46.5 (22.7)	32.0–54.0	<0.001*
Time category at ambulance call					
Noon (8–15)	19 558	44.8	41.8 (19.4)	30.0–48.0	
Early night (16–23)	15 862	36.3	45.9 (21.6)	32.0–56.0	
Late night (0–7)	8243	18.9	48.1 (22.1)	34.0–56.0	<0.001*
Category of suspected illness					
Abdominal pain	1072	2.5	45.9 (21.2)	32.0–53.0	
CPA	984	2.3	43.6 (20.3)	31.0–49.0	
Stroke	850	1.9	49.9 (22.1)	35.0–58.0	
ACS	686	1.6	42.6 (16.9)	32.0–49.0	
DOC	498	1.1	47.6 (19.5)	33.0–54.0	
Trauma	6158	14.1	46.4 (21.4)	33.0–54.0	
Internal medicine	21 197	48.5	42.3 (19.8)	30.0–49.0	
Orthopedics except for trauma	5895	13.5	45.5 (22.3)	31.0–54.0	
Neurosurgery except for stroke and DOC	4254	9.7	50.4 (22.4)	36.0–60.0	
Surgery except for abdominal pain	1066	2.4	42.6 (21.7)	29.0–51.0	
Cardiology except for ACS	1003	2.3	44.9 (20.4)	33.0–53.0	<0.001*
Person calling ambulance					
Family or self	27 041	70.3	44.4 (20.6)	31.0–52.0	
Witness	9501	24.7	44.9 (21.8)	31.0–52.0	
Welfare facility	1906	5.0	42.3 (19.6)	30.0–49.0	<0.001*
Emergency status at request call					
Less urgency	25 535	58.5	45.3 (21.0)	32.0–53.0	
Urgency	5243	12.0	45.8 (20.9)	32.0–53.0	
Emergency	2659	6.1	46.4 (22.0)	32.0–54.0	
Resuscitation	241	0.6	42.4 (18.0)	31.0–47.0	
During assessment	9983	22.9	41.4 (20.1)	29.0–48.0	<0.001*
Area where ambulance calls were made					
Urban area	32 657	74.8	42.1 (18.5)	30.0–49.0	
Eastern rural area	7661	17.5	48.6 (21.7)	34.0–58.0	
Southern rural area	3345	7.7	57.8 (31.9)	35.0–72.0	<0.001*

The detailed information about each area are not available for disclosing, because of data sharing policy.
*p Value by Kruskal-Wallis test.
†p Value by Student's t-test.
ACS, acute coronary syndromes; CPA, Cardiopulmonary arrest; DOC, disturbance of consciousness; Qu, quartile; request call, request call to hospital for transportation.

1499 and 4060, respectively). The mean (SD) time from call to hospital arrival in each district ranged from 36.3 (SD: 12.4) minutes to 72.6 (SD: 32.9) minutes, with a mean time of 48.2 (SD: 10.4) minutes (the first and third quartiles were 41.2 and 53.1, respectively; data not shown). Almost one-half of the patients were suspected of internal disease, and patients who were suspected of neurosurgical disease experienced longer times than others. Almost 70% of ambulances were called by family members or patients themselves. More than half of the patients were categorised into lower emergency situations. There were no remarkable differences across seasons or days of the week.

Components of the time from call to hospital admission

Figure 1 shows components of the time from call to hospital admission from the transportation database. It took 21.5 (SD: 13.8) minutes to arrive on the scene, on average. It took 14.3 (SD: 13.8) minutes from the scene to hospital arrival.

Effect of increasing the number of request calls on the time from call to hospital arrival

The mean (SD) time from call to hospital arrival was 44.5 (SD: 20.9) min, and the mean (SD) number of requests was 1.8 (SD: 1.8). Table 2 shows the relationship between the number of request calls for each transport and the time from call to hospital arrival using the transportation database. It shows the more the request calls made, the more is the time spent from the call to hospital arrival.

