

# BMJ Open

## The determinants of the time from emergency call to hospital arrival of ambulances

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2016-012194
Article Type:	Research
Date Submitted by the Author:	12-Apr-2016
Complete List of Authors:	Hanaki, Nao; Kyoto University Graduate School of Medicine, Department of Healthcare Economics and Quality Management Yamashita, Kazuto; Kyoto University Graduate School of Medicine, Department of Healthcare Economics and Quality Management Kunisawa, Susumu; Kyoto University Graduate School of Medicine, Department of Healthcare Economics and Quality Management Imanaka, Yuichi; Kyoto University Graduate School of Medicine, Department of Healthcare Economics and Quality Management
<b>Primary Subject Heading</b>:	Emergency medicine
Secondary Subject Heading:	Health policy
Keywords:	transportation time, request call, emergency medical service

SCHOLARONE™  
Manuscripts

1  
2  
3  
4  
5  
6 **Title:** The determinants of the time from emergency call to hospital arrival of  
7  
8 ambulances  
9  
10

11  
12  
13  
14 **Author Information:** Nao Hanaki, MD; Kazuto Yamashita, MD, Ph.D; Susumu  
15  
16 Kunisawa, MD, Ph.D.; Yuichi Imanaka, MD, MPH, Ph.D.  
17  
18  
19

20  
21  
22  
23 **Affiliations:**  
24

25  
26 Department of Healthcare Economics and Quality Management, Graduate School of  
27  
28 Medicine, Kyoto University, Yoshida Konoe-cho, Sakyo-ku, Kyoto, 606-8501, JAPAN  
29  
30 (Drs. Hanaki, Yamashita, Kunisawa and Imanaka)  
31  
32  
33  
34  
35  
36  
37

38 **Corresponding Author:** Prof. Yuichi Imanaka  
39

40  
41 Department of Healthcare Economics and Quality Management  
42

43  
44 Graduate School of Medicine, Kyoto University  
45

46  
47 Yoshida Konoe-cho, Sakyo-ku, Kyoto, 606-8501, JAPAN  
48

49  
50 TEL: +81-75-753-4454 FAX: +81-75-753-4455  
51

52  
53 E-mail: imanaka-y@umin.net  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 **Disclosure of potential conflict of interest:** All authors declare no financial  
7  
8  
9 relationships that are potentially relevant to this article.  
10

11  
12  
13  
14 **Keywords:** emergency medical service, transportation time, request call  
15  
16  
17

18  
19  
20 **Word count:** 3851 words  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 ABSTRACT  
7  
8

9 Objectives: In Japan, ambulance staff sometimes must make request calls to find  
10 hospitals that can accept patients because of an inadequate information sharing system.

11  
12  
13 This study aimed to quantify effects of the number of request calls on the time interval  
14  
15  
16 between an emergency call and hospital arrival.  
17  
18

19  
20 Design and Setting: A cross-sectional study of an ambulance records database in Nara  
21  
22  
23 prefecture, Japan.  
24

25  
26 Participants: A total of 43,663 patients (50% women; 31.2% aged 80 and over) 1)  
27  
28 transported by ambulance from April, 2013 to March, 2014, 2) aged 15 and over, and 3)  
29  
30  
31 with suspected major illness.  
32  
33

34  
35 Primary outcome measures: The time from call to hospital arrival, defined as the time  
36  
37 interval from receipt of an emergency call to ambulance arrival at a hospital.  
38  
39

40  
41 Results: The mean time interval from emergency call to hospital arrival was 44.5  
42  
43 minutes, and the mean number of requests was 1.8. Multiple linear regression analysis  
44  
45 showed that approximately 43.8% of variation in transportation times was explained by  
46  
47 patient age, sex, season, day of the week, time, category of suspected illness, person  
48  
49 calling for the ambulance, emergency status at request call, area, and number of request  
50  
51  
52 calls. A higher number of request calls was associated with longer time intervals to  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 hospital arrival (addition of 6.3 minutes per request call;  $p<0.001$ ). In an analysis  
7  
8  
9 dividing areas into three groups, there were differences in transportation time for  
10  
11  
12 diseases needing cardiologists, neurologists, neurosurgeons, and orthopedists.

13  
14  
15 Conclusions: The study revealed 6.3 additional minutes needed in transportation time  
16  
17  
18 for every refusal of a request call, and also revealed disease-specific delays among  
19  
20  
21 specific areas. An effective system should be collaboratively established by  
22  
23  
24 policymakers and physicians to ensure the rapid sharing of information about hospitals  
25  
26  
27 and emergency patients in order to reduce the time from the initial emergency call to  
28  
29  
30 hospital arrival.  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

### Strength 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 minutes.
- This study revealed that there is up to approximately a 30-minute difference 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 ambulance crew and our data consisted of patients from one prefecture in Japan.

## [INTRODUCTION]

### Background

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]. The call from the emergency patient is directly accessed by the local fire defense headquarters and the nearest available ambulance is sent to the patient[6]. Ambulance crews search for hospitals which match patient emergency status on the site. Physicians are not able to refuse patients if requested, by article 19 of the Medical Practitioners Law. However, there is no penalty if the law is not followed.

The national average of the time from calling an ambulance to hospital arrival was 39.4 minutes in 2014, 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 aging population in the world[10], and it is estimated that people aged 65 and over were 33,656,000 (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]. Because of

1  
2  
3  
4  
5  
6 advances in aging and an increase in ambulance dispatches, the time from call to  
7  
8 hospital arrival also seems to be increasing.

9  
10  
11 One recent study showed that the number of request calls to hospitals had  
12  
13 greater odds of an on-scene arrival time of over 30 minutes[13]. However, the direct  
14  
15 effect of the number of request calls on the time from call to hospital arrival is unclear.  
16  
17  
18 The aim of this study was to evaluate factors affecting the time to hospital arrival of  
19  
20 ambulances, especially the effect of the number of request calls.  
21  
22  
23  
24  
25  
26  
27  
28

## 29 **METHODS**

30  
31  
32 This was a cross-sectional study. The data sources were an ambulance  
33  
34 transportation records database (transportation database) and an ambulance request call  
35  
36 records database (request call database) in Nara prefecture, Japan. These databases  
37  
38 consist of information about patient characteristics, time and date of each call, and  
39  
40 hospital arrival.  
41  
42  
43  
44  
45

46  
47 Our inclusion criteria were transportation and request calls made by patients 1)  
48  
49 transported from 1 April 2013, to 31 March 2014, 2) aged 15 and older, and 3) with  
50  
51 suspected illness related to internal medicine, trauma, orthopedics, neurosurgery,  
52  
53 abdominal pain, surgery, cardiology, cardiopulmonary arrest (CPA), stroke, acute  
54  
55  
56  
57  
58  
59  
60



1  
2  
3  
4  
5  
6 coronary syndrome (ACS), and disturbance of consciousness (DOC). Patients'  
7  
8  
9 suspected illnesses were categorized into 10 important illnesses and other categories  
10  
11  
12 after assessment by EMS staff. The ten important illnesses were categorized as the  
13  
14 following patient situations: CPA, stroke, DOC, ACS, abdominal pain, trauma, perinatal  
15  
16 problem, pediatrics, and psychiatric illness. We excluded patients with suspected illness  
17  
18 related to perinatal problems, pediatrics, and psychiatric illness because the number of  
19  
20 hospitals which accepted these kind of patients was very small. Other categories were  
21  
22 classified as names of specialties: internal medicine, neurosurgery except for stroke or  
23  
24 DOC, surgery except for abdominal pain, orthopedics except for trauma, and cardiology  
25  
26 except for ACS, and so on. We excluded patients with suspected illnesses, except for  
27  
28 suspected illnesses related to internal medicine, orthopedics, neurosurgery, surgery, and  
29  
30 cardiology, because the number of patients with these kinds of illnesses was not large.  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41 Nara prefecture has established a medical cooperation system for ten important illnesses.  
42  
43  
44 Patients were categorized with "other category of illnesses" if they were not categorized  
45  
46 into one of these important illnesses.  
47  
48

49  
50 We excluded transportation and request calls from hospital to hospital and from  
51  
52 clinic to hospital. We decided upon these inclusion criteria because these illnesses are  
53  
54 important in terms of health policy and affect many patients. We excluded patients who  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 took longer than 1000 minutes for finding hospitals, driving to a hospital, or  
7  
8  
9 transportation as outliers. We also excluded children because the number of hospitals  
10  
11 with transportation of children is very small, and we would have needed to conduct a  
12  
13 separate study for children as distinct from adults. We treated missing data as null.  
14  
15  
16  
17  
18  
19

## 20 **Variables**

21  
22 Time and date of hospital arrival and each call (call for ambulance and request  
23  
24 call), patient characteristics (age and sex), person calling ambulance, district where the  
25  
26 EMS belongs, and patient's emergency status and category of suspicious illness were  
27  
28 recorded by EMS staff or operation staff of the EMS. We divided patients into three  
29  
30 groups and created a categorical variable of age: 1)  $\geq 15, \leq 59$ ; 2)  $\geq 60, \leq 79$ ; and 3)  $\geq 80$ .  
31  
32 We defined the seasons as spring from March to May, summer from June to August,  
33  
34 autumn from September to November, and winter from December to February. We also  
35  
36 defined noon from 8am to 3pm, early night from 4pm to 11pm, and midnight from  
37  
38 12am to 7am. In terms of ambulance control, Nara prefecture is divided into 13 areas  
39  
40 and these areas were used as places where ambulance calls were made.  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54

## 55 **Outcome measures**

1  
2  
3  
4  
5  
6 The primary outcome measure was the time from the initial emergency call to  
7  
8 hospital arrival, or more simply, the time from call for ambulance to hospital arrival.  
9  
10

### 11 **Statistical methods**

12  
13  
14 The main results are given as means and standard deviations (SD) or  
15  
16 interquartile ranges (IQR). To estimate time from call to hospital arrival after removing  
17  
18 unsuccessful request calls, we defined useless request calls as 1) request calls to  
19  
20 hospitals displaying a sign of “Accepting patients” that resulted in failure, and 2)  
21  
22 request calls to hospitals displaying a sign of “Not accepting patients” that resulted in  
23  
24 failure. To conduct this estimation, we merged the transportation database and the  
25  
26 request call database. When the time for a request call was longer than the time from  
27  
28 call to hospital, we decided these were entered incorrectly and then excluded them from  
29  
30 calculations.  
31  
32  
33  
34  
35  
36  
37  
38  
39

40 To evaluate the effect of the number of request calls on time from call to  
41  
42 hospital arrival, we employed multiple linear regression analysis. The predictive  
43  
44 variables were selected on the basis of previous research. To evaluate differences  
45  
46 between areas, we also conducted other multiple linear regression analyses, dividing  
47  
48 patients into three groups depending on the area in terms of urbanization and location:  
49  
50  
51  
52  
53  
54  
55 1) urban areas which are more urbanized than other areas (Areas U1, U2, U3, U4, U5,  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 U6, and U7), 2) the East rural area which consists of areas located in the east side of  
7  
8  
9 Nara prefecture (Areas E1, E2, and E3), and 3) the south rural area which consists of  
10  
11  
12 areas located in the south side of Nara prefecture (Areas S1, S2, and S3).  
13

14  
15 Data analysis was conducted using the statistical software package R, version  
16  
17  
18 3.2.2. Prior to the study, the study procedures were reviewed and approved (#E1023) by  
19  
20  
21 the ethics review committee of Kyoto University Graduate School of Medicine.  
22  
23  
24  
25

## 26 RESULTS

### 27 Participants

28  
29  
30  
31  
32 From April 2013 to March 2014, the number of transportations by ambulance  
33  
34  
35 was 43,663. The patient characteristics during the study period are shown in Table 1.  
36  
37  
38 These results are from the transportation database. Slightly less than one-third of  
39  
40  
41 patients were 80 years old or older, and 50% were female. The percentage of patients  
42  
43  
44 transported during the noon time period was 44.8%, which was a greater proportion  
45  
46  
47 than during other time categories. The number of patients in each area ranged from 723  
48  
49  
50 to 11,223, and the mean was 3358.7 (first and third quartile were 1499 and 4060,  
51  
52  
53 respectively). The time from call to hospital arrival in each area ranged from 36.3  
54  
55  
56 minutes to 72.6 minutes, and the mean was 48.2 minutes (first and third quartile were  
57  
58  
59  
60

41.2 and 53.1, respectively). 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 categorized into lower emergency situations. There were no remarkable differences across seasons or days of the week.

Table 1. Distribution of risk factors and association with transportation time

	n	%	Time from call to hospital arrival, mean (SD)
N = 43,663			
Age, years			
≥15, <60	14,125	32.4	45.1 (22.7)
≥60, <80	15,915	36.4	44.4 (20.2)
≥80	13,623	31.2	43.9 (19.8)
Sex			
Male	21,833	50.0	45.1 (21.7)
Female	21,830	50.0	43.8 (20.1)
Season			
Spring (March-May)	10,406	23.8	44.2 (20.1)
Summer (June-August)	11,187	25.6	43.5 (20.2)
Autumn (September-November)	10,741	24.6	44.5 (20.8)
Winter (December-February)	11,329	25.9	45.7 (22.4)
Day of the week			
Monday	6,627	15.2	43.5 (20.1)
Tuesday	6,133	14.0	43.8 (20.8)
Wednesday	5,838	13.4	43.9 (20.1)
Thursday	5,899	13.5	44.0 (20.8)
Friday	6,134	14.0	43.7 (20.0)

1				
2				
3				
4				
5	Saturday	6,436	14.7	45.8 (21.4)
6	Sunday	6,596	15.1	46.5 (22.7)
7				
8	Time category at ambulance call			
9				
10	Noon (8-15)	19,558	44.8	41.8 (19.4)
11	Early night (16-23)	15,862	36.3	45.9 (21.6)
12	Midnight (0-7)	8,243	18.9	48.1 (22.1)
13				
14	Category of suspected illness			
15				
16	Abdominal pain	1,072	2.5	45.9 (21.2)
17	CPA	984	2.3	43.6 (20.3)
18	Stroke	850	1.9	49.9 (22.1)
19	ACS	686	1.6	42.6 (16.9)
20	DOC	498	1.1	47.6 (19.5)
21	Trauma	6,158	14.1	46.4 (21.4)
22	Internal medicine	21,197	48.5	42.3 (19.8)
23	Orthopedics except for trauma	5,895	13.5	45.5 (22.3)
24	Neurosurgery except for stroke and DOC	4,254	9.7	50.4 (22.4)
25	Surgery except for abdominal pain	1,066	2.4	42.6 (21.7)
26	Cardiology except for ACS	1,003	2.3	44.9 (20.4)
27				
28	Person calling ambulance			
29				
30	Family or self	27,041	70.3	44.4 (20.6)
31	Witness	9,501	24.7	44.9 (21.8)
32	Welfare facility	1,906	5.0	42.3 (19.6)
33				
34	Emergency status at request call			
35				
36	Less urgency	25,535	58.5	45.3 (21.0)
37	Urgency	5,243	12.0	45.8 (20.9)
38	Emergency	2,659	6.1	46.4 (22.0)
39	Resuscitation	241	0.6	42.4 (18.0)
40	Mid-assessment	9,983	22.9	41.4 (20.1)
41				
42				
43				
44				
45				

SD: standard deviation, ACS: acute coronary syndromes, CPA: Cardiopulmonary arrest, DOC: disturbance of consciousness, request call: request call to hospital for transportation

### 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. Our database did not include the time from completion of request calls to leaving the scene or the time from getting into the hospital and delivering a patient to hospital staff (hospital arrival for patient). It took 11.2 minutes to evaluate the patient, on average. A shaded area shows the time from the beginning to the ending of request calls. It took 9.0 min to find the hospital to which a patient was transferred at the scene.

#### Time and the number of request calls

The mean time from call to hospital arrival was 44.5 min, and the mean number of requests was 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 request calls made, the more time spent from call to hospital arrival.

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

Number of request calls	n		Time from call to hospital arrival			
	N = 43,663	%	Mean	Median	1st Qu-3rd Qu	
1	29,499	67.6	38.2	35.0	29.0-44.0	
2	6,302	14.4	47.8	45.0	37.0-54.0	
3	3,150	7.2	55.1	52.0	43.0-62.0	
4	1,816	4.2	61.2	58.0	49.0-70.0	

5	971	2.2	68.9	66.0	55.0-78.0
6	625	1.4	73.0	69.0	59.0-82.0
7	395	0.9	79.5	76.0	65.0-89.0
8	278	0.6	81.5	79.0	67.3-91.8
9	173	0.4	92.6	89.0	73.0-104.0
10	126	0.3	90.8	90.5	74.3-105.0
≥11	328	0.8	109.6	102.5	86.0-122.2

Request call: request call to hospital for transportation, Qu: quantile

Table 3 shows the numbers and the times for request calls, categorized by hospital situations and request results. There were 80,666 request calls for 43,663 transportations. The number of useless request calls was 36,403 (44.5%) and these took almost 230,000 minutes total. After calculations excluding request calls whose duration was longer than the time from call to hospital, there were no significant differences in the time for one request call between categories. When the mean time from call to hospital arrival was calculated without useless request calls, it was shortened by 3.5 minutes.

Table 3. The numbers and times for request calls, categorized by hospital situations and request results

Number of request calls		Time for one request call, mean (SD)*
N = 80,066	N = 79,693*	
n (%)	n (%)	



Request call for "ACCEPTING" hospital resulted in success	32,416 (40.5)	32,416 (40.7)	4.9 (3.4)
Request call for "NOT ACCEPTING" hospital resulted in success	11,247 (14.0)	11,247 (14.1)	4.5 (3.9)
Request call for "ACCEPTING" hospital resulted in failure	24,902 (31.1)	24,629 (30.9)	4.2 (3.1)
Request call "NOT ACCEPTING" hospital resulted in failure	11,501 (14.4)	11,401 (14.3)	4.2 (3.5)

SD: standard deviation, request call: request call to hospital for transportation, ACCEPTING: announced accepting ambulances for emergency medical services, NA: not applicable because of missing referral result

\*: This result was from those request calls whose duration was not longer than the time from call to hospital.

## Main results

We used a multiple linear regression model 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 suspicious illness, person calling ambulance, emergency status at request call, and the number of request calls (see Table 4). We found that the number of request calls affects time from call to hospital arrival ( $\beta= 6.3$ ,  $p<0.001$ ). We also found an association between time from call to hospital arrival and age, sex, season, and person calling ambulance. From the analyses dividing patients into three groups depending on the area, the south rural area took much longer

times in neurosurgery, stroke, trauma, ACS, orthopedics, and cardiology, with reference to internal medicine, than the urban area, and it was prolonged 11.5, 10.0, 10.0, 9.9, 9.2, and 9.2 minutes, respectively. (See Supplementary Table 1). The east rural area took a much longer time in neurosurgery and trauma, with reference to internal medicine, than the urban area, and it was prolonged 9.1 and 8.1 minutes, respectively. The time in the south rural area was longer than in other areas.

Table 4. Time from call to hospital arrival: Multiple linear regression model

Explanatory variable	Estimate (95%CI)	P-value	AIC	Radj2
Intercept	27.5 (26.5, 28.5)		211,448	0.44
Age				
≥15, <60	(ref)			
≥60, <80	1.14 (0.75, 1.53)	<0.001		
≥80	0.94 (0.52, 1.36)	<0.001		
Sex				
Female	(ref)			
Male	0.64 (0.32, 0.96)	<0.001		
Season				
Spring (March-May)	(ref)			
Summer (June-August)	-0.50 (-0.94, -0.05)	0.028		
Autumn (September-November)	0.57 (0.12, 1.02)	0.012		
Winter (December-February)	0.98 (0.54, 1.42)	<0.001		
Day of the week				
Monday	(ref)			
Tuesday	-0.38 (-0.96, 0.20)	0.20		
Wednesday	-0.18 (-0.77, 0.41)	0.55		
Thursday	0.31 (-0.28, 0.90)	0.30		
Friday	-0.16 (-0.74, 0.42)	0.59		
Saturday	0.71 (0.13, 1.28)	0.016		
Sunday	1.1 (0.48, 1.63)	<0.001		

1			
2			
3			
4			
5	Time category at ambulance call		
6			
7	Noon (8-15)	(ref)	
8	Early night (16-23)	1.9 (1.58, 2.29)	<0.001
9	Midnight (0-7)	2.9 (2.49, 3.38)	<0.001
10			
11	Area		
12			
13	U1	(ref)	
14	U2	-6.7 (-7.4, -6.0)	<0.001
15	U3	-5.3 (-6.0, -4.6)	<0.001
16			
17	U4	0.50 (-0.55, 1.6)	0.35
18	U5	-2.5 (-3.1, -1.9)	<0.001
19			
20	U6	-5.4 (-5.9, -4.8)	<0.001
21	U7	-5.6 (-6.3, -4.9)	<0.001
22			
23	E1	2.8 (2.0, 3.6)	<0.001
24	E2	15.9 (15.0, 16.7)	<0.001
25	E3	-1.4 (-2.0, -0.74)	0.01
26			
27	S1	12.1 (11.2, 13.0)	<0.001
28	S2	26.1 (24.8, 27.3)	<0.001
29	S3	3.4 (2.4, 4.5)	<0.001
30			
31	Category of suspected illness		
32			
33	Abdominal pain	-0.93 (-2.0, 0.12)	0.082
34	CPA	0.06 (-1.0, 1.2)	0.92
35	Stroke	6.2 (5.1, 7.3)	<0.001
36	ACS	1.4 (0.14, 2.7)	0.03
37	DOC	3.7 (2.2, 5.2)	0.0038
38	Trauma	3.8 (3.3, 4.3)	<0.001
39			
40	Internal medicine	(ref)	
41	Orthopedics except for trauma	2.7 (2.2, 3.2)	<0.001
42	Neurosurgery except for stroke and		
43		7.4 (6.8, 7.9)	<0.001
44	DOC		
45	Surgery except for abdominal pain	-0.08 (-1.1, 0.97)	0.89
46	Cardiology except for ACS	5.0 (4.0, 6.1)	<0.001
47			
48	Person calling ambulance		
49			
50	Family or self	(ref)	
51	Witness	1.7 (0.95, 2.5)	<0.001
52	Welfare facility	2.4 (1.6, 3.2)	<0.001
53			
54	Emergency status at request call		
55			
56			
57			
58			
59			
60			

Less urgency	(ref)	
Urgency	0.59 (0.08, 1.1)	0.022
Emergency	-0.16 (-0.86, 0.54)	0.66
Resuscitation	-1.8 (-4.0, 0.40)	0.11
During assessment	-1.5 (-2.0, -1.1)	<0.001
The number of request calls, mean (SD)	6.3 (6.2, 6.4)	<0.001

SD: standard deviation, ACS: acute coronary syndromes, CPA: Cardiopulmonary arrest, DOC: disturbance of consciousness, request call: request call to hospital for transportation

## DISCUSSION

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

Regarding the category of suspicious 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 myocardial infarction, stroke, cancer, diabetes mellitus, and psychiatric illness[14]. Nara prefecture established a medical cooperation system for

1  
2  
3  
4  
5  
6 CPA, stroke, DOC, ACS, abdominal pain, trauma, perinatal problems, pediatrics, and  
7  
8  
9 psychiatric illness. In spite of national and prefectural efforts, ACS and stroke calls took  
10  
11  
12 1.4 minutes and 6.2 minutes longer in transportation time compared to Internal  
13  
14  
15 medicine. Both acute coronary syndrome and stroke are diseases where time from onset  
16  
17  
18 to hospital arrival is important for treatment and outcome[15–17]. A shortage of  
19  
20  
21 appropriate healthcare facilities in the region might be the reason for prolonged times  
22  
23  
24 from call to hospital arrival for these diseases. Further research focusing on specific  
25  
26  
27 diseases or time series might be needed.

28  
29 This study revealed that there is up to an approximately 30-minute difference in  
30  
31  
32 the time from call to hospital arrival among areas in the same prefecture (36.3 minutes  
33  
34  
35 in the shortest area and 72.6 min in the longest area). Nara is a prefecture that has a long  
36  
37  
38 north-south axis. There are three tertiary emergency hospitals in Nara prefecture, but all  
39  
40  
41 of them are located in urban areas (Areas U1, U3, and U6) that are far from the southern  
42  
43  
44 rural area. The southern area (Areas S1, S2, and S3) had longer transportation times  
45  
46  
47 than the other areas. In the southern area, categories of illnesses that seemed to need  
48  
49  
50 special facilities took longer times than in other areas. The distance from emergency  
51  
52  
53 hospital and appropriate healthcare facilities might be the cause of this difference  
54  
55  
56 between areas. One observational study discussed the shortage of emergency medical  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 facilities in rural areas in Japan[18]. One geographical study pointed out that there was a  
7  
8 regional gap in the number of tertiary care centers per million people between  
9  
10 prefectures in Japan[19].  
11

12  
13  
14 Our results also indicate that there are differences in transportation times for  
15  
16 specific diseases among regions. In southern rural areas, there were longer  
17  
18 transportation times for diseases which needed treatment by specialists such as  
19  
20 cardiologists, neurologists, neurosurgeons, and orthopedists than in the other two areas.  
21  
22 This might be associated with the shortage of medical facilities for specific illnesses in  
23  
24 these regions. Indicating disease-specific problems that are specific to each area is  
25  
26 helpful information for improving health care systems and is also a strength of our  
27  
28 study.  
29  
30  
31  
32  
33  
34  
35  
36  
37

38 Our database did not include socioeconomic information of patients, except for  
39  
40 the person who called an ambulance. In the field of acute myocardial infarction and  
41  
42 stroke, it is known that time from onset of symptoms to hospital arrival are influenced  
43  
44 by many other factors such as living alone[20], being alone at onset of symptoms[21,22],  
45  
46 being a nonwhite patient in the United States [23], and education level[24]. But, there  
47  
48 are very few studies about the relationship between time from call to hospital arrival and  
49  
50 socioeconomic factors. A cohort study showed only small statistically significant delays  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 in time from call to hospital arrival in patients living in poorer communities and those of  
7  
8  
9 black race[25]. We think information about the person who called an ambulance would  
10  
11  
12 help to indicate the socioeconomic status of patients to some degree.

13  
14  
15 In our study, we found there are no substantial differences in time between days  
16  
17  
18 of the week or seasons. One study in Tennessee, USA, found that the prolongation of  
19  
20  
21 transportation time was influenced by seasons due to variations in traffic volume[26].  
22  
23  
24 However, transportation conditions were completely different between these two  
25  
26  
27 regions and this might be one reason for differences in results between these two  
28  
29  
30 studies.

31  
32  
33 Our study revealed that time from call to hospital arrival increases by 6.3  
34  
35  
36 minutes for every request call from EMS to hospital. Driving ambulances at high  
37  
38  
39 speed[27], helicopter transportation[28–30] and centralization of hospitals[31] might be  
40  
41  
42 solutions to reduce transportation time. However, the risk of traffic accidents[32], costs  
43  
44  
45 for helicopter emergency medical services[33,34], and time and cost for centralizing  
46  
47  
48 hospitals are difficult problems to solve. Hence, it seems important to create a system  
49  
50  
51 for determining hospital admissions more quickly. As emergency transport systems are  
52  
53  
54 managed by local governments, local governments ought to create a system to share  
55  
56  
57 information about hospitals and emergency patients more promptly. One recent  
58  
59  
60

1  
2  
3  
4  
5  
6 cross-sectional study showed that services with tablet computers shortened the  
7  
8  
9 transportation time in Saga prefecture, Japan[35]. Even though there is no information  
10  
11  
12 about time from call to hospital arrival in this study, introducing these support systems  
13  
14  
15 would reduce time from call to hospital arrival or transportation time. In prefectures,  
16  
17  
18 such as Nara prefecture, where a support system with tablet computers was introduced,  
19  
20  
21 creating a more effective and convenient system is needed.

22  
23  
24 It was revealed that more than 45% of all request calls and 43 % of request  
25  
26  
27 calls to hospitals displaying a sign of “Accepting patients” result in failure. For  
28  
29  
30 physicians, they are required not only to accept patients if requested but also to display  
31  
32  
33 the hospital capacity for emergency patients appropriately. As the shortage of physicians  
34  
35  
36 is also discussed in Japan[36], effective posting of physicians and efficient working  
37  
38  
39 systems are needed.

40  
41  
42 Our study has several limitations. First, patient emergency status was decided  
43  
44  
45 by ambulance crew. Our data does not include vital signs for all patients, because  
46  
47  
48 ambulance crews are required to register vital signs of patients for only a limited  
49  
50  
51 number of suspected illnesses. We cannot analyze patient emergency status using vital  
52  
53  
54 signs. As ambulance crews assessed patients by rules depending on patient’s vital signs  
55  
56  
57 and they were also trained under the medical control system[5], the decisions made by  
58  
59  
60



1  
2  
3  
4  
5  
6 ambulance crew were viewed as credible.  
7  
8

9           Second, our data consisted of patients in Nara prefecture. Nara prefecture is  
10 one of 47 prefectures in Japan. Our results may not be applicable to all prefectures in  
11 Japan. However, there is a discrepancy in urbanization between urbanized areas and  
12 mountainous areas such as the southern area. Therefore, we can discuss the differences  
13 between areas within one prefecture.  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26

## 27 **Conclusions**

28  
29           The study revealed 6.3 additional minutes were added to transportation time by  
30 every refusal of a request call and also revealed disease-specific delays among specific  
31 areas. A system that helps EMS to find hospitals should be effectively established to  
32 share information about hospitals and emergency patients promptly in partnership with  
33 policy makers and physicians for reducing the time from call to hospital arrival.  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46

## 47 **Contributors**

48  
49           NH has had the main responsibility for calculating statistics and writing the paper. YI is  
50 the principal investigator for the project, has planned the present paper jointly with NH,  
51 and has actively taken part in revising the paper. KY and SK have taken part in planning  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 and analyzing data and revising paper.  
7  
8  
9

### 10 11 12 **Funding** 13

14 This work was financially supported in part by Health Sciences Research Grants from  
15 the Ministry of Health, Labour and Welfare of Japan (H27-iryō-ippān-001), and a  
16 Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of  
17 Science ((A) 25253033).  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28

### 29 **Competing interests** 30

31  
32 Kyoto University Department of Healthcare Economics and Quality Management had a  
33 financial contract with Nara prefecture to support analysis of its healthcare system.  
34  
35

36 This study is out of the scope of the contract, and is not financed by Nara prefecture.  
37

38  
39 Otherwise, all authors declare no financial relationships that are potentially relevant to  
40 this article.  
41  
42  
43  
44  
45  
46  
47  
48

### 49 **Ethical approval** 50

51  
52 This study was approved by the Ethical Committee, Kyoto University Graduate School  
53 of Medicine, Japan  
54  
55  
56  
57  
58  
59  
60

### Data sharing statement

No additional data are available for sharing, because of data sharing policy.

### REFERENCES

- 1 Hori S. Emergency medicine in Japan. *Keio J Med* 2010;**59**:131–  
9.<http://www.ncbi.nlm.nih.gov/pubmed/21187699> (accessed 22 Dec2015).
- 2 EDITORIAL: Medical emergencies. The Asahi Shimbun.  
2007.<http://database.asahi.com/library2/main/start.php>
- 3 No progress in emergency pregnancy care. Japan News.  
2007;:03.<https://database.yomiuri.co.jp/rekishikan/>
- 4 Shiga T, Sato T. Current emergency medical systems in Japan. *Jpn Hosp*  
2008;:71–3.<http://www.ncbi.nlm.nih.gov/pubmed/19195153> (accessed 22  
Dec2015).
- 5 Tanigawa K, Tanaka K. Emergency medical service systems in Japan: past,  
present, and future. *Resuscitation* 2006;**69**:365–70.  
doi:10.1016/j.resuscitation.2006.04.001
- 6 Suzuki T, Nishida M, Suzuki Y, *et al.* Issues and Solutions in Introducing

- 1  
2  
3  
4  
5  
6 Western Systems to the Pre-hospital Care System in Japan. *West J Emerg Med*  
7  
8  
9 2008;**9**:166–  
10  
11  
12 70.<http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2672269&tool=pmcentrez&rendertype=abstract> (accessed 22 Dec2015).  
13  
14  
15  
16  
17  
18 7 Japan Fire and Disaster Management Agency. The 2015 white paper (Japanese)  
19  
20 2015. 2015;:67.[http://www.fdma.go.jp/neuter/topics/fieldList9\\_3.html](http://www.fdma.go.jp/neuter/topics/fieldList9_3.html) (accessed  
21  
22 23 Mar2016).  
23  
24  
25  
26 8 Takahashi M, Kohsaka S, Miyata H, *et al*. Association between prehospital time  
27  
28 interval and short-term outcome in acute heart failure patients. *J Card Fail*  
29  
30 2011;**17**:742–7. doi:10.1016/j.cardfail.2011.05.005  
31  
32  
33  
34  
35 9 Dinh MM, Bein K, Roncal S, *et al*. Redefining the golden hour for severe head  
36  
37 injury in an urban setting: the effect of prehospital arrival times on patient  
38  
39 outcomes. *Injury* 2013;**44**:606–10. doi:10.1016/j.injury.2012.01.011  
40  
41  
42  
43  
44 10 World Population Prospects - Population Division - United Nations.  
45  
46 <http://esa.un.org/unpd/wpp/Publications/> (accessed 19 Jan2016).  
47  
48  
49  
50 11 Statistics Bureau Home Page/Population Estimates Monthly Report.  
51  
52 <http://www.stat.go.jp/english/data/jinsui/tsuki/index.htm> (accessed 19 Jan2016).  
53  
54  
55  
56 12 Annual Report on the Aging Society: 2014 (Summary) - Cabinet Office Home  
57  
58  
59  
60

Page. [http://www8.cao.go.jp/kourei/english/annualreport/2014/2014pdf\\_e.html](http://www8.cao.go.jp/kourei/english/annualreport/2014/2014pdf_e.html)

(accessed 19 Jan2016).

- 13 Nagata I, Abe T, Nakata Y, *et al.* Factors related to prolonged on-scene time during ambulance transportation for critical emergency patients in a big city in Japan: a population-based observational study. *BMJ Open* 2016;**6**:e009599. doi:10.1136/bmjopen-2015-009599
- 14 Ministry of Health L and W. Ministry of Health, Labour and Welfare: Medical Care. <http://www.mhlw.go.jp/english/policy/health-medical/medical-care/index.html> (accessed 25 Jan2016).
- 15 Francone M, Bucciarelli-Ducci C, Carbone I, *et al.* Impact of primary coronary angioplasty delay on myocardial salvage, infarct size, and microvascular damage in patients with ST-segment elevation myocardial infarction: insight from cardiovascular magnetic resonance. *J Am Coll Cardiol* 2009;**54**:2145–53. doi:10.1016/j.jacc.2009.08.024
- 16 Aquaro GD, Pingitore A, Strata E, *et al.* Relation of pain-to-balloon time and myocardial infarct size in patients transferred for primary percutaneous coronary intervention. *Am J Cardiol* 2007;**100**:28–34. doi:10.1016/j.amjcard.2007.02.050

- 1  
2  
3  
4  
5  
6 17 Powers WJ, Derdeyn CP, Biller J, *et al.* 2015 AHA/ASA Focused Update of the  
7  
8  
9 2013 Guidelines for the Early Management of Patients With Acute Ischemic  
10  
11  
12 Stroke Regarding Endovascular Treatment. *Stroke*  
13  
14  
15 2015;**46**:STR.0000000000000074. doi:10.1161/STR.0000000000000074  
16  
17  
18 18 Ehara A. Are city population and the number of emergency medical facilities  
19  
20 correlated? *Pediatr Int* 2009;**51**:258–9. doi:10.1111/j.1442-200X.2008.02694.x  
21  
22  
23 19 Miwa M, Kawaguchi H, Arima H, *et al.* The effect of the development of an  
24  
25 emergency transfer system on the travel time to tertiary care centres in Japan. *Int*  
26  
27 *J Health Geogr* 2006;**5**:25. doi:10.1186/1476-072X-5-25  
28  
29  
30 20 Bouma J, Broer J, Bleeker J, *et al.* Longer pre-hospital delay in acute myocardial  
31  
32 infarction in women because of longer doctor decision time. *J Epidemiol*  
33  
34 *Community Health* 1999;**53**:459–  
35  
36 64.<http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1756944&tool=pmcentrez&rendertype=abstract> (accessed 20 Jan2016).  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46 21 Raczynski JM, Finnegan JR, Zapka JG, *et al.* REACT theory-based intervention  
47  
48 to reduce treatment-seeking delay for acute myocardial infarction. Rapid Early  
49  
50 Action for Coronary Treatment. *Am J Prev Med* 1999;**16**:325–  
51  
52 34.<http://www.ncbi.nlm.nih.gov/pubmed/10493291> (accessed 20 Jan2016).  
53  
54  
55  
56  
57  
58  
59  
60

- 1  
2  
3  
4  
5  
6 22 Perry K, Petrie KJ, Ellis CJ, *et al*. Symptom expectations and delay in acute  
7  
8 myocardial infarction patients. *Heart* 2001;**86**:91–  
9  
10 3.[http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1729795&tool=pm](http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1729795&tool=pmcentrez&rendertype=abstract)  
11  
12 centrez&rendertype=abstract (accessed 20 Jan2016).  
13  
14  
15  
16  
17 23 Goldberg RJ, Gurwitz JH, Gore JM. Duration of, and temporal trends  
18  
19 (1994-1997) in, prehospital delay in patients with acute myocardial infarction:  
20  
21 the second National Registry of Myocardial Infarction. *Arch Intern Med*  
22  
23 1999;**159**:2141–7.<http://www.ncbi.nlm.nih.gov/pubmed/10527291> (accessed 20  
24  
25 Jan2016).  
26  
27  
28  
29  
30  
31 24 Zapka JG, Oakes JM, Simons-Morton DG, *et al*. Missed opportunities to impact  
32  
33 fast response to AMI symptoms. *Patient Educ Couns* 2000;**40**:67–  
34  
35 82.<http://www.ncbi.nlm.nih.gov/pubmed/10705066> (accessed 20 Jan2016).  
36  
37  
38  
39  
40 25 Kleindorfer DO, Lindsell CJ, Broderick JP, *et al*. Community socioeconomic  
41  
42 status and prehospital times in acute stroke and transient ischemic attack: do  
43  
44 poorer patients have longer delays from 911 call to the emergency department?  
45  
46  
47  
48  
49  
50  
51  
52  
53 26 Golden AP, Odoi A. Emergency medical services transport delays for suspected  
54  
55 stroke and myocardial infarction patients. *BMC Emerg Med* 2015;**15**:34.  
56  
57  
58  
59  
60

- 1  
2  
3  
4  
5  
6 doi:10.1186/s12873-015-0060-3  
7  
8  
9 27 Petzäll K, Petzäll J, Jansson J, *et al.* Time saved with high speed driving of  
10 ambulances. *Accid Anal Prev* 2011;**43**:818–22. doi:10.1016/j.aap.2010.10.032  
11  
12  
13  
14 28 Funder KS, Rasmussen LS, Lohse N, *et al.* Long-term follow-up of trauma  
15 patients before and after implementation of a physician-staffed helicopter: A  
16 prospective observational study. *Injury* 2016;**47**:7–13.  
17  
18  
19  
20  
21  
22  
23 doi:10.1016/j.injury.2015.10.032  
24  
25  
26 29 Fjaeldstad A, Kirk MH, Knudsen L, *et al.* Physician-staffed emergency  
27 helicopter reduces transportation time from alarm call to highly specialized centre.  
28  
29  
30  
31  
32 *Dan Med J* 2013;**60**:A4666.<http://www.ncbi.nlm.nih.gov/pubmed/23809975>  
33  
34  
35 (accessed 3 Dec2015).  
36  
37  
38 30 Johnsen AS, Fattah S, Sollid SJM, *et al.* Utilisation of helicopter emergency  
39 medical services in the early medical response to major incidents: a systematic  
40 literature review. *BMJ Open* 2016;**6**:e010307.  
41  
42  
43  
44  
45  
46  
47 doi:10.1136/bmjopen-2015-010307  
48  
49 31 Kobayashi D, Otsubo T, Imanaka Y. The effect of centralization of health care  
50 services on travel time and its equality. *Health Policy* 2015;**119**:298–306.  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60



- 1  
2  
3  
4  
5  
6 32 Becker LR, Zaloshnja E, Levick N, *et al.* Relative risk of injury and death in  
7  
8 ambulances and other emergency vehicles. *Accid Anal Prev* 2003;**35**:941–  
9  
10 8.<http://www.ncbi.nlm.nih.gov/pubmed/12971929> (accessed 27 Jan2016).  
11  
12  
13  
14 33 Taylor CB, Stevenson M, Jan S, *et al.* A systematic review of the costs and  
15  
16 benefits of helicopter emergency medical services. *Injury* 2010;**41**:10–20.  
17  
18 doi:10.1016/j.injury.2009.09.030  
19  
20  
21  
22  
23 34 Taylor C, Jan S, Curtis K, *et al.* The cost-effectiveness of physician staffed  
24  
25 Helicopter Emergency Medical Service (HEMS) transport to a major trauma  
26  
27 centre in NSW, Australia. *Injury* 2012;**43**:1843–9.  
28  
29  
30  
31  
32 doi:10.1016/j.injury.2012.07.184  
33  
34  
35 35 Yamada KC, Inoue S, Sakamoto Y. An effective support system of emergency  
36  
37 medical services with tablet computers. *JMIR mHealth uHealth* 2015;**3**:e23.  
38  
39  
40  
41  
42  
43  
44 36 Ishikawa T, Ohba H, Yokooka Y, *et al.* Forecasting the absolute and relative  
45  
46 shortage of physicians in Japan using a system dynamics model approach. *Hum*  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

**Legend of Figure 1**

Figure 1. Components of time from call to hospital admission

For peer review only

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

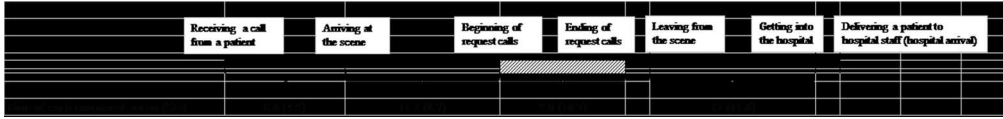


Figure 1. Components of time from call to hospital admission

314x36mm (96 x 96 DPI)

For peer review only

Supplement table 1. Difference between the areas of time from call to hospital arrival: Multiple linear regression model

Formatted: Left

Formatted Table

Explanatory variable	Urban area (n = 32657)		East rural area (n = 7661)		South rural area (n = 3345)	
	Estimate (95%CI)	P-value	Estimate (95%CI)	P-value	Estimate	P-value
Intercept	29.7 (28.6, 30.7)	<0.001	30.8 (28.3, 33.3)	<0.001	27.4 (22.0, 32.7)	
Category of suspicious illness						
Abdominal pain	-0.74 (-1.9, 0.41)	0.21	-1.5 (-3.6, 0.57)	0.15	1.9 (-4.1, 8.0)	0.53
CPA	-1.2 (12.4, -0.029)	0.044	4.6 (2.3, 6.8)	0.048	-0.12 (-6.6, 6.4)	0.97
Stroke	6.4 (5.1, 7.7)	<0.001	5.9 (3.8, 8.0)	0.0011	9.9 (0.54, 17.8)	0.0038
ACS	0.26 (-1.2, 1.8)	0.73	2.1 (-0.21, 4.4)	0.075	10.0 (3.5, 16.6)	0.0027
DOC	3.8 (2.0, 5.5)	0.01	4.4 (1.9, 7.0)	0.00065	4.7 (-6.2, 15.6)	0.40
Trauma	1.8 (1.2, 2.3)	<0.001	8.1 (7.1, 9.2)	<0.001	10.0 (6.7, 13.2)	<0.001
Internal medicine	(ref)		(ref)		(ref)	
Orthopedics except for Trauma	1.5 (1.0, 2.0)	<0.001	4.5 (3.2, 5.7)	<0.001	9.2 (6.2, 12.1)	<0.001
Neurosurgery except for Stroke and DOC	6.6 (6.0, 7.1)	<0.001	9.1 (7.7, 10.5)	<0.001	11.5 (8.0, 14.9)	<0.001
Surgery except for Abdominal pain	-0.081 (-1.1, 0.98)	0.88	-0.34 (-3.3, 2.6)	0.82	-0.48 (-6.6, 5.6)	0.88
Cardiology except for ACS	4.4 (3.4, 5.4)	<0.001	5.5 (1.9, 9.1)	0.0025	9.2 (0.54, 17.8)	0.37

SD: standard deviation, ACS: acute coronary syndromes, CPA: Cardiopulmonary arrest,  
 DOC: disturbance of consciousness, referral call: referral call to hospital for transportation

Urban area, East rural area, and South rural area consists of 7, 3 and 3 areas respectively.