Effect of unsuccessful request calls on the time from request call to hospital arrival

Table 3 shows the number and the time for request call categorised by hospital displayed acceptability and request results. There were 79 693 request calls for 43 663 transportations. The number of unsuccessful request calls was 36 030 (45.2%) and these took more than 150 000 min in total. The number of request calls to hospitals that displayed 'Not accepting patients' was 22 648 (28.4%) and 11 401 (50.3%) request calls resulted in failure. When the mean time from call to hospital arrival was calculated without unsuccessful request calls, it was shortened by 3.5 min.

Effect of the number of request calls on the time from call to hospital arrival

We conducted a multilevel linear regression analysis to describe time from call to hospital arrival. In this model, 44% of the variation was explained by the parameters age, sex, season, day of the week, time, area, category of suspected illness, person calling ambulance, emergency status at request call and the number of request calls
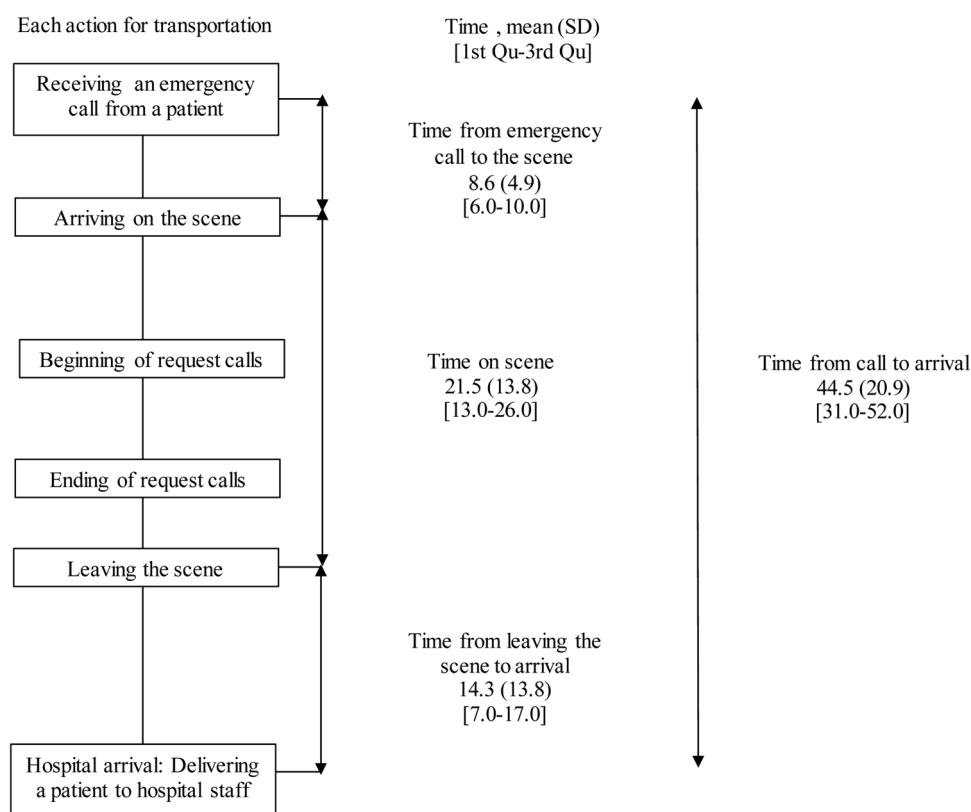
Figure 1 Components of time from request call to hospital admission. Data for the time from the ending of request calls to leaving the scene and the time from entering a hospital to delivering a patient to hospital staff were not available. SD, standard deviation; Qu, quartile.

Table 2 The number of request call and time from call to hospital arrival for each patient

The number of request call	n N=43 663	Per cent	Time from call to hospital arrival		p Value
			Mean (SD)	1st Qu–3rd Qu	
1	29 499	67.6	38.2 (16.2)	29.0–44.0	
2	6302	14.4	47.8 (16.9)	37.0–54.0	
3	3150	7.2	55.1 (18.4)	43.0–62.0	
4	1816	4.2	61.2 (19.3)	49.0–70.0	
5	971	2.2	68.9 (20.7)	55.0–78.0	
6	625	1.4	73 (21.2)	59.0–82.0	
7	395	0.9	79.5 (23.5)	65.0–89.0	
8	278	0.6	81.5 (20.8)	67.3–91.8	
9	173	0.4	92.6 (29.2)	73.0–104.0	
10	126	0.3	90.8 (25.4)	74.3–105.0	
≥11	328	0.8	109.6 (25.9)	86.0–122.2	<0.001*

*p Value by Jonckheere-Terpstra trend test request call: request call to hospital for transportation.
Qu, quartile.