This table shows only the result of Category of suspicious illness.

For peer review only

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

## STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract - p3 in abstract and p7 in METHODS (b) Provide in the abstract an informative and balanced summary of what was done and what was found – p3
<b>Introduction</b>		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported -p6
Objectives	3	State specific objectives, including any prespecified hypotheses – p7
<b>Methods</b>		
Study design	4	Present key elements of study design early in the paper – p7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection –p7-8
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants - p7 (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable – p9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group –p7
Bias	9	Describe any efforts to address potential sources of bias – p8
Study size	10	Explain how the study size was arrived at – p7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why - p10
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding –p10 (b) Describe any methods used to examine subgroups and interactions –p10 (c) Explain how missing data were addressed –p9 (d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy – p10 (e) Describe any sensitivity analyses –p10

Continued on next page

**Results**

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed –p11 (b) Give reasons for non-participation at each stage –p11 (c) Consider use of a flow diagram – no use
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders –p11 (b) Indicate number of participants with missing data for each variable of interest-p12 table1 (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure -p12 <i>Cross-sectional study</i> —Report numbers of outcome events or summary measures
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included-p16 (b) Report category boundaries when continuous variables were categorized –p12 (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period – no entry because
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses –p16 and supplement table 1

**Discussion**

Key results	18	Summarise key results with reference to study objectives - p19
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias –p23
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence –p19
Generalisability	21	Discuss the generalisability (external validity) of the study results –p23

**Other information**

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based –p24
---------	----	--

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## The 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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2016-012194.R1
Article Type:	Research
Date Submitted by the Author:	26-Jun-2016
Complete List of Authors:	Hanaki, Nao; Kyoto University Graduate School of Medicine, Department of Healthcare Economics and Quality Management Yamashita, Kazuto; Kyoto University Graduate School of Medicine, Department of Healthcare Economics and Quality Management Kunisawa, Susumu; Kyoto University Graduate School of Medicine, Department of Healthcare Economics and Quality Management Imanaka, Yuichi; Kyoto University Graduate School of Medicine, Department of Healthcare Economics and Quality Management
<b>Primary Subject Heading</b>:	Emergency medicine
Secondary Subject Heading:	Health policy
Keywords:	transportation time, request call, emergency medical service

SCHOLARONE™  
Manuscripts



1  
2  
3  
4  
5  
6 **Title:** The effect of the number of request calls on the time from call to hospital arrival:  
7  
8

9 a cross-sectional study of an ambulance record database in Nara prefecture, Japan  
10  
11  
12  
13  
14  
15  
16  
17

18 **Author Information:** Nao Hanaki, MD; Kazuto Yamashita, MD, Ph.D.; Susumu  
19

20 Kunisawa, MD, Ph.D.; Yuichi Imanaka, MD, MPH, Ph.D.  
21  
22  
23  
24  
25  
26  
27

28 **Authors' Affiliation:**

29 Department of Healthcare Economics and Quality Management, Graduate School of  
30

31 Medicine, Kyoto University, Yoshida Konoe-cho, Sakyo-ku, Kyoto, 606-8501, JAPAN  
32  
33  
34

35 (Drs. Hanaki, Yamashita, Kunisawa and Imanaka)  
36  
37  
38  
39  
40  
41

42 **Corresponding Author:** Prof. Yuichi Imanaka

43 Department of Healthcare Economics and Quality Management  
44

45 Graduate School of Medicine, Kyoto University  
46  
47

48 Yoshida Konoe-cho, Sakyo-ku, Kyoto, 606-8501, JAPAN  
49  
50

51 TEL: +81-75-753-4454 FAX: +81-75-753-4455  
52  
53  
54

55 E-mail: [imanaka-y@umin.net](mailto:imanaka-y@umin.net)  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6  
7  
8  
9 **Disclosure of potential conflict of interest:** All authors declare no financial  
10  
11 relationships that are potentially relevant to this article.  
12  
13

14  
15  
16  
17 **Keywords:** emergency medical service, transportation time, request call  
18  
19

20  
21  
22  
23 **Word count:** 3728 words  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

## 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 and over) 1) transported by ambulance from April, 2013 to March, 2014, 2) aged 15 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 minutes, and the mean number of requests was 1.8. Multilevel linear regression analysis showed that approximately 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

1  
2  
3  
4  
5  
6 hospital arrival (addition of 6.3 minutes per request call;  $p<0.001$ ). In an analysis  
7  
8  
9 dividing areas into three groups, there were differences in transportation time for  
10  
11  
12 diseases needing cardiologists, neurologists, neurosurgeons, and orthopedists.

13  
14  
15 Conclusions: The study revealed 6.3 additional minutes needed in transportation time  
16  
17  
18 for every refusal of a request call, and also revealed disease-specific delays among  
19  
20  
21 specific areas. An effective system should be collaboratively established by  
22  
23  
24 policymakers and physicians to ensure the rapid identification of an available hospital  
25  
26  
27 for patient transportation in order to reduce the time from the initial emergency call to  
28  
29  
30 hospital arrival.  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

### Strength 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 minutes.
- This study revealed that there is up to approximately a 30-minute difference 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 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 dialing ('119'). The emergency call is directly received by the local fire defense 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 are unable to refuse patients without good reason.

1  
2  
3  
4  
5  
6 The national average of the time from calling an ambulance to hospital arrival  
7  
8  
9 was 39.4 minutes in 2014, is increasing every year[7], and is a known predictor of  
10  
11  
12 outcomes of acute heart failure[8] and head trauma[9]. Japan has the most rapidly aging  
13  
14  
15 population in the world[10], and it is estimated that people aged 65 and over were  
16  
17  
18 33,656,000 (26.5% of the population) in 2015[11]. As the number of elderly people will  
19  
20  
21 reach a peak of 33.78 million in 2042, the percentage of elderly people will reach  
22  
23  
24 39.9 % in 2060[12]. The number of ambulance dispatches was nearly 6.0 million in  
25  
26  
27 2014 and this reflected a trend of increases over the previous 6 years[7]. Because of  
28  
29  
30 rapidly aging population and an increase in ambulance dispatches, the time from call to  
31  
32  
33 hospital arrival will invariably increase unless major changes are implemented in the  
34  
35  
36 emergency care and resource distribution systems.

37  
38 One recent study showed that the number of request calls to hospitals had  
39  
40  
41 greater odds of an on-scene arrival time of over 30 minutes[13]. However, the direct  
42  
43  
44 effect of the number of request calls on the time from call to hospital arrival is unclear.  
45  
46  
47 The aim of this study was to evaluate factors affecting the time to hospital arrival of  
48  
49  
50 ambulances, especially the effect of the number of request calls.

## 51 52 53 54 55 **METHODS** 56 57 58 59 60

## Data and setting

This was a cross-sectional study. The data sources were an ambulance transportation records database (transportation database) and an ambulance request call records database (request call database) in Nara prefecture, Japan. The location and map of Nara prefecture are shown in Supplement Figure 1. The prefectural population was 1.36 million in 2015, with a population density of 369 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 hospital accepting request calls, whether or not the hospital indicated the admission acceptability



1  
2  
3  
4  
5  
6 of patients, and the result of the request call. In Nara prefecture, ambulance crews have  
7  
8  
9 a tablet-type portable computer for searching hospital statuses with regard to admission  
10  
11  
12 acceptability. Using these computers, the crew members input the date and time of each  
13  
14  
15 action for transportation and the assessment results (such as each patient's emergency  
16  
17  
18 situation and suspected illnesses).

19  
20  
21 Nara prefecture has established a medical cooperation system for these ten  
22  
23  
24 important illnesses through the formation of a medical institution network in order to  
25  
26  
27 provide coordinated care for patients. Under this system, patient emergency situations  
28  
29  
30 are categorized into five levels, and suspected illnesses are categorized into ten  
31  
32  
33 important illnesses and other categories. These categories are assessed by ambulance  
34  
35  
36 crews based on designated criteria and protocols. The ten important illnesses are  
37  
38  
39 categorized as follows: cardiopulmonary arrest (CPA), stroke, disturbance of  
40  
41  
42 consciousness (DOC), acute coronary syndrome (ACS), abdominal pain, trauma, sever  
43  
44  
45 burn, perinatal problem, pediatrics, and psychiatric illness. The other categories are  
46  
47  
48 classified according to medical specialties, including internal medicine, neurosurgery  
49  
50  
51 except for stroke or DOC, surgery except for abdominal pain, orthopedics except for  
52  
53  
54 trauma, and cardiology except for ACS. Patients were categorized into the "other  
55  
56  
57 category" if they were not categorized into one of these important illnesses.  
58  
59  
60

## 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 and older, and 3) with suspected illness related to internal medicine, trauma, orthopedics, neurosurgery, abdominal pain, surgery, cardiology, cardiopulmonary arrest (CPA), stroke, acute coronary syndrome (ACS), and disturbance of consciousness (DOC). Patients' suspected illnesses were categorized into 10 important illnesses and other categories after assessment by EMS staff. The ten important illnesses were categorized as the following patient situations: CPA, stroke, DOC, ACS, abdominal pain, trauma, perinatal problem, pediatrics, and psychiatric illness. We excluded patients with suspected illness related to perinatal problems, pediatrics, and psychiatric illness because the number of hospitals which accepted these kind of patients was very small. We also excluded patients with suspected illnesses, except for those concerning internal medicine, orthopedics, 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 upon these inclusion criteria because these illnesses are important in terms of health policy and affect many patients. We excluded patients who

1  
2  
3  
4  
5  
6 took longer than 1000 minutes for finding hospitals, driving to a hospital, or  
7  
8  
9 transportation as outliers. We also excluded children because the number of hospitals  
10  
11 with transportation of children is very small, and we would have needed to conduct a  
12  
13 separate study for children as distinct from adults. We treated missing data as null  
14  
15  
16 values, while the cases retained in the analysis.  
17  
18  
19

## 20 21 22 23 **Variables**

24  
25  
26 Date and time of hospital arrival, time from arrival on scene to the beginning  
27  
28 of request calls, time from the beginning of request calls to the ending of the calls, time  
29  
30 from the ending of the calls to hospital arrival, time from leaving the scene to hospital  
31  
32 arrival, patient characteristics (age and sex), person calling ambulance, registered  
33  
34 district of the EMS, and patient's emergency status and category of suspected illness as  
35  
36 recorded by on-scene EMS staff or operational staff at the local fire defense  
37  
38 headquarters. We divided patients into three groups according to age: 1) 15 to  $\leq 59$  years,  
39  
40  
41 2) 60 to 79 years, and 3) 80 years or more; the cut-off at 60 years was selected as it is  
42  
43 the traditional retirement age in Japan. We defined the seasons as spring from March to  
44  
45 May, summer from June to August, autumn from September to November, and winter  
46  
47 from December to February. We also defined noon from 8am to 3pm, early night from  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 4pm to 11pm, and late night from 12am to 7am. We defined on-scene time as the sum of  
7  
8  
9 the time from arrival on scene to the beginning of a request call and the time from the  
10  
11 beginning of the request call to the ending of the call. With regard to ambulance  
12  
13 administration, Nara prefecture is divided into 13 districts that were used to identify the  
14  
15 places where ambulance calls were made.  
16  
17  
18  
19

### 20 21 22 23 **Primary outcome measure**

24  
25  
26 The primary outcome measure was the time from the initial emergency call by  
27  
28 the patients to hospital arrival, i.e., the time from the call for an ambulance to hospital  
29  
30 arrival.  
31  
32  
33  
34  
35  
36  
37

### 38 **Statistical methods**

39  
40 The main results were calculated as means and standard deviations (SD), and  
41  
42 the baseline patient characteristics were compared using Student's t-test or the  
43  
44 Kruskal-Wallis test. First, to estimate the effect of increasing the number of request calls  
45  
46 on the time from call to hospital arrival, we conducted the Jonckheere-Terpstra trend  
47  
48 test.  
49  
50  
51  
52  
53

54  
55 Second, in order to estimate the time from request call to hospital arrival after  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 excluding unsuccessful request calls, we defined unsuccessful request calls as 1) request  
7  
8  
9 calls to hospitals indicated as “Accepting patients” that resulted in failure, and 2)  
10  
11  
12 request calls to hospitals indicated as “Not accepting patients” that resulted in failure.  
13  
14  
15 To conduct this estimation, we merged the transportation database and the request call  
16  
17  
18 database. When the time for a request call was longer than the time from call to hospital  
19  
20  
21 in request call database, we decided these were entered incorrectly and then excluded  
22  
23  
24 them from calculations.

25  
26 Third, to evaluate the effect of the number of request calls on time from call to  
27  
28  
29 hospital arrival, we conducted a multilevel linear regression analysis with random  
30  
31  
32 effects to correct for patient clustering in the districts. The predictive variables were  
33  
34  
35 selected on the basis of previous research[17–23]. We also conducted a subgroup  
36  
37  
38 analysis for on-scene time and time from leaving the scene to hospital arrival.

39  
40  
41 Lastly, to evaluate differences in the time from request call to hospital arrival  
42  
43  
44 among various types of areas, we also conducted other multilevel linear regression  
45  
46  
47 analyses, where patients were divided into the following three groups depending on the  
48  
49  
50 level of urbanization and location of the registered district of the EMS: 1) urban area,  
51  
52  
53 which encompasses seven districts that are more urbanized than other areas in Nara  
54  
55  
56 prefecture (population was 1.08 million and the population density was 1,578 per square  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 kilometer in 2015), 2) the eastern rural area, which consists of three districts located in  
7  
8  
9 the east side of Nara prefecture (population was 0.21 million and the population density  
10  
11 was 319 per square kilometer in 2015), and 3) the southern rural area, which consists of  
12  
13 three districts located in the south side of Nara prefecture (population was 0.07 million  
14  
15 and the population density was 30.9 per square kilometer in 2015).  
16  
17  
18  
19

20  
21 Data analysis was conducted using the statistical software package R, version  
22  
23 3.2.2. Prior to the study, the study procedures were reviewed and approved (#E1023) by  
24  
25 the ethics review committee of Kyoto University Graduate School of Medicine.  
26  
27  
28  
29  
30  
31

## 32 RESULTS

### 33 Cases

34  
35  
36 From April 2013 to March 2014, the number of transportations by ambulance  
37  
38 was 43,663. The mean time from request call to hospital arrival was 44.5 (SD: 20.9)  
39  
40 minutes. The distribution of risk factors and their association with transportation time  
41  
42 are shown in Table 1. Slightly less than one-third of patients were 80 years old or older,  
43  
44 and 50% were female. The percentage of patients transported during the noon time  
45  
46 period was 44.8%, which was a greater proportion than during other time categories.  
47  
48  
49 The number of patients in each area ranged from 723 to 11,223, and the mean was  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

3358.7 (first and third quartile were 1499 and 4060, respectively). The time from call to hospital arrival in each district ranged from 36.3 minutes to 72.6 minutes, with a mean time of 48.2 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 categorized into lower emergency situations. There were no remarkable differences across seasons or days of the week.

Table 1. Risk Factors Distribution and Association with transportation time

	n		Time from call to hospital arrival, mean	P-value
	N =	%	(SD)	
	43,663			
Age,y				
≥15, <60	14,125	32.4	45.1 (22.7)	
≥60, <80	15,915	36.4	44.4 (20.2)	
≥80	13,623	31.2	43.9 (19.8)	<0.001*
Sex				
Male	21,833	50.0	45.1 (21.7)	
Female	21,830	50.0	43.8 (20.1)	<0.001†
Season				
Spring (March-May)	10,406	23.8	44.2 (20.1)	
Summer (June-August)	11,187	25.6	43.5 (20.2)	
Autumn (September-November)	10,741	24.6	44.5 (20.8)	
Winter (December-February)	11,329	25.9	45.7 (22.4)	<0.001*
Day of the week				
Monday	6,627	15.2	43.5 (20.1)	
Tuesday	6,133	14.0	43.8 (20.8)	

Wednesday	5,838	13.4	43.9 (20.1)	
Thursday	5,899	13.5	44.0 (20.8)	
Friday	6,134	14.0	43.7 (20.0)	
Saturday	6,436	14.7	45.8 (21.4)	
Sunday	6,596	15.1	46.5 (22.7)	<0.001†
Time category at ambulance call				
Noon (8-15)	19,558	44.8	41.8 (19.4)	
Early night (16-23)	15,862	36.3	45.9 (21.6)	
Late night (0-7)	8,243	18.9	48.1 (22.1)	<0.001†
Category of suspected illness				
Abdominal pain	1,072	2.5	45.9 (21.2)	
CPA	984	2.3	43.6 (20.3)	
Stroke	850	1.9	49.9 (22.1)	
ACS	686	1.6	42.6 (16.9)	
DOC	498	1.1	47.6 (19.5)	
Trauma	6,158	14.1	46.4 (21.4)	
Internal medicine	21,197	48.5	42.3 (19.8)	
Orthopedics except for Trauma	5,895	13.5	45.5 (22.3)	
Neurosurgery except for Stroke and DOC	4,254	9.7	50.4 (22.4)	
Surgery except for Abdominal pain	1,066	2.4	42.6 (21.7)	
Cardiology except for ACS	1,003	2.3	44.9 (20.4)	<0.001†
Person calling ambulance				
Family or self	27,041	70.3	44.4 (20.6)	
Witness	9,501	24.7	44.9 (21.8)	
Welfare facility	1,906	5.0	42.3 (19.6)	<0.001†
Emergency status at request call				
Less urgency	25,535	58.5	45.3 (21.0)	
Urgency	5,243	12.0	45.8 (20.9)	
Emergency	2,659	6.1	46.4 (22.0)	
Resuscitation	241	0.6	42.4 (18.0)	
During assessment	9,983	22.9	41.4 (20.1)	<0.001†

\* P-value by Student t-test

† P-value by Kruskal-Wallis test

SD: standard deviation, ACS: acute coronary syndromes, CPA: Cardiopulmonary arrest,

DOC: disturbance of consciousness, request call: request call to hospital for transportation



The detailed information about each area are not available for disclosing, because of data sharing policy.

### 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 (13.8) minutes on scene, on average. It took 14.3 (13.8) minutes from the scene to hospital arrival.

### Time and the number of request calls

The mean time from call to hospital arrival was 44.5 min, and the mean number of requests was 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 request calls made, the more time spent from call to hospital arrival.

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

The number of request call	n		Time from call to hospital arrival		P-value
	N = 43,663	%	mean (SD)		
1	29,499	67.6	38.2 (16.2)		
2	6,302	14.4	47.8 (16.9)		
3	3,150	7.2	55.1 (18.4)		
4	1,816	4.2	61.2 (19.3)		
5	971	2.2	68.9 (20.7)		
6	625	1.4	73 (21.2)		

7	395	0.9	79.5 (23.5)	
8	278	0.6	81.5 (20.8)	
9	173	0.4	92.6 (29.2)	
10	126	0.3	90.8 (25.4)	
≥11	328	0.8	109.6 (25.9)	<0.001*

\* P-value by Jonckheere-Terpstra trend test

request call: request call to hospital for transportation,

Qu: quantile, request call: request call to hospital for transportation

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

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

Hospital Displayed Admission Acceptability	Result	Number of request call n (%) N = 79,693	Time for one request call, mean (SD)	P-value *
Accepting patients	Success	32,416 (40.7)	4.9 (3.4)	
Not accepting patients	Success	11,247 (14.1)	4.5 (3.9)	

Accepting patients	Failure	24,629 (30.9)	4.2 (3.1)	
Not accepting patients	Failure	11,401 (14.3)	4.2 (3.5)	<0.001†

\* P-value by Kruskal-Wallis test

SD: standard deviation, request call: request call to hospital for transportation

ACCEPTABLE : announce accepting ambulance for emergency medical service

### Main results

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 (see Table 4 and Supplement Table 1). The model that did not include the variable “the number of request calls” was only able to explain 11% of the observed variations (see Supplement Table 2). We found that the number of request calls affected time from call to hospital arrival ( $\beta= 6.3$ ,  $p<0.001$ ), which indicated that a refusal of a request call extended the time from call to hospital arrival by 6.3 minutes. 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 ( $\beta= 5.3$ ,  $p<0.001$ ) and time from leaving the scene to hospital

arrival ( $\beta= 1.6, p<0.001$ ).

From the analyses dividing patients into three groups according to the location of the registered district of the EMS, the mean transportation times in the urban area, eastern rural area, and southern rural area were 42.1 (SD: 18.5), 48.6 (SD: 21.7), 57.8 (SD: 31.9), respectively. The southern rural area had much longer transportation times than other two areas. When compared with internal medicine, longer transportation times were observed for neurosurgery (+11.5 minutes), stroke (+9.9 minutes), trauma (+10.0 minutes), ACS (+10.0 minutes), orthopedics (+9.2 minutes), and cardiology (+9.2 minutes) in the southern rural area. (See Supplementary Table 3). 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 9.1 and 8.1 minutes, respectively.

Table 4. Time from Call to hospital arrival: multilevel linear regression analysis

Explanatory valuable	Estimate (95%CI)	P-value
Intercept	30.1 (24.5, 35.6)	
Fixed effects		
Age		
$\geq 15, < 60$	(ref)	
$\geq 60, < 80$	1.14 (0.75, 1.53)	<0.001
$\geq 80$	0.94 (0.52, 1.36)	<0.001
Sex		
Female	(ref)	

1			
2			
3			
4			
5	Male	0.64 (0.32, 0.96)	<0.001
6			
7	Season		
8	Spring (March-May)	(ref)	
9			
10	Summer (June-August)	-0.50 (-0.95, -0.05)	0.028
11	Autumn (September-November)	0.57 (0.12, 1.02)	0.012
12			
13	Winter (December-February)	0.98 (0.54, 1.42)	<0.001
14	Day of the week		
15	Monday	(ref)	
16			
17	Tuesday	-0.38 (-0.96, 0.20)	0.20
18	Wednesday	-0.18 (-0.77, 0.41)	0.55
19			
20	Thursday	0.31 (-0.28, 0.90)	0.30
21	Friday	-0.16 (-0.74, 0.42)	0.59
22			
23	Saturday	0.71 (0.13, 1.28)	0.016
24	Sunday	1.1 (0.48, 1.63)	<0.001
25			
26	Time category at ambulance call		
27	Noon (8-15)	(ref)	
28			
29	Early night (16-23)	1.9 (1.58, 2.29)	<0.001
30	Late night (0-7)	2.9 (2.49, 3.38)	<0.001
31			
32	Category of suspected illness		
33	Abdominal pain	-0.93 (-2.0, 0.12)	0.082
34	CPA	0.06 (-1.0, 1.2)	0.92
35			
36	Stroke	6.2 (5.1, 7.3)	<0.001
37	ACS	1.4 (0.14, 2.7)	0.03
38			
39	DOC	3.7 (2.2, 5.2)	<0.001
40	Trauma	3.8 (3.3, 4.3)	<0.001
41			
42	Internal medicine	(ref)	
43	Orthopedics except for Trauma	2.7 (2.2, 3.2)	<0.001
44	Neurosurgery except for Stroke and DOC	7.4 (6.8, 7.9)	<0.001
45			
46	Surgery except for Abdominal pain	-0.08 (-1.1, 0.97)	0.89
47	Cardiology except for ACS	5.0 (4.0, 6.1)	<0.001
48			
49	Person calling ambulance		
50	Family or self	(ref)	
51			
52	Witness	-1.7 (-2.5, -0.95)	<0.001
53	Welfare facility	0.6 (0.27, 1.1)	<0.001
54			
55	Emergency status at request call		
56	Less urgency	(ref)	
57			
58			
59			
60			

Urgency	0.59 (0.08, 1.1)	0.022
Emergency	-0.16 (-0.86, 0.54)	0.66
Resuscitation	-1.8 (-4.0, 0.40)	0.11
During assessment	-1.5 (-2.0, -1.1)	<0.001
The number of request call	6.3 (6.2, 6.4)	<0.001
Random effects		
Variance of (SD)	95.52 (9.8)	
AIC	320,647	
Radj2	0.44	

SD: standard deviation, ACS: acute coronary syndromes, CPA: Cardiopulmonary arrest, DOC: disturbance of consciousness, request call: request call to hospital for transportation

## DISCUSSION

In this cross-sectional study, we evaluated the effect of the number of request calls to the time from call to hospital arrival. This study indicated that the time from call to hospital arrival would decrease by 4.6 minutes if all unsuccessful request calls were eliminated. Time from call to hospital arrival increases by 6.3 minutes for every request call from EMS to hospital, after adjusting for other variables. 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

1  
2  
3  
4  
5  
6 five diseases: acute myocardial infarction, stroke, cancer, diabetes mellitus, and  
7  
8  
9 psychiatric illness[24]. Nara prefecture established a medical cooperation system for  
10  
11  
12 CPA, stroke, DOC, ACS, abdominal pain, trauma, perinatal problems, pediatrics, and  
13  
14  
15 psychiatric illness. In spite of national and prefectural efforts, ACS and stroke calls took  
16  
17  
18 1.4 minutes and 6.2 minutes longer in transportation time compared to Internal  
19  
20  
21 medicine. Both acute coronary syndrome and stroke are diseases where time from onset  
22  
23  
24 to hospital arrival is important for treatment and outcome[25–27]. A shortage of  
25  
26  
27 appropriate healthcare facilities in the region might be the reason for prolonged times  
28  
29  
30 from call to hospital arrival for these diseases. As the number of patients with  
31  
32  
33 cardiovascular diseases increases in Japan's aging society, further research that focuses  
34  
35  
36 on specific diseases or time series may be required.

37  
38 This study revealed that transportation times varied depending on the location  
39  
40  
41 of patient when the emergency call was made. There was approximately 30-minute  
42  
43  
44 difference in the time from request call to hospital arrival among the 13 districts  
45  
46  
47 (minimum of 36.3 minutes and maximum of 72.6 min) in a single prefecture. Nara  
48  
49  
50 prefecture has a long north-south axis with three tertiary emergency hospitals. However,  
51  
52  
53 all there of these hospitals are located in urban areas that are geographically distant from  
54  
55  
56 the southern rural area. As a result, the southern rural area was found to have longer  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 transportation times than the other areas. In that area, the categories of illnesses that  
7  
8  
9 require special facilities such as coronary care units or stroke care units had longer  
10  
11  
12 transportation times than in other areas. The distance from emergency hospital and  
13  
14  
15 appropriate healthcare facilities might be the cause of this difference between areas.  
16  
17  
18 One observational study discussed the shortage of emergency medical facilities in rural  
19  
20  
21 areas in Japan[28]. One geographical study pointed out that there was a regional gap in  
22  
23  
24 the number of tertiary care centers per million people between prefectures in Japan[29].  
25

26  
27 Our results also indicate that there are differences in transportation times for  
28  
29  
30 specific diseases among regions. In southern rural areas, there were longer  
31  
32  
33 transportation times for diseases which needed treatment by specialists such as  
34  
35  
36 cardiologists, neurologists, neurosurgeons, and orthopedists than in the other two areas.  
37  
38  
39 This might be associated with the shortage of medical facilities for specific illnesses in  
40  
41  
42 these regions. Indicating disease-specific problems that are specific to each area is  
43  
44  
45 helpful information for improving health care systems and is also a strength of our  
46  
47  
48 study.  
49

50  
51 Our database did not include socioeconomic information of patients, except for  
52  
53  
54 the person who called an ambulance. In the field of acute myocardial infarction and  
55  
56  
57 stroke, it is known that time from onset of symptoms to hospital arrival are influenced  
58  
59  
60



1  
2  
3  
4  
5  
6 by many other factors such as living alone[18], being alone at onset of symptoms[19,20],  
7  
8  
9 being a nonwhite patient in the United States [21], and education level[22]. In addition,  
10  
11 indicators of patient socioeconomic status, such as mean income of the residential  
12  
13 area[30,31] and race[30], have also been reported to influence the time from an  
14  
15 emergency call to hospital arrival. We think information about the person who called an  
16  
17 ambulance would help to indicate the socioeconomic status of patients to some degree.  
18  
19  
20  
21

22  
23 In our study, we found there are no substantial differences in time between days  
24  
25 of the week or seasons. One study in Tennessee, USA, found that the prolongation of  
26  
27 transportation time was influenced by seasons due to variations in traffic volume[23].  
28  
29 However, transportation conditions were very different between Tennessee and Nara,  
30  
31 which may explain in part the observed differences in results between these two studies.  
32  
33  
34  
35  
36  
37

38 Our study revealed that time from call to hospital arrival increases by 6.3  
39  
40 minutes for every request call from EMS to hospital. It also revealed that more than  
41  
42 45% of all request calls and 43% of request calls to hospitals indicating a status of  
43  
44 “Accepting patients” resulted in failure. Driving ambulances at high speed[32],  
45  
46 helicopter transportation[33–35] and centralization of hospitals[36] might be solutions  
47  
48 to reduce transportation time. However, the risk of traffic accidents[37], costs for  
49  
50 helicopter emergency medical services[38,39], and time and cost for centralizing  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 hospitals are difficult problems to solve. Hence, it may be important to create a system  
7  
8  
9 for quickly determining appropriate hospitals and ensuring faster admissions to decrease  
10  
11  
12 the number of request calls.  
13

14  
15 It may be beneficial for policymakers to create a system to share information  
16  
17 about hospitals and emergency patients more promptly especially for an aging society  
18  
19 with an increasing number of ambulance dispatches. One recent cross-sectional study  
20  
21 showed that services with tablet computers shortened the transportation time in Saga  
22  
23 prefecture, Japan[40]; even though there was no information about time from call to  
24  
25 hospital arrival in that study, introducing these support systems would reduce time from  
26  
27 call to hospital arrival or transportation time. In prefectures, such as Nara prefecture,  
28  
29 where a support system with tablet computers was introduced, creating a more effective  
30  
31 and convenient system is needed. Physicians, are not only required to accept patients if  
32  
33 requested, but must also appropriately indicate the hospital's capacity for emergency  
34  
35 patients appropriately. As a result, this places an additional burden on physicians. Due to  
36  
37 the shortage of physicians in Japan[41], there is a need for more effective posting of  
38  
39 physicians and efficient working systems.  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50

51  
52  
53  
54  
55 Our study has several limitations. First, patient emergency status was decided  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 by ambulance crew. Our data does not include vital signs for all patients, because  
7  
8  
9 ambulance crews are required to register vital signs of patients for only a limited  
10  
11  
12 number of suspected illnesses. We cannot analyze patient emergency status using vital  
13  
14  
15 signs. As ambulance crews assessed patients by rules depending on patient's vital signs  
16  
17  
18 and they were also trained under the medical control system[5], the decisions made by  
19  
20  
21 ambulance crew were viewed as credible.

22  
23  
24 Second, our data consisted of patients in Nara prefecture. Nara prefecture is  
25  
26  
27 one of 47 prefectures in Japan. Our results may not be applicable to all prefectures in  
28  
29  
30 Japan. However, there is a discrepancy in urbanization between urbanized areas and  
31  
32  
33 mountainous areas such as the southern area. Therefore, we can discuss the differences  
34  
35  
36 between areas within one prefecture.

37  
38  
39 Lastly, there are several factors that are known to influence the time from  
40  
41  
42 request calls to hospital arrival, but we were unable to include them in analysis due to  
43  
44  
45 data limitations. These factors include prehospital strategies[42], level of training of  
46  
47  
48 ambulance crews[43], and hospital capacity[44]. Future studies should address the  
49  
50  
51 influence of these factors.

## 52 53 54 55 **Conclusions**

1  
2  
3  
4  
5  
6 The study revealed 6.3 additional minutes were added to transportation time by  
7  
8  
9 every refusal of a request call and also revealed disease-specific delays among specific  
10  
11  
12 areas. A system that helps EMS to find hospitals should be effectively established to  
13  
14  
15 share information about hospitals and emergency patients promptly in partnership with  
16  
17  
18 policymakers and physicians for reducing the time from call to hospital arrival.  
19

### 20 21 22 23 **Contributors**

24  
25  
26 NH has had the main responsibility for calculating statistics and writing the paper. YI is  
27  
28  
29 the principal investigator for the project, has planned the present paper jointly with NH,  
30  
31  
32 and has actively taken part in revising the paper. KY and SK have taken part in planning  
33  
34  
35 and analyzing data and revising paper.  
36  
37  
38  
39  
40

### 41 **Funding**

42  
43  
44 This work was financially supported in part by Health Sciences Research Grants from  
45  
46  
47 the Ministry of Health, Labour and Welfare of Japan (H27-iryō-ippān-001), and a  
48  
49  
50 Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of  
51  
52  
53 Science ([A] 25253033 and [A] 16H02634).  
54  
55  
56  
57  
58  
59  
60

### Competing interests

Kyoto University Department of Healthcare Economics and Quality Management had a financial contract with Nara prefecture to support analysis of its healthcare system.

This study is out of the scope of the contract, and is not financed by Nara prefecture.

Otherwise, all authors declare no financial relationships that are potentially relevant to this article.

### Ethical approval

This study was approved by the Ethical Committee, Kyoto University Graduate School of Medicine, Japan

### Data sharing statement

No additional data are available for sharing, because of data sharing policy.

### REFERENCES

- 1 Hori S. Emergency medicine in Japan. *Keio J Med* 2010;**59**:131–  
9.<http://www.ncbi.nlm.nih.gov/pubmed/21187699> (accessed 22 Dec2015).
- 2 EDITORIAL: Medical emergencies. The Asahi Shimbun.

- 2007.<http://database.asahi.com/library2/main/start.php>
- 3 No progress in emergency pregnancy care. Japan News.  
2007;:03.<https://database.yomiuri.co.jp/rekishikan/>
- 4 Shiga T, Sato T. Current emergency medical systems in Japan. *Jpn Hosp*  
2008;:71–3.<http://www.ncbi.nlm.nih.gov/pubmed/19195153> (accessed 22  
Dec2015).
- 5 Tanigawa K, Tanaka K. Emergency medical service systems in Japan: past,  
present, and future. *Resuscitation* 2006;**69**:365–70.  
doi:10.1016/j.resuscitation.2006.04.001
- 6 Suzuki T, Nishida M, Suzuki Y, *et al.* Issues and Solutions in Introducing  
Western Systems to the Pre-hospital Care System in Japan. *West J Emerg Med*  
2008;**9**:166–  
70.<http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2672269&tool=pmcentrez&rendertype=abstract> (accessed 22 Dec2015).
- 7 Japan Fire and Disaster Management Agency. The 2015 white paper (Japanese)  
2015. 2015;:67.[http://www.fdma.go.jp/neuter/topics/fieldList9\\_3.html](http://www.fdma.go.jp/neuter/topics/fieldList9_3.html) (accessed  
23 Mar2016).
- 8 Takahashi M, Kohsaka S, Miyata H, *et al.* Association between prehospital time

- 1  
2  
3  
4  
5  
6 interval and short-term outcome in acute heart failure patients. *J Card Fail*  
7  
8  
9 2011;**17**:742–7. doi:10.1016/j.cardfail.2011.05.005  
10  
11  
12 9 Dinh MM, Bein K, Roncal S, *et al*. Redefining the golden hour for severe head  
13  
14 injury in an urban setting: the effect of prehospital arrival times on patient  
15  
16 outcomes. *Injury* 2013;**44**:606–10. doi:10.1016/j.injury.2012.01.011  
17  
18  
19  
20  
21 10 World Population Prospects - Population Division - United Nations.  
22  
23 <http://esa.un.org/unpd/wpp/Publications/> (accessed 19 Jan2016).  
24  
25  
26  
27 11 Statistics Bureau Home Page/Population Estimates Monthly Report.  
28  
29 <http://www.stat.go.jp/english/data/jinsui/tsuki/index.htm> (accessed 19 Jan2016).  
30  
31  
32  
33 12 Annual Report on the Aging Society: 2014 (Summary) - Cabinet Office Home  
34  
35 Page. [http://www8.cao.go.jp/kourei/english/annualreport/2014/2014pdf\\_e.html](http://www8.cao.go.jp/kourei/english/annualreport/2014/2014pdf_e.html)  
36  
37 (accessed 19 Jan2016).  
38  
39  
40  
41 13 Nagata I, Abe T, Nakata Y, *et al*. Factors related to prolonged on-scene time  
42  
43 during ambulance transportation for critical emergency patients in a big city in  
44  
45 Japan: a population-based observational study. *BMJ Open* 2016;**6**:e009599.  
46  
47 doi:10.1136/bmjopen-2015-009599  
48  
49  
50  
51  
52  
53 14 Ministry of Internal Affairs and Communications. Population Census 2015.  
54  
55 2016.<http://www.stat.go.jp/english/data/kokusei/index.htm> (accessed 6 Jun2016).  
56  
57  
58  
59  
60

- 1  
2  
3  
4  
5  
6 15 Ministry of Health L and W. Annual Health, Labour, and Welfare Report  
7  
8  
9 2011-2012.  
10  
11 2012.<http://www.mhlw.go.jp/english/policy/health-medical/health/index.html>  
12  
13 (accessed 6 Jun2016).  
14  
15  
16  
17 16 Communications M of IA and. Social Indicators by Prefecture 2014 :System of  
18  
19 Social and Demographic Statistics.  
20  
21 2015.[http://www.e-stat.go.jp/SG1/estat/GL32010201.do?method=searchTop&an](http://www.e-stat.go.jp/SG1/estat/GL32010201.do?method=searchTop&andKeyword=hospital)  
22  
23  
24  
25  
26  
27  
28  
29 17 Ayrik C, Ergene U, Kinay O, *et al.* Factors influencing emergency department  
30  
31 arrival time and in-hospital management of patients with acute myocardial  
32  
33 infarction. *Adv Ther*;23:244–55.<http://www.ncbi.nlm.nih.gov/pubmed/16751157>  
34  
35  
36  
37 (accessed 22 Dec2015).  
38  
39  
40 18 Bouma J, Broer J, Bleeker J, *et al.* Longer pre-hospital delay in acute myocardial  
41  
42 infarction in women because of longer doctor decision time. *J Epidemiol*  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60



- 1  
2  
3  
4  
5  
6 to reduce treatment-seeking delay for acute myocardial infarction. Rapid Early  
7  
8  
9 Action for Coronary Treatment. *Am J Prev Med* 1999;**16**:325–  
10  
11  
12 34.<http://www.ncbi.nlm.nih.gov/pubmed/10493291> (accessed 20 Jan2016).  
13  
14  
15 20 Perry K, Petrie KJ, Ellis CJ, *et al.* Symptom expectations and delay in acute  
16  
17 myocardial infarction patients. *Heart* 2001;**86**:91–  
18  
19  
20 3.<http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1729795&tool=pm>  
21  
22 centrez&rendertype=abstract (accessed 20 Jan2016).  
23  
24  
25  
26 21 Goldberg RJ, Gurwitz JH, Gore JM. Duration of, and temporal trends  
27  
28 (1994-1997) in, prehospital delay in patients with acute myocardial infarction:  
29  
30 the second National Registry of Myocardial Infarction. *Arch Intern Med*  
31  
32 1999;**159**:2141–7.<http://www.ncbi.nlm.nih.gov/pubmed/10527291> (accessed 20  
33  
34  
35  
36  
37  
38  
39  
40  
41 22 Zapka JG, Oakes JM, Simons-Morton DG, *et al.* Missed opportunities to impact  
42  
43 fast response to AMI symptoms. *Patient Educ Couns* 2000;**40**:67–  
44  
45  
46  
47 82.<http://www.ncbi.nlm.nih.gov/pubmed/10705066> (accessed 20 Jan2016).  
48  
49  
50 23 Golden AP, Odoi A. Emergency medical services transport delays for suspected  
51  
52 stroke and myocardial infarction patients. *BMC Emerg Med* 2015;**15**:34.  
53  
54  
55  
56  
57  
58  
59  
60

- 1  
2  
3  
4  
5  
6 24 Ministry of Health L and W. Ministry of Health, Labour and Welfare: Medical  
7  
8 Care.  
9  
10  
11 <http://www.mhlw.go.jp/english/policy/health-medical/medical-care/index.html>  
12  
13 (accessed 25 Jan2016).  
14  
15  
16  
17 25 Francone M, Bucciarelli-Ducci C, Carbone I, *et al.* Impact of primary coronary  
18  
19 angioplasty delay on myocardial salvage, infarct size, and microvascular damage  
20  
21 in patients with ST-segment elevation myocardial infarction: insight from  
22  
23 cardiovascular magnetic resonance. *J Am Coll Cardiol* 2009;**54**:2145–53.  
24  
25  
26  
27 doi:10.1016/j.jacc.2009.08.024  
28  
29  
30  
31 26 Aquaro GD, Pingitore A, Strata E, *et al.* Relation of pain-to-balloon time and  
32  
33 myocardial infarct size in patients transferred for primary percutaneous coronary  
34  
35 intervention. *Am J Cardiol* 2007;**100**:28–34. doi:10.1016/j.amjcard.2007.02.050  
36  
37  
38  
39 27 Powers WJ, Derdeyn CP, Biller J, *et al.* 2015 AHA/ASA Focused Update of the  
40  
41 2013 Guidelines for the Early Management of Patients With Acute Ischemic  
42  
43 Stroke Regarding Endovascular Treatment. *Stroke*  
44  
45  
46  
47 2015;**46**:STR.0000000000000074. doi:10.1161/STR.0000000000000074  
48  
49  
50  
51 28 Ehara A. Are city population and the number of emergency medical facilities  
52  
53 correlated? *Pediatr Int* 2009;**51**:258–9. doi:10.1111/j.1442-200X.2008.02694.x  
54  
55  
56  
57  
58  
59  
60

- 1  
2  
3  
4  
5  
6 29 Miwa M, Kawaguchi H, Arima H, *et al*. The effect of the development of an  
7  
8 emergency transfer system on the travel time to tertiary care centres in Japan. *Int*  
9  
10 *J Health Geogr* 2006;**5**:25. doi:10.1186/1476-072X-5-25  
11  
12  
13  
14 30 Kleindorfer DO, Lindsell CJ, Broderick JP, *et al*. Community socioeconomic  
15  
16 status and prehospital times in acute stroke and transient ischemic attack: do  
17  
18 poorer patients have longer delays from 911 call to the emergency department?  
19  
20 *Stroke* 2006;**37**:1508–13. doi:10.1161/01.STR.0000222933.94460.dd  
21  
22  
23  
24 31 Govindarajan A, Schull M. Effect of socioeconomic status on out-of-hospital  
25  
26 transport delays of patients with chest pain. *Ann Emerg Med* 2003;**41**:481–90.  
27  
28 doi:10.1067/mem.2003.108  
29  
30  
31  
32 32 Petzäll K, Petzäll J, Jansson J, *et al*. Time saved with high speed driving of  
33  
34 ambulances. *Accid Anal Prev* 2011;**43**:818–22. doi:10.1016/j.aap.2010.10.032  
35  
36  
37  
38 33 Funder KS, Rasmussen LS, Lohse N, *et al*. Long-term follow-up of trauma  
39  
40 patients before and after implementation of a physician-staffed helicopter: A  
41  
42 prospective observational study. *Injury* 2016;**47**:7–13.  
43  
44  
45  
46  
47 doi:10.1016/j.injury.2015.10.032  
48  
49  
50  
51 34 Fjaeldstad A, Kirk MH, Knudsen L, *et al*. Physician-staffed emergency  
52  
53 helicopter reduces transportation time from alarm call to highly specialized centre.  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 *Dan Med J* 2013;**60**:A4666.<http://www.ncbi.nlm.nih.gov/pubmed/23809975>

7  
8  
9 (accessed 3 Dec2015).