(see table 4 and online supplementary table S1). The model that did not include the variable 'the number of request calls' was only able to explain 11% of the observed variations (see online supplementary table S2). We found that the number of request calls affected time from call to hospital arrival (β=6.3, p<0.001), which indicated that a refusal of a request call extended the time from call to hospital arrival by 6.3 min. We also observed associations between time from call to hospital arrival and age, sex, season and person calling ambulance. In the subgroup analysis, we found that the number of request calls affected on-scene time (β=4.6, p<0.001) and time from leaving the scene to hospital arrival (β=1.6, p<0.001).

District differences in the time from request call to hospital arrival

From the results of multilevel linear regression analysis, we found that there were significant variations in transportation time between the 13 districts (z-score=23.4) and the 3 areas (z-score=6.8) (see table 4 and online supplementary table S3). From the analyses dividing patients into three groups according to the location of the registered district of the EMS, the mean (SD) transportation times in the urban area, eastern rural area and southern rural area were 42.1 (SD: 18.5), 48.6 (SD: 21.7), and 57.8 (SD: 31.9), respectively. The southern

rural area had much longer transportation times than the other two areas. When compared with internal medicine, longer transportation times were observed for neurosurgery (+11.5 min), stroke (+9.9 min), trauma (+10.0 min), ACS (+10.1 min), orthopaedics (+9.2 min) and cardiology (+9.2 min) in the southern rural area (see online supplementary table S4). The eastern rural area took a much longer time in neurosurgery and trauma, with reference to internal medicine, than the urban area and it was prolonged by 9.1 and 8.1 min, respectively.

DISCUSSION

In this cross-sectional study, we evaluated the effect of the number of request calls on the time from call to hospital arrival. This study indicated that the time from call to hospital arrival would decrease by 4.6 min if all unsuccessful request calls were eliminated. The time from call to hospital arrival increases by 6.3 min for every request call from EMS to hospital, after adjusting for other variables. The time from call to hospital arrival is also related to age, sex, season and person calling the ambulance.

Regarding the category of suspected illness, abdominal pain is associated with the shortest transport time, followed by surgery. The Ministry of Health, Labour and Welfare asked the prefecture governments to establish medical cooperation systems for five diseases: acute

Table 3 The number and the time for request call categorised by hospital displayed acceptability and request results

Hospital displayed admission acceptability	Result	Number of request call n (%) N=79 693	Time from call to hospital arrival		p Value *
			Mean (SD)	1st Qu–3rd Qu	
Accepting patients	Success	32 416 (40.7)	4.9 (3.4)	2.0–6.0	
Not accepting patients	Success	11 247 (14.1)	4.5 (3.9)	2.0–6.0	
Accepting patients	Failure	24 629 (30.9)	4.2 (3.1)	2.0–5.7	
Not accepting patients	Failure	11 401 (14.3)	4.2 (3.5)	2.0–5.3	<0.001

*p Value by Kruskal-Wallis test request call: request call to hospital for transportation.
Qu, quartile.

Table 4 Time from Call to hospital arrival: multilevel linear regression analysis: with random effects to correct for patients clustering in the 13 districts

Explanatory valuable	Estimate (95% CI)	p Value
Fixed effects		
Intercept	31.8 (26.4 to 37.2)	<0.001
Age, years		
≥15, <60	(ref)	
≥60, <80	1.1 (0.75 to 1.5)	<0.001
≥80	0.94 (0.52 to 1.4)	<0.001
Sex		
Female	(ref)	
Male	0.64 (0.32 to 0.96)	<0.001
Season		
Spring (March–May)	(ref)	
Summer (June–August)	−0.50 (−0.95 to −0.053)	0.028
Autumn (September–November)	0.57 (0.12 to 1.0)	0.012
Winter (December–February)	0.98 (0.54 to 1.4)	<0.001
Day of the week		
Monday	(ref)	
Tuesday	−0.38 (−0.96 to 0.20)	0.20
Wednesday	−0.18 (−0.77 to 0.41)	0.55
Thursday	0.31 (−0.28 to 0.90)	0.30
Friday	−0.16 (−0.74 to 0.42)	0.59
Saturday	0.71 (0.13 to 1.3)	0.016
Sunday	1.1 (0.48 to 1.6)	<0.001
Time category at ambulance call		
Noon (8–15)	(ref)	
Early night (16–23)	1.9 (1.6 to 2.3)	<0.001
Late night (0–7)	2.9 (2.5 to 3.9)	<0.001
Category of suspected illness		
Abdominal pain	−0.93 (−2.0 to 0.12)	0.082
CPA	0.062 (−1.0 to 1.2)	0.92
Stroke	6.2 (5.1 to 7.3)	<0.001
ACS	1.4 (0.14 to 2.7)	0.03
DOC	3.7 (2.2 to 5.2)	<0.001
Trauma	3.8 (3.3 to 4.3)	<0.001
Internal medicine	(ref)	
Orthopaedics except for trauma	2.7 (2.2 to 3.2)	<0.001
Neurosurgery except for stroke and DOC	7.4 (6.8 to 7.9)	<0.001
Surgery except for abdominal pain	−0.076 (−1.1 to 0.97)	0.89
Cardiology except for ACS	5.0 (4.0 to 6.1)	<0.001
Person calling ambulance		
Family or self	(ref)	
Witness	−1.7 (−2.5 to −0.95)	<0.001
Welfare facility	0.6 (0.27 to 1.1)	<0.001
Emergency status at request call		
Less urgency	(ref)	
Urgency	0.59 (0.08 to 1.1)	0.022
Emergency	−0.16 (−0.86 to 0.54)	0.66
Resuscitation	−1.8 (−4.0 to 0.40)	0.11
During assessment	−1.5 (−2.0 to −1.1)	<0.001
The number of request call	6.3 (6.2 to 6.4)	<0.001
Random effects, variance (SD)		
Intercept	95.5 (9.8)	
z-score	23.4	
AIC	320 647	
Radj2	0.44	

ACS, acute coronary syndromes; CPA, Cardiopulmonary arrest; DOC, disturbance of consciousness; request call, request call to hospital for transportation.

myocardial infarction, stroke, cancer, diabetes mellitus and psychiatric illness.[24] Nara prefecture established a medical cooperation system for CPA, stroke, DOC, ACS, abdominal pain, trauma, perinatal problems, paediatrics and psychiatric illness. In spite of national and prefectural efforts, ACS and stroke calls took 1.4 min and 6.2 min longer in transportation time compared to internal medicine. Both ACS and stroke are diseases where time from onset to hospital arrival is important for treatment and outcome.[25–27] A shortage of appropriate healthcare facilities in the region might be the reason for prolonged times from call to hospital arrival for these diseases. As the number of patients with cardiovascular diseases increases in Japan's ageing society, further research that focuses on specific diseases or time series may be required.

This study revealed that transportation times varied depending on the patient's location when the emergency call was made. There was an ~30 min difference in the time from request call to hospital arrival among the 13 districts (minimum of 36.3 min and maximum of 72.6 min) in a single prefecture. Nara prefecture has a long north–south axis with three tertiary emergency hospitals. However, all of these hospitals are located in urban areas that are geographically distant from the southern rural area. As a result, the southern rural area was found to have longer transportation times than the other areas. In that area, the categories of illnesses that require special facilities such as coronary care units or stroke care units had longer transportation times than in other areas. The distance from emergency hospital and appropriate healthcare facilities might be the cause of this difference between areas. One observational study discussed the shortage of emergency medical facilities in rural areas in Japan.[28] One geographical study pointed out that there was a regional gap in the number of tertiary care centres per million people between prefectures in Japan.[29]

Our results also indicate that there are differences in transportation times for specific diseases among regions. In southern rural areas, there were longer transportation times for diseases that needed treatment by specialists such as cardiologists, neurologists, neurosurgeons and orthopaedists than in the other two areas. This might be associated with the shortage of medical facilities for specific illnesses in these regions. Indicating disease-specific problems that are specific to each area is helpful information for improving healthcare systems and is also a strength of our study.