- 10  
11  
12 35 Johnsen AS, Fattah S, Sollid SJM, *et al.* Utilisation of helicopter emergency  
13  
14 medical services in the early medical response to major incidents: a systematic  
15  
16 literature review. *BMJ Open* 2016;**6**:e010307.

17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
doi:10.1136/bmjopen-2015-010307

- 36 Kobayashi D, Otsubo T, Imanaka Y. The effect of centralization of health care  
services on travel time and its equality. *Health Policy* 2015;**119**:298–306.

doi:10.1016/j.healthpol.2014.11.008

- 37 Becker LR, Zaloshnja E, Levick N, *et al.* Relative risk of injury and death in  
ambulances and other emergency vehicles. *Accid Anal Prev* 2003;**35**:941–  
8.<http://www.ncbi.nlm.nih.gov/pubmed/12971929> (accessed 27 Jan2016).

- 38 Taylor CB, Stevenson M, Jan S, *et al.* A systematic review of the costs and  
benefits of helicopter emergency medical services. *Injury* 2010;**41**:10–20.

doi:10.1016/j.injury.2009.09.030

- 39 Taylor C, Jan S, Curtis K, *et al.* The cost-effectiveness of physician staffed  
Helicopter Emergency Medical Service (HEMS) transport to a major trauma  
centre in NSW, Australia. *Injury* 2012;**43**:1843–9.

- 1  
2  
3  
4  
5  
6 doi:10.1016/j.injury.2012.07.184  
7  
8  
9 40 Yamada KC, Inoue S, Sakamoto Y. An effective support system of emergency  
10  
11 medical services with tablet computers. *JMIR mHealth uHealth* 2015;**3**:e23.  
12  
13 doi:10.2196/mhealth.3293  
14  
15  
16  
17 41 Ishikawa T, Ohba H, Yokooka Y, *et al.* Forecasting the absolute and relative  
18  
19 shortage of physicians in Japan using a system dynamics model approach. *Hum*  
20  
21 *Resour Health* 2013;**11**:41. doi:10.1186/1478-4491-11-41  
22  
23  
24  
25  
26 42 Schull MJ, Vaillancourt S, Donovan L, *et al.* Underuse of prehospital strategies  
27  
28 to reduce time to reperfusion for ST-elevation myocardial infarction patients in 5  
29  
30 Canadian provinces. *CJEM* 2009;**11**:473–  
31  
32 80.<http://www.ncbi.nlm.nih.gov/pubmed/19788792> (accessed 15 Dec2015).  
33  
34  
35  
36  
37 43 Schuster M, Pints M, Fiege M. Duration of mission time in prehospital  
38  
39 emergency medicine: effects of emergency severity and physicians level of  
40  
41 education. *Emerg Med J* 2010;**27**:398–403. doi:10.1136/emj.2009.074211  
42  
43  
44  
45  
46 44 Burt CW, McCaig LF. Staffing, capacity, and ambulance diversion in emergency  
47  
48 departments: United States, 2003-04. *Adv Data* 2006;:1–  
49  
50 23.<http://www.ncbi.nlm.nih.gov/pubmed/17037024> (accessed 7 Jun2016).  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

For peer review only

## Figure Legends

Figure 1. Components of time from request call to hospital admission

Supplement Figure 1. Location and map of Nara prefecture

The left side of the figure shows a map of Japan. The lines represent prefectural borders, and Nara prefecture is indicated in black. The right side of the figure shows a map of Nara prefecture. The light gray area is the eastern rural area and the black area is the southern rural area. The black circles indicate the location of the tertiary emergency hospitals in Nara prefecture.

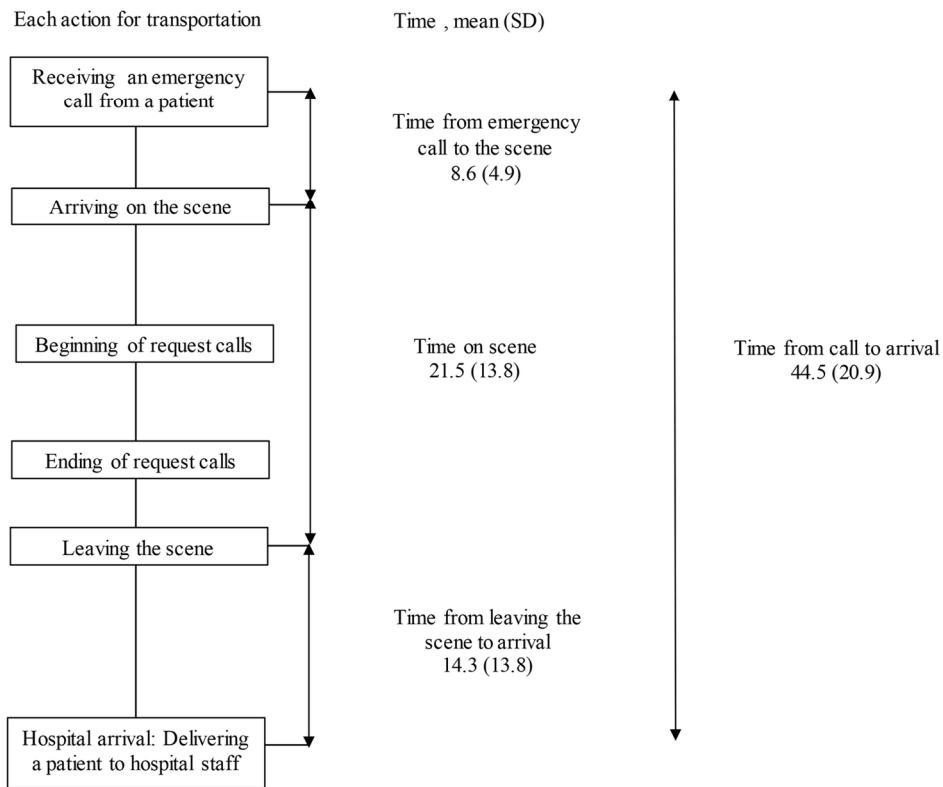


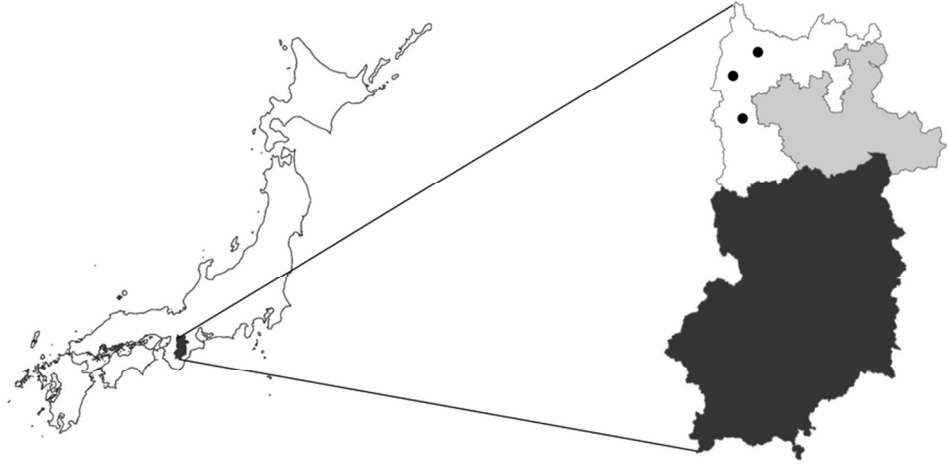
Figure 1. Components of time from request call to hospital admission

139x112mm (300 x 300 DPI)

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60



1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60



Supplement Figure 1. Location and map of Nara prefecture  
The left side of the figure shows a map of Japan. The lines represent prefectural borders, and Nara prefecture is indicated in black. The right side of the figure shows a map of Nara prefecture. The light gray area is the eastern rural area and the black area is the southern rural area. The black circles indicate the location of the tertiary emergency hospitals in Nara prefecture.

80x37mm (300 x 300 DPI)

Review only

Supplement table 1. Difference between the areas of time from call to hospital arrival: Multiple linear regression model

Explanatory variable	Urban area (n = 32657)		East rural area (n = 7661)		South rural area (n = 3345)	
	Estimate (95%CI)	P-value	Estimate (95%CI)	P-value	Estimate	P-value
Intercept	29.7 (28.6, 30.7)	<0.001	30.8 (28.3, 33.3)	<0.001	27.4 (22.0, 32.7)	
Category of suspicious illness						
— Abdominal pain	-0.74 (-1.9, 0.41)	0.21	-1.5 (-3.6, 0.57)	0.15	1.9 (-4.1, 8.0)	0.53
— CPA	-1.2 (-2.4, 0.029)	0.044	4.6 (2.3, 6.8)	0.008	-0.12 (-6.6, 6.4)	0.97
— Stroke	6.4 (5.1, 7.7)	<0.001	5.9 (3.8, 8.0)	0.0011	9.9 (0.54, 17.8)	0.0038
— ACS	0.26 (-1.2, 1.8)	0.73	2.1 (-0.21, 4.4)	0.05	10.0 (3.5, 16.6)	0.0027
— DOC	3.8 (2.0, 5.5)	0.01	4.4 (1.9, 7.0)	0.0065	4.7 (-6.2, 15.6)	0.40
— Trauma	1.8 (1.2, 2.3)	<0.001	8.1 (7.1, 9.2)	<0.001	10.0 (6.7, 13.2)	<0.001
— Internal medicine	(ref)		(ref)		(ref)	
— Orthopedics except for Trauma	1.5 (1.0, 2.0)	<0.001	4.5 (3.2, 5.7)	<0.001	9.2 (6.2, 12.1)	<0.001
— Neurosurgery except for Stroke and DOC	6.6 (6.0, 7.1)	<0.001	9.1 (7.7, 10.5)	<0.001	11.5 (8.0, 14.9)	<0.001
— Surgery except for Abdominal pain	-0.081 (-1.1, 0.98)	0.88	-0.34 (-3.3, 2.6)	0.82	-0.48 (-6.6, 5.6)	0.88
— Cardiology except for ACS	4.4 (3.4, 5.4)	<0.001	5.5 (1.9, 9.1)	0.0025	9.2 (0.54, 17.8)	0.37

SD: standard deviation, ACS: acute coronary syndromes, CPA: Cardiopulmonary arrest,  
DOC: disturbance of consciousness, referral call: referral call to hospital for transportation

Urban area, East rural area, and South rural area consists of 7, 3 and 3 areas respectively.

This table shows only the result of Category of suspicious illness.

Supplement Table 1. On scene time and time from scene to hospital arrival: multilevel linear regression analysis

<u>Explanatory variable</u>	<u>On scene</u>		<u>From scene to hospital arrival</u>	
	<u>Estimate (95%CI)</u>	<u>P-value</u>	<u>Estimate (95%CI)</u>	<u>P-value</u>
<u>Intercept</u>	<u>9.9 (7.8, 11.9)</u>	<u>&lt;0.001</u>	<u>12.8 (7.3, 18.4)</u>	<u>&lt;0.001</u>
<u>Fixed effects</u>				
<u>Age</u>				
<u>≥15, &lt;60</u>	<u>(ref)</u>		<u>(ref)</u>	
<u>≥60, &lt;80</u>	<u>0.44 (0.18, 0.69)</u>	<u>&lt;0.001</u>	<u>0.66 (0.40, 0.92)</u>	<u>&lt;0.001</u>
<u>≥80</u>	<u>0.85 (0.58, 1.1)</u>	<u>&lt;0.001</u>	<u>-0.007 (-0.29, 0.28)</u>	<u>0.96</u>
<u>Sex</u>				
<u>Female</u>	<u>(ref)</u>		<u>(ref)</u>	
<u>Male</u>	<u>-0.12 (-0.33, 0.093)</u>	<u>0.28</u>	<u>0.69 (0.47, 0.90)</u>	<u>&lt;0.001</u>
<u>Season</u>				
<u>Spring (March-May)</u>	<u>(ref)</u>		<u>(ref)</u>	
<u>Summer (June-August)</u>	<u>-0.50 (-0.79, -0.20)</u>	<u>&lt;0.001</u>	<u>-0.12 (-0.42, 0.18)</u>	<u>0.43</u>
<u>Autumn (September-November)</u>	<u>0.29 (-0.0030, 0.59)</u>	<u>0.052</u>	<u>0.11 (-0.19, 0.41)</u>	<u>0.48</u>
<u>Winter (December-February)</u>	<u>0.85 (0.56, 1.1)</u>	<u>&lt;0.001</u>	<u>0.082 (-0.22, 0.38)</u>	<u>0.59</u>
<u>Day of the week</u>				
<u>Monday</u>	<u>(ref)</u>		<u>(ref)</u>	
<u>Tuesday</u>	<u>-0.074 (-0.46, 0.31)</u>	<u>0.71</u>	<u>-0.15 (-0.54, 0.24)</u>	<u>0.46</u>
<u>Wednesday</u>	<u>-0.0015 (-0.39, 0.39)</u>	<u>0.99</u>	<u>-0.062 (-0.46, 0.33)</u>	<u>0.76</u>
<u>Thursday</u>	<u>0.015 (-0.37, 0.40)</u>	<u>0.94</u>	<u>0.24 (-0.15, 0.64)</u>	<u>0.23</u>
<u>Friday</u>	<u>-0.11 (-0.49, 0.27)</u>	<u>0.58</u>	<u>0.022 (-0.37, 0.41)</u>	<u>0.91</u>
<u>Saturday</u>	<u>-0.040 (-0.42, 0.34)</u>	<u>0.83</u>	<u>0.75 (0.37, 1.1)</u>	<u>&lt;0.01</u>

<u>Sunday</u>	<u>-0.032 (-0.41, 0.34)</u>	<u>0.87</u>	<u>1.2 (0.77, 1.5)</u>	<u>&lt;0.001</u>
<u>Time category at ambulance call</u>				
<u>Noon (8-15)</u>	<u>(ref)</u>		<u>(ref)</u>	
<u>Early night (16-23)</u>	<u>0.87 (0.64, 1.1)</u>	<u>&lt;0.001</u>	<u>0.93 (0.69, 1.2)</u>	<u>&lt;0.001</u>
<u>Late night (0-7)</u>	<u>2.0 (1.7, 2.2)</u>	<u>&lt;0.001</u>	<u>0.51 (0.22, 0.81)</u>	<u>&lt;0.01</u>
<u>Category of suspected illness</u>				
<u>Abdominal pain</u>	<u>-1.2 (-1.9, -0.48)</u>	<u>&lt;0.001</u>	<u>0.21 (-0.49, 0.92)</u>	<u>0.55</u>
<u>CPA</u>	<u>-4.6 (-1.2, 0.27)</u>	<u>0.22</u>	<u>-0.019 (-0.76, 0.72)</u>	<u>0.96</u>
<u>Stroke</u>	<u>2.6 (1.9, 3.4)</u>	<u>&lt;0.001</u>	<u>3.4 (2.6, 4.0)</u>	<u>&lt;0.001</u>
<u>ACS</u>	<u>-1.6 (-2.5, -0.78)</u>	<u>&lt;0.01</u>	<u>3.2 (2.3, 4.0)</u>	<u>&lt;0.001</u>
<u>DOC</u>	<u>2.8 (1.8, 3.8)</u>	<u>&lt;0.001</u>	<u>0.81 (-0.20, 1.8)</u>	<u>0.12</u>
<u>Trauma</u>	<u>1.5 (1.2, 1.8)</u>	<u>&lt;0.001</u>	<u>2.0 (1.7, 2.4)</u>	<u>&lt;0.001</u>
<u>Internal medicine</u>	<u>(ref)</u>		<u>(ref)</u>	
<u>Orthopedics except for Trauma</u>	<u>0.74 (0.41, 1.1)</u>	<u>&lt;0.001</u>	<u>1.6 (1.3, 2.0)</u>	<u>&lt;0.001</u>
<u>Neurosurgery except for Stroke and DOC</u>	<u>3.2 (2.9, 3.6)</u>	<u>&lt;0.001</u>	<u>4.1 (3.8, 4.5)</u>	<u>&lt;0.001</u>
<u>Surgery except for Abdominal pain</u>	<u>0.43 (-0.26, 1.1)</u>	<u>0.22</u>	<u>-0.32 (-1.0, 0.38)</u>	<u>0.37</u>
<u>Cardiology except for ACS</u>	<u>-0.14 (-0.84, 0.56)</u>	<u>0.69</u>	<u>4.2 (3.5, 4.9)</u>	<u>&lt;0.001</u>
<u>Person calling ambulance</u>				
<u>Family or self</u>	<u>(ref)</u>		<u>(ref)</u>	
<u>Witness</u>	<u>2.0 (1.7, 2.2)</u>	<u>&lt;0.001</u>	<u>-0.85 (-1.1, -0.58)</u>	<u>&lt;0.001</u>
<u>Welfare facility</u>	<u>-1.2 (-1.7, -0.74)</u>	<u>&lt;0.001</u>	<u>0.28 (-0.23, 0.79)</u>	<u>0.29</u>
<u>Emergency status at request call</u>				
<u>Less urgency</u>	<u>(ref)</u>		<u>(ref)</u>	
<u>Urgency</u>	<u>0.64 (0.30, 0.97)</u>	<u>&lt;0.01</u>	<u>-0.055 (-0.39, 0.28)</u>	<u>0.75</u>
<u>Emergency</u>	<u>-0.0071 (-0.47, 0.45)</u>	<u>0.98</u>	<u>-0.013 (-0.46, 0.48)</u>	<u>0.96</u>
<u>Resuscitation</u>	<u>-0.015 (-1.4, 1.4)</u>	<u>0.98</u>	<u>-1.3 (-2.7, 0.20)</u>	<u>0.092</u>
<u>During assessment</u>	<u>-1.4 (-1.6, -1.1)</u>	<u>&lt;0.001</u>	<u>-0.24 (-0.52, -0.41)</u>	<u>0.11</u>

<u>The number of request call</u>	<u>4.6 (4.6, 4.7)</u>	<u>&lt;0.001</u>	<u>1.6 (1.6, 1.7)</u>	<u>&lt;0.001</u>
<u>Random effects</u>				
<u>Variance of (SD)</u>	<u>12.7 (3.6)</u>		<u>96.9 (9.8)</u>	
<u>AIC</u>	<u>288,604</u>		<u>290,048</u>	
<u>Radj2</u>	<u>0.44</u>	<u>—</u>	<u>0.31</u>	<u>—</u>

SD: standard deviation, ACS: acute coronary syndromes, CPA:

Cardiopulmonary arrest,

DOC: disturbance of consciousness, request call: request call to

hospital for transportation

Supplement Table 2. Time from call to hospital arrival without variable "the number of request call " : multilevel linear regression analysis

<u>Explanatory valuable</u>	<u>From Call to hospital arrival</u>	
	<u>Estimate (95%CI)</u>	<u>P-value</u>
<u>Intercept</u>	<u>42.1 (36.1, 48.0)</u>	<u>&lt;0.001</u>
<u>Fixed effects</u>		
<u>Age</u>		
<u>≥15, &lt;60</u>	<u>(ref)</u>	
<u>≥60, &lt;80</u>	<u>-0.21 (-0.69, 0.75)</u>	<u>0.039</u>
<u>≥80</u>	<u>-0.44 (-0.95, 0.081)</u>	<u>0.098</u>
<u>Sex</u>		
<u>Female</u>	<u>(ref)</u>	
<u>Male</u>	<u>0.71 (0.32, 1.1)</u>	<u>&lt;0.001</u>
<u>Season</u>		
<u>Spring (March-May)</u>	<u>(ref)</u>	
<u>Summer (June-August)</u>	<u>-0.93 (-1.5, -0.38)</u>	<u>&lt;0.001</u>
<u>Autumn (September-November)</u>	<u>0.19 (-0.37, 0.74)</u>	<u>0.50</u>
<u>Winter (December-February)</u>	<u>1.68 (1.1, 2.2)</u>	<u>&lt;0.001</u>
<u>Day of the week</u>		
<u>Monday</u>	<u>(ref)</u>	
<u>Tuesday</u>	<u>0.030 (-0.69, 0.75)</u>	<u>0.93</u>
<u>Wednesday</u>	<u>0.18 (-0.55, 0.90)</u>	<u>0.63</u>
<u>Thursday</u>	<u>0.52 (-0.20, 1.2)</u>	<u>0.16</u>
<u>Friday</u>	<u>0.097 (-0.61, 0.81)</u>	<u>0.79</u>
<u>Saturday</u>	<u>1.8 (1.1, 2.5)</u>	<u>&lt;0.001</u>
<u>Sunday</u>	<u>2.8 (2.1, 3.5)</u>	<u>&lt;0.001</u>
<u>Time category at ambulance call</u>		
<u>Noon (8-15)</u>	<u>(ref)</u>	
<u>Early night (16-23)</u>	<u>4.6 (4.1, 5.0)</u>	<u>&lt;0.001</u>
<u>Late night (0-7)</u>	<u>7.1 (6.6, 7.6)</u>	<u>&lt;0.001</u>
<u>Category of suspected illness</u>		
<u>Abdominal pain</u>	<u>2.0 (0.75, 3.3)</u>	<u>&lt;0.01</u>
<u>CPA</u>	<u>1.5 (0.18, 2.9)</u>	<u>0.026</u>
<u>Stroke</u>	<u>7.6 (6.1, 9.0)</u>	<u>&lt;0.001</u>

<u>ACS</u>	<u>-0.87 (-2.4, 0.71)</u>	<u>0.28</u>
<u>DOC</u>	<u>5.9 (4.1, 7.8)</u>	<u>&lt;0.001</u>
<u>Trauma</u>	<u>4.3 (3.6, 4.9)</u>	<u>&lt;0.001</u>
<u>Internal medicine</u>	<u>(ref)</u>	
<u>Orthopedics except for Trauma</u>	<u>3.8 (2.2, 4.9)</u>	<u>&lt;0.001</u>
<u>Neurosurgery except for Stroke and DOC</u>	<u>5.9 (7.6, 9.0)</u>	<u>&lt;0.001</u>
<u>Surgery except for Abdominal pain</u>	<u>0.47 (3.6, 4.9)</u>	<u>0.47</u>
<u>Cardiology except for ACS</u>	<u>3.5 (2.2, 4.9)</u>	<u>&lt;0.001</u>
<u>Person calling ambulance</u>		
<u>Family or self</u>	<u>(ref)</u>	
<u>Witness</u>	<u>1.1 (0.59, 1.6)</u>	<u>&lt;0.001</u>
<u>Welfare facility</u>	<u>-1.7 (-2.6, -0.72)</u>	<u>&lt;0.001</u>
<u>Emergency status at request call</u>		
<u>Less urgency</u>	<u>(ref)</u>	
<u>Urgency</u>	<u>0.96 (0.071, 1.3)</u>	<u>0.029</u>
<u>Emergency</u>	<u>0.69 (-0.17, 1.6)</u>	<u>0.12</u>
<u>Resuscitation</u>	<u>-2.4 (-5.0, 0.31)</u>	<u>0.083</u>
<u>During assessment</u>	<u>-3.2 (-3.6, -2.6)</u>	<u>&lt;0.001</u>
<u>The number of request call</u>		
<u>Random effects</u>		
<u>Variance of (SD)</u>	<u>109.5 (10.5)</u>	<u>— —</u>
<u>AIC</u>	<u>336,767</u>	
<u>Radj2</u>	<u>0.11</u>	<u>— —</u>

SD: standard deviation, ACS: acute coronary syndromes, CPA: Cardiopulmonary arrest,  
DOC: disturbance of consciousness, request call: request call to hospital for transportation

Supplement table 3. Difference between the areas of time from call to hospital arrival: multilevel linear regression analysis

Explanatory variable	Urban area (n = 32657)		Eastern rural area (n = 7661)		Southern rural area (n = 3345)	
	Estimate (95% CI)	P-value	Estimate (95% CI)	P-value	Estimate (95% CI)	P-value
Intercept	26.1 (24.5, 29.3)	<0.001	32.5 (20.5, 44.5)	<0.001	36.1 (20.9, 51.3)	<0.001
Age						
≥15, <60	(ref)		(ref)		(ref)	
≥60, <80	1.19 (0.79, 1.60)	<0.001	1.90 (1.02, 2.77)	<0.001	-0.84 (-3.4, 1.7)	0.52
≥80	0.83 (0.46, 1.33)	<0.001	1.22 (0.27, 2.17)	0.0012	1.2 (-1.4, 3.9)	0.36
Sex						
Female	(ref)		(ref)		(ref)	
Male	0.31 (0.32, 0.96)	0.066	0.31 (-0.40, 1.02)	0.39	4.2 (2.3, 6.2)	<0.001
Season						
Spring (March-May)	(ref)		(ref)		(ref)	
Summer (June-August)	-0.85 (-1.32, -0.39)	<0.001	-0.023 (-1.02, 0.98)	0.960	2.3 (-0.50, 5.0)	0.110
Autumn (September-November)	0.16 (-0.31, 0.63)	0.510	0.82 (-0.18, 1.81)	0.110	3.6 (0.81, 6.4)	0.012
Winter (December-February)	0.68 (0.22, 1.14)	0.004	1.67 (0.68, 2.66)	0.001	2.8 (0.027, 5.5)	0.049
Day of the week						
Monday	(ref)		(ref)		(ref)	
Tuesday	-0.16 (-0.77, 0.44)	0.60	-1.22 (-2.52, 0.080)	0.07	-0.55 (-4.1, 3.0)	0.76
Wednesday	0.028 (-0.59, 0.64)	0.93	0.028 (-1.30, 1.36)	0.97	-2.1 (-5.7, 1.5)	0.26
Thursday	0.48 (-0.13, 1.09)	0.12	0.11 (-1.21, 1.44)	0.87	-0.93 (-4.6, 2.7)	0.62



<u>Friday</u>	<u>-0.080 (-0.69,</u> <u>0.53)</u>	<u>0.80</u>	<u>-0.68 (-1.98,</u> <u>0.62)</u>	<u>0.31</u>	<u>0.41 (-3.2,</u> <u>4.0)</u>	<u>0.82</u>
<u>Saturday</u>	<u>0.62 (0.024,</u> <u>1.22)</u>	<u>0.042</u>	<u>0.11 (-1.18,</u> <u>1.41)</u>	<u>0.87</u>	<u>3.6 (0.12,</u> <u>7.1)</u>	<u>0.044</u>
<u>Sunday</u>	<u>0.700 (0.10,</u> <u>1.20)</u>	<u>0.022</u>	<u>0.99 (-0.30,</u> <u>2.28)</u>	<u>0.13</u>	<u>4.3 (0.88,</u> <u>7.6)</u>	<u>&lt;0.001</u>
<u>Time category at</u>						
<u>ambulance call</u>						
<u>Noon (8-15)</u>	<u>(ref)</u>		<u>(ref)</u>		<u>(ref)</u>	
<u>Early night (16-23)</u>	<u>1.7 (1.3, 2.1)</u>	<u>&lt;0.001</u>	<u>2.6 (1.78,</u> <u>3.37)</u>	<u>&lt;0.001</u>	<u>4.2 (2.0,</u> <u>6.4)</u>	<u>&lt;0.001</u>
<u>Late night (0-7)</u>	<u>2.8 (2.3, 3.3)</u>	<u>&lt;0.001</u>	<u>3.1 (2.06,</u> <u>4.07)</u>	<u>&lt;0.001</u>	<u>4.8 (2.0,</u> <u>7.5)</u>	<u>&lt;0.001</u>
<u>Category of suspected</u>						
<u>illness</u>						
<u>Abdominal pain</u>	<u>-0.73 (-1.9,</u> <u>0.42)</u>	<u>0.21</u>	<u>-1.5 (-3.6,</u> <u>0.57)</u>	<u>0.15</u>	<u>2.0 (-4.1,</u> <u>8.0)</u>	<u>0.53</u>
<u>CPA</u>	<u>-1.2 (-2.4, -</u> <u>0.023)</u>	<u>0.046</u>	<u>4.6 (2.3, 6.8)</u>	<u>&lt;0.001</u>	<u>-0.087 (-</u> <u>6.5, 6.4)</u>	<u>0.98</u>
<u>Stroke</u>	<u>6.4 (5.1, 7.7)</u>	<u>&lt;0.001</u>	<u>5.9 (3.8, 8.0)</u>	<u>&lt;0.001</u>	<u>9.9 (3.3,</u> <u>16.6)</u>	<u>0.0038</u>
<u>ACS</u>	<u>0.26 (-1.2, 1.8)</u>	<u>0.73</u>	<u>2.1 (-0.21,</u> <u>4.4)</u>	<u>0.076</u>	<u>10.0 (3.5,</u> <u>16.6)</u>	<u>0.0027</u>
<u>DOC</u>	<u>3.8 (2.0, 5.5)</u>	<u>&lt;0.001</u>	<u>4.4 (1.9, 7.0)</u>	<u>&lt;0.001</u>	<u>4.7 (-6.1,</u> <u>15.5)</u>	<u>0.40</u>
<u>Trauma</u>	<u>1.8 (1.2, 2.3)</u>	<u>&lt;0.001</u>	<u>8.1 (7.1, 9.2)</u>	<u>&lt;0.001</u>	<u>10.0 (6.7,</u> <u>13.2)</u>	<u>&lt;0.001</u>
<u>Internal medicine</u>	<u>(ref)</u>		<u>(ref)</u>		<u>(ref)</u>	
<u>Orthopedics except for</u>					<u>9.2 (6.3,</u>	
<u>Trauma</u>	<u>1.5 (1.0, 2.0)</u>	<u>&lt;0.001</u>	<u>4.5 (3.2, 5.7)</u>	<u>&lt;0.001</u>	<u>12.1)</u>	<u>&lt;0.001</u>
<u>Neurosurgery except for</u>			<u>9.1 (7.7,</u>		<u>11.5 (8.0,</u>	
<u>Stroke and DOC</u>	<u>6.6 (6.0, 7.1)</u>	<u>&lt;0.001</u>	<u>10.5)</u>	<u>&lt;0.001</u>	<u>14.9)</u>	<u>&lt;0.001</u>
<u>Surgery except for</u>	<u>-0.084 (-1.1,</u>		<u>-0.33 (-3.3,</u>		<u>-0.46 (-</u>	
<u>Abdominal pain</u>	<u>0.98)</u>	<u>0.88</u>	<u>2.6)</u>	<u>0.82</u>	<u>6.5, 5.6)</u>	<u>0.88</u>
<u>Cardiology except for</u>					<u>9.2 (0.59,</u>	
<u>ACS</u>	<u>4.4 (3.4, 5.4)</u>	<u>&lt;0.001</u>	<u>5.5 (1.9, 9.1)</u>	<u>0.0025</u>	<u>17.8)</u>	<u>0.37</u>

<u>Person calling ambulance</u>						
<u>Family or self</u>	(ref)		(ref)		(ref)	
<u>Witness</u>	<u>0.35 (-0.068,</u>	<u>0.1</u>	<u>0.98 (0.11,</u>	<u>0.027</u>	<u>2.3 (-0.23,</u>	<u>0.075</u>
	<u>0.76)</u>		<u>1.8)</u>		<u>4.9)</u>	
<u>Welfare facility</u>	<u>-0.79 (-1.6,</u>	<u>0.056</u>	<u>1.1 (-0.80,</u>	<u>0.25</u>	<u>-7.3 (-</u>	<u>&lt;0.001</u>
	<u>0.021)</u>		<u>3.1)</u>		<u>10.8, -3.9)</u>	
<u>Emergency status at request call</u>						
<u>Less urgency</u>	(ref)		(ref)		(ref)	
<u>Urgency</u>	<u>0.84 (0.30,</u>	<u>0.0023</u>	<u>1.7 (0.66,</u>	<u>0.002</u>	<u>-3.3 (-6.2,</u>	<u>0.029</u>
	<u>1.4)</u>		<u>2.8)</u>		<u>-0.35)</u>	
<u>Emergency</u>	<u>-0.033 (-0.78,</u>	<u>0.93</u>	<u>0.012 (-1.5,</u>	<u>0.99</u>	<u>-2.7 (-6.7,</u>	<u>0.19</u>
	<u>0.72)</u>		<u>1.5)</u>		<u>1.3)</u>	
<u>Resuscitation</u>	<u>-0.99 (-3.2,</u>	<u>0.37</u>	<u>-3.2 (-9.2,</u>	<u>0.29</u>	<u>-5.5 (-</u>	<u>0.44</u>
	<u>1.2)</u>		<u>2.7)</u>		<u>19.3, 8.4)</u>	
<u>During assessment</u>	<u>-1.24 (-1.7, -</u>	<u>&lt;0.001</u>	<u>-1.9 (-2.8, -</u>	<u>&lt;0.001</u>	<u>-3.6 (-6.3,</u>	<u>0.0088</u>
	<u>0.80)</u>		<u>1.0)</u>		<u>-0.94)</u>	
<u>The number of request call (mean (SD))</u>	<u>6.2 (6.1, 6.3)</u>	<u>&lt;0.001</u>	<u>6.5 (6.3, 6.7)</u>	<u>&lt;0.001</u>	<u>6.7 (6.2,</u>	<u>&lt;0.001</u>
					<u>7.2)</u>	
<u>Random effects</u>						
<u>Variance of (SD)</u>	<u>8.5 (2.9)</u>	<u>—</u>	<u>81.7 (9.0)</u>	<u>—</u>	<u>126.4</u>	<u>—</u>
					<u>(11.2)</u>	
<u>AIC</u>	<u>231005</u>		<u>58625</u>		<u>27533</u>	
<u>Radj2</u>	<u>0.41</u>	<u>—</u>	<u>0.52</u>	<u>—</u>	<u>0.32</u>	<u>—</u>

SD: standard deviation, ACS: acute coronary syndromes, CPA:

Cardiopulmonary arrest,

DOC: disturbance of consciousness, request call: request call to hospital for transportation

## STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract -p2, p4 in abstract and p9 in METHODS (b) Provide in the abstract an informative and balanced summary of what was done and what was found – p4
<b>Introduction</b>		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported -p7
Objectives	3	State specific objectives, including any prespecified hypotheses – p8
<b>Methods</b>		
Study design	4	Present key elements of study design early in the paper – p9
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection –p9-11
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants – p11 (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable – p12-13
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group –p9
Bias	9	Describe any efforts to address potential sources of bias – p9-10
Study size	10	Explain how the study size was arrived at – p9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why - p12
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding –p13 (b) Describe any methods used to examine subgroups and interactions –p15 (c) Explain how missing data were addressed –p12 (d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy – p14 (e) Describe any sensitivity analyses –p14

Continued on next page

**Results**

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed –p15 (b) Give reasons for non-participation at each stage –not applicable (c) Consider use of a flow diagram – no use
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders –p15-17 (b) Indicate number of participants with missing data for each variable of interest-p16 table1 (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —Report numbers of outcome events or summary measures -p16
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included -p21-23 (b) Report category boundaries when continuous variables were categorized –p13 (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period – not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses –p21 and supplement table 3

**Discussion**

Key results	18	Summarise key results with reference to study objectives – p23
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias –p27-28
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence –p26-27
Generalisability	21	Discuss the generalisability (external validity) of the study results –p28

**Other information**

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based –p30
---------	----	--

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## The 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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2016-012194.R2
Article Type:	Research
Date Submitted by the Author:	29-Sep-2016
Complete List of Authors:	Hanaki, Nao; Kyoto University Graduate School of Medicine, Department of Healthcare Economics and Quality Management Yamashita, Kazuto; Kyoto University Graduate School of Medicine, Department of Healthcare Economics and Quality Management Kunisawa, Susumu; Kyoto University Graduate School of Medicine, Department of Healthcare Economics and Quality Management Imanaka, Yuichi; Kyoto University Graduate School of Medicine, Department of Healthcare Economics and Quality Management
<b>Primary Subject Heading</b>:	Emergency medicine
Secondary Subject Heading:	Health policy, Public health, Health services research, Medical management
Keywords:	transportation time, request call, emergency medical service, ambulance transportation

SCHOLARONE™  
Manuscripts

Only

1  
2  
3  
4  
5  
6 **Title:** The effect of the number of request calls on the time from call to hospital arrival:  
7  
8

9 a cross-sectional study of an ambulance record database in Nara prefecture, Japan  
10  
11  
12  
13  
14  
15  
16  
17

18 **Author Information:** Nao Hanaki, MD; Kazuto Yamashita, MD, Ph.D.; Susumu  
19

20 Kunisawa, MD, Ph.D.; Yuichi Imanaka, MD, MPH, Ph.D.  
21  
22  
23  
24  
25  
26  
27

28 **Authors' Affiliation:**

29 Department of Healthcare Economics and Quality Management, Graduate School of  
30  
31  
32 Medicine, Kyoto University, Yoshida Konoe-cho, Sakyo-ku, Kyoto, 606-8501, JAPAN  
33  
34  
35 (Drs. Hanaki, Yamashita, Kunisawa and Imanaka)  
36  
37  
38  
39  
40  
41

42 **Corresponding Author:** Prof. Yuichi Imanaka

43 Department of Healthcare Economics and Quality Management

44 Graduate School of Medicine, Kyoto University

45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
Yoshida Konoe-cho, Sakyo-ku, Kyoto, 606-8501, JAPAN

TEL: +81-75-753-4454 FAX: +81-75-753-4455

E-mail: [imanaka-y@umin.net](mailto:imanaka-y@umin.net)

1  
2  
3  
4  
5  
6  
7  
8  
9 **Disclosure of potential conflict of interest:** All authors declare no financial  
10  
11 relationships that are potentially relevant to this article.  
12  
13

14  
15  
16  
17 **Keywords:** emergency medical service, transportation time, request call, ambulance  
18  
19 transportation  
20  
21  
22  
23

24  
25  
26 **Word count:** 3,937 words (from the Introduction to the Conclusions)  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 ABSTRACT  
7  
8

9 Objectives: In Japan, ambulance staff sometimes must make request calls to find  
10 hospitals that can accept patients because of an inadequate information sharing system.

11  
12 This study aimed to quantify effects of the number of request calls on the time interval  
13 between an emergency call and hospital arrival.  
14  
15  
16  
17  
18

19 Design and Setting: A cross-sectional study of an ambulance records database in Nara  
20 prefecture, Japan.  
21  
22  
23  
24

25 Cases: A total of 43,663 patients (50% women; 31.2% aged 80 and over): (1)  
26 transported by ambulance from April 2013 to March 2014, (2) aged 15 and over, and (3)  
27 with suspected major illness.  
28  
29  
30  
31  
32  
33

34 Primary outcome measures: The time from call to hospital arrival, defined as the time  
35 interval from receipt of an emergency call to ambulance arrival at a hospital.  
36  
37  
38  
39

40 Results: The mean time interval from emergency call to hospital arrival was 44.5  
41 minutes, and the mean number of requests was 1.8. Multilevel linear regression analysis  
42 showed that approximately 43.8% of variations in transportation times were explained  
43 by patient age, sex, season, day of the week, time, category of suspected illness, person  
44 calling for the ambulance, emergency status at request call, area, and number of request  
45 calls. A higher number of request calls was associated with longer time intervals to  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60



1  
2  
3  
4  
5  
6 hospital arrival (addition of 6.3 minutes per request call;  $p<0.001$ ). In an analysis  
7  
8  
9 dividing areas into three groups, there were differences in transportation time for  
10  
11  
12 diseases needing cardiologists, neurologists, neurosurgeons, and orthopedists.  
13

14  
15 Conclusions: The study revealed 6.3 additional minutes needed in transportation time  
16  
17 for every refusal of a request call, and also revealed disease-specific delays among  
18  
19 specific areas. An effective system should be collaboratively established by  
20  
21  
22 policymakers and physicians to ensure the rapid identification of an available hospital  
23  
24  
25 for patient transportation in order to reduce the time from the initial emergency call to  
26  
27  
28 hospital arrival.  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

### 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 minutes.
- This study revealed that there is a difference of up to approximately 30 minutes 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 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 dialing "119." The emergency call is directly received by the local fire defense 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 are unable to refuse patients without good reason.

1  
2  
3  
4  
5  
6 The national average of the time from calling an ambulance to hospital arrival  
7  
8  
9 was 39.4 minutes in 2014, is increasing every year[7], and is a known predictor of  
10  
11  
12 outcomes of acute heart failure[8] and head trauma[9]. Japan has the most rapidly aging  
13  
14  
15 population in the world[10], and it is estimated that there were 33,656,000 people aged  
16  
17  
18 65 and over (26.5% of the population) in 2015[11]. As the number of elderly people will  
19  
20  
21 reach a peak of 33.78 million in 2042, the percentage of elderly people will reach  
22  
23  
24 39.9 % in 2060[12]. The number of ambulance dispatches was nearly 6.0 million in  
25  
26  
27 2014 and this reflected a trend of increases over the previous 6 years[7]. Because of the  
28  
29  
30 rapidly aging population and an increase in ambulance dispatches, the time from call to  
31  
32  
33 hospital arrival will invariably increase unless major changes are implemented in the  
34  
35  
36 emergency care and resource distribution systems.