Our database did not include patients' socioeconomic information, except for the person who called an ambulance. In the fields of acute myocardial infarction and stroke, it is known that the time from onset of symptoms to hospital arrival is influenced by many other factors such as living alone,[18] being alone at the onset of symptoms,[19 20] being a non-white patient in the USA[21] and education level.[22] In addition, indicators of patient's socioeconomic status, such as mean income of the residential area[30 31] and race,[30] have also been reported to influence the time from an emergency call to hospital arrival. We think information about the person who called an ambulance would help to indicate the socioeconomic status of patients to some degree.

In our study, we found there were no substantial differences in times between days of the week or seasons. One study in Tennessee, USA, found that the prolongation of transportation time was influenced by seasons due to variations in traffic volume.[23] However, transportation conditions are very different between Tennessee and Nara, which may explain in part the observed differences in results between these two studies.

Our study revealed that time from call to hospital arrival increases by 6.3 min for every request call from EMS to hospital. It also revealed that more than 45% of all request calls and 43% of request calls to hospitals indicating a status of 'Accepting patients' resulted in failure. Driving ambulances at high speed,[32] helicopter transportation[33–35] and centralisation of hospitals[36] might be solutions to reduce transportation time. However, the risk of traffic accidents,[37] costs for helicopter EMS[38 39] and time and cost for centralising hospitals are difficult problems to solve. Hence, it may be important to create a system for quickly determining appropriate hospitals and ensuring faster admissions to decrease the number of request calls.

It may be beneficial for policymakers to create a system to share information about hospitals and emergency patients more promptly especially for an ageing society with an increasing number of ambulance dispatches. One recent cross-sectional study showed that services with tablet computers shortened the transportation time in Saga prefecture, Japan;[40] even though there was no information about time from call to hospital arrival in that study, introducing these support systems would reduce time from call to hospital arrival or transportation time. In prefectures, such as Nara, where a support system with tablet computers was introduced, creating a more effective and convenient system is needed. Physicians are not only required to accept patients if requested, but must also appropriately indicate the hospital's capacity for emergency patients. As a result, this places an additional burden on physicians. Owing to the shortage of physicians in Japan,[41] there is a need for more effective posting of physicians and efficient working systems.

Our study has several limitations. First, patient emergency status was decided by the ambulance crew. Our data do not include vital signs for all patients, because ambulance crews are required to register vital signs of patients for only a limited number of suspected illnesses. We therefore cannot analyse patient's emergency status using vital signs. As ambulance crews assessed patients by rules depending on patient's vital signs and they were also trained under the medical control system,[5] the decisions made by ambulance crews were viewed as credible.

Second, our data consisted of patients in Nara prefecture which is 1 of the 47 prefectures in Japan. Our

results may not be applicable to all prefectures in Japan. However, there is a discrepancy in urbanisation between urbanised areas and mountainous areas such as the southern area. Therefore, we can discuss the differences between areas within one prefecture.

Finally, there are several factors that are known to influence the time from request calls to hospital arrival, but we were unable to include them in the analysis due to data limitations. These factors include prehospital strategies,[42] level of training of ambulance crews,[43] and hospital capacity.[44] Future studies should address the influence of these factors.

CONCLUSIONS

The study revealed that 6.3 additional minutes were added to transportation time by every refusal of a request call and also revealed disease-specific delays among specific areas. A system that helps EMS to find hospitals should be effectively established to share information about hospitals and emergency patients promptly in partnership with policymakers and physicians for reducing the time from call to hospital arrival.

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