37  
38 One recent study showed that the number of request calls to hospitals had  
39  
40  
41 greater odds of an on-scene arrival time of over 30 minutes[13]. However, the direct  
42  
43  
44 effect of the number of request calls on the time from call to hospital arrival is unclear.  
45  
46  
47 The aim of this study was to evaluate factors affecting the time to hospital arrival of  
48  
49  
50 ambulances, especially the effect of the number of request calls.

## 51 52 53 54 55 **METHODS**

## Data and setting

This was a cross-sectional study. The data sources were an ambulance transportation records database (transportation database) and an ambulance request call records database (request call database) in Nara prefecture, Japan. The location and map of Nara prefecture are shown in Supplement Figure 1. The prefectural population was 1.36 million in 2015, with a population density of 369 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

1  
2  
3  
4  
5  
6 of patients, and the result of the request call. In Nara prefecture, ambulance crews have  
7  
8  
9 a tablet-type portable computer for searching hospital statuses with regard to admission  
10  
11  
12 acceptability. Using these computers, the crew members input the date and time of each  
13  
14  
15 action for transportation and the assessment results (such as each patient's emergency  
16  
17  
18 situation and suspected illnesses).

19  
20  
21 Nara prefecture has established a medical cooperation system for these ten  
22  
23  
24 important illnesses through the formation of a medical institution network in order to  
25  
26  
27 provide coordinated care for patients. Under this system, patient emergency situations  
28  
29  
30 are categorized into five levels, and suspected illnesses are categorized into ten  
31  
32  
33 important illnesses and other categories. These categories are assessed by ambulance  
34  
35  
36 crews based on designated criteria and protocols. The ten important illnesses are  
37  
38  
39 categorized as follows: cardiopulmonary arrest (CPA), stroke, disturbance of  
40  
41  
42 consciousness (DOC), acute coronary syndrome (ACS), abdominal pain, trauma, severe  
43  
44  
45 burn, perinatal problem, pediatrics, and psychiatric illness. The other categories are  
46  
47  
48 classified according to medical specialties, including internal medicine, neurosurgery  
49  
50  
51 except for stroke or DOC, surgery except for abdominal pain, orthopedics except for  
52  
53  
54 trauma, and cardiology except for ACS. Patients were categorized into the "other  
55  
56  
57 category" if they were not categorized into one of these important illnesses.  
58  
59  
60

## 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 and older, and 3) with suspected illness related to internal medicine, trauma, orthopedics, neurosurgery, abdominal pain, surgery, cardiology, CPA, stroke, ACS, and DOC. Patients' suspected illnesses were categorized into 10 important illnesses and other categories after assessment by EMS staff. The ten important illnesses were categorized as the following patient situations: CPA, stroke, DOC, ACS, abdominal pain, trauma, perinatal problem, pediatrics, and psychiatric illness. We excluded patients with suspected illness related to perinatal problems, pediatrics, and psychiatric illness because the number of hospitals that accepted these kind of patients was very small. We also excluded patients with suspected illnesses, except for those concerning internal medicine, orthopedics, 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 upon 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 minutes for finding hospitals, driving to a hospital, or

1  
2  
3  
4  
5  
6 transportation as outliers. We also excluded children because the number of hospitals  
7  
8  
9 allowing transportation of children is very small, and we would have needed to conduct  
10  
11  
12 a separate study for children as distinct from adults. We treated missing data as null  
13  
14  
15 values, while the cases were retained in the analysis.  
16  
17  
18  
19

## 20 Variables

21  
22  
23 Date and time of hospital arrival, time from arrival on scene to the beginning of  
24  
25  
26 request calls, time from the beginning of request calls to the ending of the calls, time  
27  
28  
29 from the ending of the calls to hospital arrival, time from leaving the scene to hospital  
30  
31  
32 arrival, patient characteristics (age and sex), person calling ambulance, registered  
33  
34  
35 district of the EMS, and patient's emergency status and category of suspected illness as  
36  
37  
38 recorded by on-scene EMS staff or operational staff at the local fire defense  
39  
40  
41 headquarters. We divided patients into three groups according to age: (1) 15 to  $\leq 59$   
42  
43  
44 years, (2) 60 to 79 years, and (3) 80 years or more; the cut-off at 60 years was selected  
45  
46  
47 as it is the traditional retirement age in Japan. We defined the seasons as spring from  
48  
49  
50 March to May, summer from June to August, autumn from September to November, and  
51  
52  
53 winter from December to February. We also defined noon from 8am to 3pm, early night  
54  
55  
56 from 4pm to 11pm, and late night from 12am to 7am. We defined on-scene time as the  
57  
58  
59  
60



1  
2  
3  
4  
5  
6 sum of the time from arriving on the scene to leaving the scene.  
7  
8

9 With regard to ambulance administration, Nara prefecture is divided into 13  
10 districts that were used to identify the places where ambulance calls were made.  
11  
12 Thirteen districts were divided into the following three groups depending on the level of  
13 urbanization and location of the registered district of the EMS: 1) urban area, which  
14 encompasses seven districts that are more urbanized than other areas in Nara prefecture  
15 (population was 1.08 million and the population density was 1,578 per square kilometer  
16 in 2015), 2) the eastern rural area, which consists of three districts located in the east  
17 side of Nara prefecture (population was 0.21 million and the population density was 319  
18 per square kilometer in 2015), and 3) the southern rural area, which consists of three  
19 districts located in the south side of Nara prefecture (population was 0.07 million and  
20 the population density was 30.9 per square kilometer in 2015).  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44

#### 45 **Primary outcome measure**

46 The primary outcome measure was the time from the initial emergency call by  
47 the patients to hospital arrival, that is, the time from the call for an ambulance to  
48 hospital arrival.  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

## Statistical methods

The main results were calculated as means and standard deviations (SD), 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

1  
2  
3  
4  
5  
6 variables were selected on the basis of previous research[17–23]. To evaluate the  
7  
8  
9 differences of time from call to hospital arrival between the three areas, we conducted a  
10  
11  
12 multilevel linear regression analysis with a random intercept model that allowed  
13  
14  
15 different intercepts with the three areas. We also conducted a subgroup analysis for  
16  
17  
18 on-scene time and time from leaving the scene to hospital arrival.  
19

20  
21 Lastly, to evaluate the differences of time from call to hospital arrival between  
22  
23  
24 the three areas, we conducted a multilevel linear regression analysis with a random  
25  
26  
27 intercept model that allowed different intercepts with the three areas. To evaluate  
28  
29  
30 differences in the time from request call to hospital arrival among the three areas, we  
31  
32  
33 also conducted another multilevel linear regression analysis with a random intercept  
34  
35  
36 model to correct for patient clustering in the districts where patients were divided into  
37  
38  
39 three areas.  
40

41 Data analysis was conducted using the statistical software package R, version  
42  
43  
44 3.2.2. Prior to the study, the study procedures were reviewed and approved (#E1023) by  
45  
46  
47 the ethics review committee of Kyoto University Graduate School of Medicine.  
48  
49  
50

## 51 52 **RESULTS**

### 53 54 55 **Cases** 56 57 58 59 60

1  
2  
3  
4  
5  
6 From April 2013 to March 2014, the number of transportations by ambulance  
7  
8 was 43,663. The mean (SD) of time from request call to hospital arrival was 44.5 (SD:  
9  
10 20.9) minutes. The distribution of risk factors and their association with transportation  
11  
12 time are shown in Table 1. Slightly less than one-third of patients were 80 years old or  
13  
14 older, and 50% were female. The percentage of patients transported during the noon  
15  
16 time period was 44.8%, which was a greater proportion than during other time  
17  
18 categories. The number of patients in each area ranged from 723 to 11,223, and the  
19  
20 mean (SD) was 3,358.7 (SD: 3,046.3) (the first and third quartile were 1,499 and 4,060,  
21  
22 respectively). The mean (SD) time from call to hospital arrival in each district ranged  
23  
24 from 36.3 (SD: 12.4) minutes to 72.6 (SD: 32.9) minutes, with a mean time of 48.2 (SD:  
25  
26 10.4) minutes (the first and third quartiles were 41.2 and 53.1, respectively; data not  
27  
28 shown). Almost one-half of the patients were suspected of internal disease, and patients  
29  
30 who were suspected of neurosurgical disease experienced longer times than others.  
31  
32 Almost 70% of ambulances were called by family members or patients themselves.  
33  
34 More than half of the patients were categorized into lower emergency situations. There  
35  
36 were no remarkable differences across seasons or days of the week.  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50

51  
52  
53  
54 Table 1. Risk Factors Distribution and Association with transportation time  
55  
56  
57  
58  
59  
60

	n	Time from call to hospital arrival			P-value
		N =	%	mean (SD)	
<hr/>					
Age,y					
≥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	6,627	15.2	43.5 (20.1)	30.0-51.0	
Tuesday	6,133	14.0	43.8 (20.8)	31.0-51.0	
Wednesday	5,838	13.4	43.9 (20.1)	31.0-52.0	
Thursday	5,899	13.5	44.0 (20.8)	31.0-52.0	
Friday	6,134	14.0	43.7 (20.0)	31.0-51.0	
Saturday	6,436	14.7	45.8 (21.4)	32.0-54.0	
Sunday	6,596	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)	8,243	18.9	48.1 (22.1)	34.0-56.0	<0.001*
Category of suspected illness					
Abdominal pain	1,072	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	6,158	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	5,895	13.5	45.5 (22.3)	31.0-54.0	
Neurosurgery except for Stroke and DOC	4,254	9.7	50.4 (22.4)	36.0-60.0	
Surgery except for Abdominal pain	1,066	2.4	42.6 (21.7)	29.0-51.0	
Cardiology except for ACS	1,003	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	9,501	24.7	44.9 (21.8)	31.0-52.0	
Welfare facility	1,906	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	5,243	12.0	45.8 (20.9)	32.0-53.0	
Emergency	2,659	6.1	46.4 (22.0)	32.0-54.0	
Resuscitation	241	0.6	42.4 (18.0)	31.0-47.0	
During assessment	9,983	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	7,661	17.5	48.6 (21.7)	34.0-58.0	
Southern rural area	3,345	7.7	57.8 (31.9)	35.0-72.0	<0.001*

\* P-value by Kruskal-Wallis test

† P-value by Student's t-test

SD: standard deviation, Qu: quartile, ACS: acute coronary syndromes, CPA: Cardiopulmonary arrest,

DOC: disturbance of consciousness, request call: request call to hospital for transportation

The detailed information about each area are not available for disclosing, because of data sharing policy.

### 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 request calls made, the more time spent from call to hospital arrival.

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

The number of request call	n		Time from call to hospital arrival		P-value
	N = 43,663	%	mean (SD)	1st Qu-3rd Qu	
1	29,499	67.6	38.2 (16.2)	29.0-44.0	
2	6,302	14.4	47.8 (16.9)	37.0-54.0	
3	3,150	7.2	55.1 (18.4)	43.0-62.0	
4	1,816	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,

SD: standard deviation, Qu: quartile

### 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 categorized 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 minutes 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 minutes.

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

Hospital Displayed Admission Acceptability	Result	Number of request call	Time from call to hospital arrival		P-value *
		n (%)	mean (SD)	1st Qu-3rd Qu	
		N = 79,693			
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, SD: standard deviation, Qu: quartile



### 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 (see Table 4 and Supplement Table 1). The model that did not include the variable “the number of request calls” was only able to explain 11% of the observed variations (see Supplement Table 2). We found that the number of request calls affected time from call to hospital arrival ( $\beta = 6.3$ ,  $p < 0.001$ ), which indicated that a refusal of a request call extended the time from call to hospital arrival by 6.3 minutes. 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 ( $\beta = 4.6$ ,  $p < 0.001$ ) and time from leaving the scene to hospital arrival ( $\beta = 1.6$ ,  $p < 0.001$ ).

### 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 dispersions in transportation time between the 13 districts (z-score = 23.4) and the 3 areas (z-score = 6.8). (See Table 4 and Supplement table 3.) 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 minutes), stroke (+9.9 minutes), trauma (+10.0 minutes), ACS (+10.1 minutes), orthopedics (+9.2 minutes), and cardiology (+9.2 minutes) in the southern rural area. (See Supplementary Table 4.) 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 minutes, respectively.

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, 37.2)	<0.001

1			
2			
3			
4			
5			
6	Age		
7	≥15, <60	(ref)	
8	≥60, <80	1.1 (0.75, 1.5)	<0.001
9	≥80	0.94 (0.52, 1.4)	<0.001
10			
11	Sex		
12	Female	(ref)	
13	Male	0.64 (0.32, 0.96)	<0.001
14			
15	Season		
16	Spring (March-May)	(ref)	
17	Summer (June-August)	-0.50 (-0.95, -0.053)	0.028
18	Autumn (September-November)	0.57 (0.12, 1.0)	0.012
19	Winter (December-February)	0.98 (0.54, 1.4)	<0.001
20			
21	Day of the week		
22	Monday	(ref)	
23	Tuesday	-0.38 (-0.96, 0.20)	0.20
24	Wednesday	-0.18 (-0.77, 0.41)	0.55
25	Thursday	0.31 (-0.28, 0.90)	0.30
26	Friday	-0.16 (-0.74, 0.42)	0.59
27	Saturday	0.71 (0.13, 1.3)	0.016
28	Sunday	1.1 (0.48, 1.6)	<0.001
29			
30	Time category at ambulance call		
31	Noon (8-15)	(ref)	
32	Early night (16-23)	1.9 (1.6, 2.3)	<0.001
33	Late night (0-7)	2.9 (2.5, 3.9)	<0.001
34			
35	Category of suspected illness		
36	Abdominal pain	-0.93 (-2.0, 0.12)	0.082
37	CPA	0.062 (-1.0, 1.2)	0.92
38	Stroke	6.2 (5.1, 7.3)	<0.001
39	ACS	1.4 (0.14, 2.7)	0.03
40	DOC	3.7 (2.2, 5.2)	<0.001
41	Trauma	3.8 (3.3, 4.3)	<0.001
42	Internal medicine	(ref)	
43	Orthopedics except for Trauma	2.7 (2.2, 3.2)	<0.001
44	Neurosurgery except for Stroke and DOC	7.4 (6.8, 7.9)	<0.001
45	Surgery except for Abdominal pain	-0.076 (-1.1, 0.97)	0.89
46	Cardiology except for ACS	5.0 (4.0, 6.1)	<0.001
47			
48			
49			
50			
51			
52			
53			
54			
55			
56			
57			
58			
59			
60			

Person calling ambulance		
Family or self	(ref)	
Witness	-1.7 (-2.5, -0.95)	<0.001
Welfare facility	0.6 (0.27, 1.1)	<0.001
Emergency status at request call		
Less urgency	(ref)	
Urgency	0.59 (0.08, 1.1)	0.022
Emergency	-0.16 (-0.86, 0.54)	0.66
Resuscitation	-1.8 (-4.0, 0.40)	0.11
During assessment	-1.5 (-2.0, -1.1)	<0.001
The number of request call	6.3 (6.2, 6.4)	<0.001
Random effects, variance [SD]		
Intercept	95.5 [9.8]	
z-score	23.4	
AIC	320,647	
Radj2	0.44	

SD: standard deviation, ACS: acute coronary syndromes,  
 CPA: Cardiopulmonary arrest, DOC: disturbance of consciousness,  
 request call: request call to hospital for transportation

## 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 minutes if all unsuccessful request calls were eliminated. The time from call to hospital arrival increases by 6.3 minutes 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

1  
2  
3  
4  
5  
6 ambulance.

7  
8  
9       Regarding the category of suspected illness, abdominal pain is associated with  
10 the shortest transport time, followed by surgery. The Ministry of Health, Labour and  
11 Welfare asked the prefecture governments to establish medical cooperation systems for  
12 five diseases: acute myocardial infarction, stroke, cancer, diabetes mellitus, and  
13 psychiatric illness[24]. Nara prefecture established a medical cooperation system for  
14 CPA, stroke, DOC, ACS, abdominal pain, trauma, perinatal problems, pediatrics, and  
15 psychiatric illness. In spite of national and prefectural efforts, ACS and stroke calls took  
16 1.4 minutes and 6.2 minutes longer in transportation time compared to internal medicine.  
17 Both acute coronary syndrome and stroke are diseases where time from onset to hospital  
18 arrival is important for treatment and outcome[25–27]. A shortage of appropriate  
19 healthcare facilities in the region might be the reason for prolonged times from call to  
20 hospital arrival for these diseases. As the number of patients with cardiovascular  
21 diseases increases in Japan's aging society, further research that focuses on specific  
22 diseases or time series may be required.  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48

49       This study revealed that transportation times varied depending on the patient's  
50 location when the emergency call was made. There was an approximately 30-minute  
51 difference in the time from request call to hospital arrival among the 13 districts  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 (minimum of 36.3 minutes and maximum of 72.6 min) in a single prefecture. Nara  
7  
8  
9 prefecture has a long north-south axis with three tertiary emergency hospitals. However,  
10  
11  
12 all of these hospitals are located in urban areas that are geographically distant from the  
13  
14  
15 southern rural area. As a result, the southern rural area was found to have longer  
16  
17  
18 transportation times than the other areas. In that area, the categories of illnesses that  
19  
20  
21 require special facilities such as coronary care units or stroke care units had longer  
22  
23  
24 transportation times than in other areas. The distance from emergency hospital and  
25  
26  
27 appropriate healthcare facilities might be the cause of this difference between areas.  
28  
29  
30 One observational study discussed the shortage of emergency medical facilities in rural  
31  
32  
33 areas in Japan[28]. One geographical study pointed out that there was a regional gap in  
34  
35  
36 the number of tertiary care centers per million people between prefectures in Japan[29].  
37

38  
39  
40 Our results also indicate that there are differences in transportation times for  
41  
42  
43 specific diseases among regions. In southern rural areas, there were longer  
44  
45  
46 transportation times for diseases that needed treatment by specialists such as  
47  
48  
49 cardiologists, neurologists, neurosurgeons, and orthopedists than in the other two areas.  
50  
51  
52 This might be associated with the shortage of medical facilities for specific illnesses in  
53  
54  
55 these regions. Indicating disease-specific problems that are specific to each area is  
56  
57  
58 helpful information for improving health care systems and is also a strength of our  
59  
60

1  
2  
3  
4  
5  
6 study.  
7  
8

9 Our database did not include patients' socioeconomic information, except for  
10 the person who called an ambulance. In the field of acute myocardial infarction and  
11 stroke, it is known that the time from onset of symptoms to hospital arrival is influenced  
12 by many other factors such as living alone[18], being alone at the onset of  
13 symptoms[19,20], being a nonwhite patient in the United States [21], and education  
14 level[22]. In addition, indicators of patient socioeconomic status, such as mean income  
15 of the residential area[30,31] and race[30], have also been reported to influence the time  
16 from an emergency call to hospital arrival. We think information about the person who  
17 called an ambulance would help to indicate the socioeconomic status of patients to some  
18 degree.  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37

38 In our study, we found there were no substantial differences in times between  
39 days of the week or seasons. One study in Tennessee, USA, found that the prolongation  
40 of transportation time was influenced by seasons due to variations in traffic volume[23].  
41 However, transportation conditions are very different between Tennessee and Nara,  
42 which may explain in part the observed differences in results between these two studies.  
43  
44  
45  
46  
47  
48  
49  
50  
51

52 Our study revealed that time from call to hospital arrival increases by 6.3  
53 minutes for every request call from EMS to hospital. It also revealed that more than  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 45% of all request calls and 43% of request calls to hospitals indicating a status of  
7  
8  
9 “Accepting patients” resulted in failure. Driving ambulances at high speed[32],  
10  
11  
12 helicopter transportation[33–35], and centralization of hospitals[36] might be solutions  
13  
14  
15 to reduce transportation time. However, the risk of traffic accidents[37], costs for  
16  
17  
18 helicopter emergency medical services[38,39], and time and cost for centralizing  
19  
20  
21 hospitals are difficult problems to solve. Hence, it may be important to create a system  
22  
23  
24 for quickly determining appropriate hospitals and ensuring faster admissions to decrease  
25  
26  
27 the number of request calls.  
28

29  
30 It may be beneficial for policymakers to create a system to share information  
31  
32 about hospitals and emergency patients more promptly especially for an aging society  
33  
34  
35 with an increasing number of ambulance dispatches. One recent cross-sectional study  
36  
37  
38 showed that services with tablet computers shortened the transportation time in Saga  
39  
40  
41 prefecture, Japan[40]; even though there was no information about time from call to  
42  
43  
44 hospital arrival in that study, introducing these support systems would reduce time from  
45  
46  
47 call to hospital arrival or transportation time. In prefectures, such as Nara prefecture,  
48  
49  
50 where a support system with tablet computers was introduced, creating a more effective  
51  
52  
53 and convenient system is needed. Physicians are not only required to accept patients if  
54  
55  
56 requested, but must also appropriately indicate the hospital’s capacity for emergency  
57  
58  
59  
60



1  
2  
3  
4  
5  
6 patients appropriately. As a result, this places an additional burden on physicians. Due to  
7  
8  
9 the shortage of physicians in Japan[41], there is a need for more effective posting of  
10  
11  
12 physicians and efficient working systems.  
13

14  
15  
16  
17  
18 Our study has several limitations. First, patient emergency status was decided  
19  
20 by the ambulance crew. Our data do not include vital signs for all patients, because  
21  
22 ambulance crews are required to register vital signs of patients for only a limited  
23  
24 number of suspected illnesses. We therefore cannot analyze patient emergency status  
25  
26 using vital signs. As ambulance crews assessed patients by rules depending on patient's  
27  
28 vital signs and they were also trained under the medical control system[5], the decisions  
29  
30 made by ambulance crews were viewed as credible.  
31  
32  
33  
34  
35  
36  
37

38 Second, our data consisted of patients in Nara prefecture. Nara prefecture is  
39  
40 one of 47 prefectures in Japan. Our results may not be applicable to all prefectures in  
41  
42 Japan. However, there is a discrepancy in urbanization between urbanized areas and  
43  
44 mountainous areas such as the southern area. Therefore, we can discuss the differences  
45  
46 between areas within one prefecture.  
47  
48  
49  
50  
51

52 Lastly, there are several factors that are known to influence the time from  
53  
54 request calls to hospital arrival, but we were unable to include them in the analysis due  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6 to data limitations. These factors include prehospital strategies[42], level of training of  
7  
8  
9 ambulance crews[43], and hospital capacity[44]. Future studies should address the  
10  
11  
12 influence of these factors.

### 13 14 15 16 17 18 **Conclusions**

19  
20 The study revealed that 6.3 additional minutes were added to transportation  
21  
22 time by every refusal of a request call and also revealed disease-specific delays among  
23  
24 specific areas. A system that helps EMS to find hospitals should be effectively  
25  
26 established to share information about hospitals and emergency patients promptly in  
27  
28 partnership with policymakers and physicians for reducing the time from call to hospital  
29  
30 arrival.  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40

### 41 **Contributors**

42  
43 NH has had the main responsibility for calculating statistics and writing the paper. YI is  
44  
45 the principal investigator for the project, planned the present paper jointly with NH, and  
46  
47 has actively taken part in revising the paper. KY and SK have taken part in planning and  
48  
49 analyzing data and revising the paper.  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

## Funding

This work was financially supported in part by the Health Sciences Research Grants from the Ministry of Health, Labour and Welfare of Japan (H27-iryō-ippān-001), and a Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of Science ([A] 25253033 and [A] 16H02634).

## Competing interests

Kyoto University Department of Healthcare Economics and Quality Management had a financial contract with Nara prefecture to support analysis of its healthcare system.

This study is out of the scope of the contract, and is not financed by Nara prefecture.

Otherwise, all authors declare no financial relationships that are potentially relevant to this article.

## Ethical approval

This study was approved by the Ethical Committee, Kyoto University Graduate School of Medicine, Japan

## Data sharing statement

No additional data are available for sharing, because of data sharing policy.

## REFERENCES

- 1 Hori S. Emergency medicine in Japan. *Keio J Med* 2010;**59**:131–  
9.<http://www.ncbi.nlm.nih.gov/pubmed/21187699> (accessed 22 Dec2015).
- 2 EDITORIAL: Medical emergencies. The Asahi Shimbun.  
2007.<http://database.asahi.com/library2/main/start.php>
- 3 No progress in emergency pregnancy care. Japan News.  
2007;:03.<https://database.yomiuri.co.jp/rekishikan/>
- 4 Shiga T, Sato T. Current emergency medical systems in Japan. *Jpn Hosp*  
2008;:71–3.<http://www.ncbi.nlm.nih.gov/pubmed/19195153> (accessed 22  
Dec2015).
- 5 Tanigawa K, Tanaka K. Emergency medical service systems in Japan: past,  
present, and future. *Resuscitation* 2006;**69**:365–70.  
doi:10.1016/j.resuscitation.2006.04.001
- 6 Suzuki T, Nishida M, Suzuki Y, *et al.* Issues and Solutions in Introducing  
Western Systems to the Pre-hospital Care System in Japan. *West J Emerg Med*  
2008;**9**:166–

- 1  
2  
3  
4  
5  
6 70.<http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2672269&tool=pmcentrez&rendertype=abstract> (accessed 22 Dec2015).
- 7  
8  
9  
10  
11  
12 7 Japan Fire and Disaster Management Agency. The 2015 white paper (Japanese)  
13  
14 2015. 2015;:67.[http://www.fdma.go.jp/neuter/topics/fieldList9\\_3.html](http://www.fdma.go.jp/neuter/topics/fieldList9_3.html) (accessed  
15  
16 23 Mar2016).
- 17  
18  
19  
20  
21 8 Takahashi M, Kohsaka S, Miyata H, *et al*. Association between prehospital time  
22  
23 interval and short-term outcome in acute heart failure patients. *J Card Fail*  
24  
25 2011;**17**:742–7. doi:10.1016/j.cardfail.2011.05.005
- 26  
27  
28  
29  
30 9 Dinh MM, Bein K, Roncal S, *et al*. Redefining the golden hour for severe head  
31  
32 injury in an urban setting: the effect of prehospital arrival times on patient  
33  
34 outcomes. *Injury* 2013;**44**:606–10. doi:10.1016/j.injury.2012.01.011
- 35  
36  
37  
38 10 World Population Prospects - Population Division - United Nations.  
39  
40 <http://esa.un.org/unpd/wpp/Publications/> (accessed 19 Jan2016).
- 41  
42  
43  
44 11 Statistics Bureau Home Page/Population Estimates Monthly Report.  
45  
46 <http://www.stat.go.jp/english/data/jinsui/tsuki/index.htm> (accessed 19 Jan2016).
- 47  
48  
49  
50 12 Annual Report on the Aging Society: 2014 (Summary) - Cabinet Office Home  
51  
52 Page. [http://www8.cao.go.jp/kourei/english/annualreport/2014/2014pdf\\_e.html](http://www8.cao.go.jp/kourei/english/annualreport/2014/2014pdf_e.html)  
53  
54 (accessed 19 Jan2016).
- 55  
56  
57  
58  
59  
60

- 1  
2  
3  
4  
5  
6 13 Nagata I, Abe T, Nakata Y, *et al.* Factors related to prolonged on-scene time  
7  
8 during ambulance transportation for critical emergency patients in a big city in  
9  
10 Japan: a population-based observational study. *BMJ Open* 2016;**6**:e009599.  
11  
12 doi:10.1136/bmjopen-2015-009599  
13  
14  
15  
16  
17 14 Ministry of Internal Affairs and Communications. Population Census 2015.  
18  
19 2016.<http://www.stat.go.jp/english/data/kokusei/index.htm> (accessed 6 Jun2016).  
20  
21  
22  
23 15 Ministry of Health L and W. Annual Health, Labour, and Welfare Report  
24  
25 2011-2012.  
26  
27 2012.<http://www.mhlw.go.jp/english/policy/health-medical/health/index.html>  
28  
29 (accessed 6 Jun2016).  
30  
31  
32  
33  
34 16 Communications M of IA and. Social Indicators by Prefecture 2014 :System of  
35  
36 Social and Demographic Statistics.  
37  
38 2015.[http://www.e-stat.go.jp/SG1/estat/GL32010201.do?method=searchTop&an](http://www.e-stat.go.jp/SG1/estat/GL32010201.do?method=searchTop&andKeyword=hospital)  
39  
40  
41  
42  
43  
44  
45  
46  
47 17 Ayrik C, Ergene U, Kinay O, *et al.* Factors influencing emergency department  
48  
49 arrival time and in-hospital management of patients with acute myocardial  
50  
51 infarction. *Adv Ther*;**23**:244–55.<http://www.ncbi.nlm.nih.gov/pubmed/16751157>  
52  
53  
54  
55 (accessed 22 Dec2015).  
56  
57  
58  
59  
60

- 1  
2  
3  
4  
5  
6 18 Bouma J, Broer J, Bleeker J, *et al.* Longer pre-hospital delay in acute myocardial  
7  
8 infarction in women because of longer doctor decision time. *J Epidemiol*  
9  
10 *Community Health* 1999;**53**:459–  
11  
12  
13  
14 64.[http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1756944&tool=pm](http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1756944&tool=pmcentrez&rendertype=abstract)  
15  
16 [centrez&rendertype=abstract](http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1756944&tool=pmcentrez&rendertype=abstract) (accessed 20 Jan2016).  
17  
18  
19  
20 19 Raczynski JM, Finnegan JR, Zapka JG, *et al.* REACT theory-based intervention  
21  
22 to reduce treatment-seeking delay for acute myocardial infarction. Rapid Early  
23  
24 Action for Coronary Treatment. *Am J Prev Med* 1999;**16**:325–  
25  
26  
27 34.<http://www.ncbi.nlm.nih.gov/pubmed/10493291> (accessed 20 Jan2016).  
28  
29  
30  
31  
32 20 Perry K, Petrie KJ, Ellis CJ, *et al.* Symptom expectations and delay in acute  
33  
34 myocardial infarction patients. *Heart* 2001;**86**:91–  
35  
36  
37 3.[http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1729795&tool=pm](http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1729795&tool=pmcentrez&rendertype=abstract)  
38  
39 [centrez&rendertype=abstract](http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1729795&tool=pmcentrez&rendertype=abstract) (accessed 20 Jan2016).  
40  
41  
42  
43 21 Goldberg RJ, Gurwitz JH, Gore JM. Duration of, and temporal trends  
44  
45 (1994-1997) in, prehospital delay in patients with acute myocardial infarction:  
46  
47 the second National Registry of Myocardial Infarction. *Arch Intern Med*  
48  
49 1999;**159**:2141–7.<http://www.ncbi.nlm.nih.gov/pubmed/10527291> (accessed 20  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60 Jan2016).

- 1  
2  
3  
4  
5  
6 22 Zapka JG, Oakes JM, Simons-Morton DG, *et al.* Missed opportunities to impact  
7  
8  
9 fast response to AMI symptoms. *Patient Educ Couns* 2000;**40**:67–  
10  
11  
12 82.<http://www.ncbi.nlm.nih.gov/pubmed/10705066> (accessed 20 Jan2016).  
13  
14  
15 23 Golden AP, Odoi A. Emergency medical services transport delays for suspected  
16  
17  
18 stroke and myocardial infarction patients. *BMC Emerg Med* 2015;**15**:34.  
19  
20  
21 doi:10.1186/s12873-015-0060-3  
22  
23  
24 24 Ministry of Health L and W. Ministry of Health, Labour and Welfare: Medical  
25  
26  
27 Care.  
28  
29  
30 <http://www.mhlw.go.jp/english/policy/health-medical/medical-care/index.html>  
31  
32 (accessed 25 Jan2016).  
33  
34  
35 25 Francone M, Bucciarelli-Ducci C, Carbone I, *et al.* Impact of primary coronary  
36  
37  
38 angioplasty delay on myocardial salvage, infarct size, and microvascular damage  
39  
40  
41 in patients with ST-segment elevation myocardial infarction: insight from  
42  
43  
44 cardiovascular magnetic resonance. *J Am Coll Cardiol* 2009;**54**:2145–53.  
45  
46  
47 doi:10.1016/j.jacc.2009.08.024  
48  
49  
50 26 Aquaro GD, Pingitore A, Strata E, *et al.* Relation of pain-to-balloon time and  
51  
52  
53 myocardial infarct size in patients transferred for primary percutaneous coronary  
54  
55  
56 intervention. *Am J Cardiol* 2007;**100**:28–34. doi:10.1016/j.amjcard.2007.02.050  
57  
58  
59  
60



- 1  
2  
3  
4  
5  
6 27 Powers WJ, Derdeyn CP, Biller J, *et al.* 2015 AHA/ASA Focused Update of the  
7  
8  
9 2013 Guidelines for the Early Management of Patients With Acute Ischemic  
10  
11  
12 Stroke Regarding Endovascular Treatment. *Stroke*  
13  
14 2015;**46**:STR.0000000000000074. doi:10.1161/STR.0000000000000074  
15  
16  
17 28 Ehara A. Are city population and the number of emergency medical facilities  
18  
19 correlated? *Pediatr Int* 2009;**51**:258–9. doi:10.1111/j.1442-200X.2008.02694.x  
20  
21  
22  
23 29 Miwa M, Kawaguchi H, Arima H, *et al.* The effect of the development of an  
24  
25 emergency transfer system on the travel time to tertiary care centres in Japan. *Int*  
26  
27 *J Health Geogr* 2006;**5**:25. doi:10.1186/1476-072X-5-25  
28  
29  
30  
31 30 Kleindorfer DO, Lindsell CJ, Broderick JP, *et al.* Community socioeconomic  
32  
33 status and prehospital times in acute stroke and transient ischemic attack: do  
34  
35 poorer patients have longer delays from 911 call to the emergency department?  
36  
37  
38 *Stroke* 2006;**37**:1508–13. doi:10.1161/01.STR.0000222933.94460.dd  
39  
40  
41  
42 31 Govindarajan A, Schull M. Effect of socioeconomic status on out-of-hospital  
43  
44 transport delays of patients with chest pain. *Ann Emerg Med* 2003;**41**:481–90.  
45  
46  
47 doi:10.1067/mem.2003.108  
48  
49  
50  
51 32 Petzäll K, Petzäll J, Jansson J, *et al.* Time saved with high speed driving of  
52  
53 ambulances. *Accid Anal Prev* 2011;**43**:818–22. doi:10.1016/j.aap.2010.10.032  
54  
55  
56  
57  
58  
59  
60

- 1  
2  
3  
4  
5  
6 33 Funder KS, Rasmussen LS, Lohse N, *et al.* Long-term follow-up of trauma  
7  
8 patients before and after implementation of a physician-staffed helicopter: A  
9  
10 prospective observational study. *Injury* 2016;**47**:7–13.  
11  
12 doi:10.1016/j.injury.2015.10.032  
13  
14  
15  
16  
17 34 Fjaeldstad A, Kirk MH, Knudsen L, *et al.* Physician-staffed emergency  
18  
19 helicopter reduces transportation time from alarm call to highly specialized centre.  
20  
21 *Dan Med J* 2013;**60**:A4666.<http://www.ncbi.nlm.nih.gov/pubmed/23809975>  
22  
23 (accessed 3 Dec2015).  
24  
25  
26  
27  
28 35 Johnsen AS, Fattah S, Sollid SJM, *et al.* Utilisation of helicopter emergency  
29  
30 medical services in the early medical response to major incidents: a systematic  
31  
32 literature review. *BMJ Open* 2016;**6**:e010307.  
33  
34  
35  
36  
37  
38  
39  
40  
41 36 Kobayashi D, Otsubo T, Imanaka Y. The effect of centralization of health care  
42  
43 services on travel time and its equality. *Health Policy* 2015;**119**:298–306.  
44  
45  
46  
47  
48  
49  
50 37 Becker LR, Zaloshnja E, Levick N, *et al.* Relative risk of injury and death in  
51  
52 ambulances and other emergency vehicles. *Accid Anal Prev* 2003;**35**:941–  
53  
54  
55  
56  
57  
58  
59  
60

- 1  
2  
3  
4  
5  
6 38 Taylor CB, Stevenson M, Jan S, *et al.* A systematic review of the costs and  
7  
8 benefits of helicopter emergency medical services. *Injury* 2010;**41**:10–20.  
9  
10 doi:10.1016/j.injury.2009.09.030  
11  
12  
13  
14 39 Taylor C, Jan S, Curtis K, *et al.* The cost-effectiveness of physician staffed  
15  
16 Helicopter Emergency Medical Service (HEMS) transport to a major trauma  
17  
18 centre in NSW, Australia. *Injury* 2012;**43**:1843–9.  
19  
20  
21  
22 doi:10.1016/j.injury.2012.07.184  
23  
24  
25  
26 40 Yamada KC, Inoue S, Sakamoto Y. An effective support system of emergency  
27  
28 medical services with tablet computers. *JMIR mHealth uHealth* 2015;**3**:e23.  
29  
30  
31  
32 doi:10.2196/mhealth.3293  
33  
34  
35 41 Ishikawa T, Ohba H, Yokooka Y, *et al.* Forecasting the absolute and relative  
36  
37 shortage of physicians in Japan using a system dynamics model approach. *Hum*  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60
- 42 Schull MJ, Vaillancourt S, Donovan L, *et al.* Underuse of prehospital strategies  
to reduce time to reperfusion for ST-elevation myocardial infarction patients in 5  
Canadian provinces. *CJEM* 2009;**11**:473–  
80.<http://www.ncbi.nlm.nih.gov/pubmed/19788792> (accessed 15 Dec2015).
- 43 Schuster M, Pints M, Fiege M. Duration of mission time in prehospital

1  
2  
3  
4  
5  
6 emergency medicine: effects of emergency severity and physicians level of

7  
8  
9 education. *Emerg Med J* 2010;**27**:398–403. doi:10.1136/emj.2009.074211

10  
11  
12 44 Burt CW, McCaig LF. Staffing, capacity, and ambulance diversion in emergency

13  
14 departments: United States, 2003-04. *Adv Data* 2006;:1–

15  
16  
17 23.<http://www.ncbi.nlm.nih.gov/pubmed/17037024> (accessed 7 Jun2016).

## Figure Legends

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

Supplement Figure 1. Location and map of Nara prefecture

The left side of the figure shows a map of Japan. The lines represent prefectural borders, and Nara prefecture is indicated in black. The right side of the figure shows a map of Nara prefecture. The light gray area is the eastern rural area and the black area is the southern rural area. The black circles indicate the location of the tertiary emergency hospitals in Nara prefecture.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

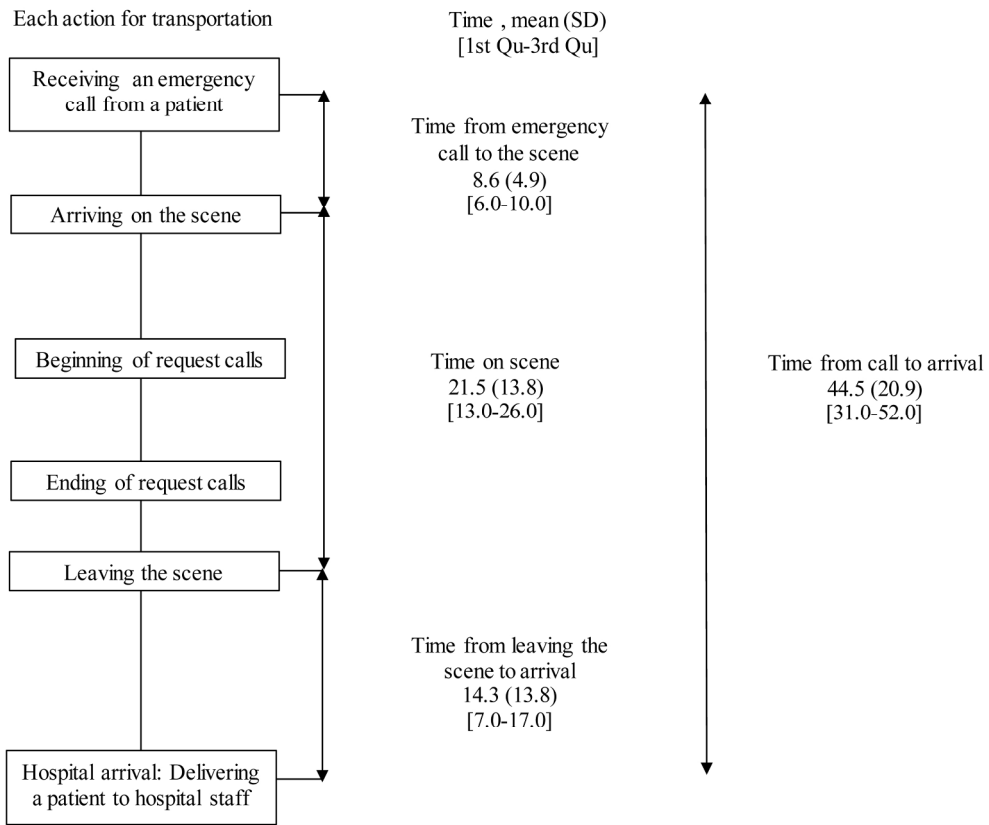
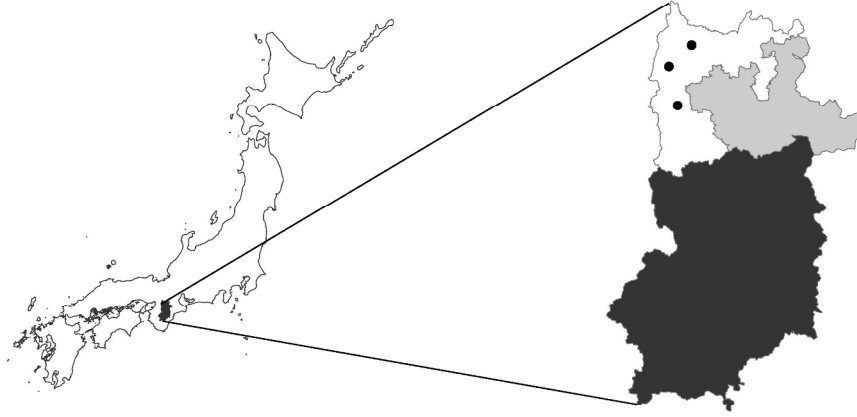


Figure 1. Components of time from request call to hospital admission  
 Data for the time from the ending of request calls to leaving the scene and the time from entering a hospital to delivering a patient to hospital staff were not available.  
 SD: standard deviation, Qu: quartile

201x168mm (300 x 300 DPI)

only



Supplement Figure 1. Location and map of Nara prefecture

The left side of the figure shows a map of Japan. The lines represent prefectural borders, and Nara prefecture is indicated in black. The right side of the figure shows a map of Nara prefecture. The light gray area is the eastern rural area and the black area is the southern rural area. The black circles indicate the location of the tertiary emergency hospitals in Nara prefecture.

297x210mm (226 x 223 DPI)

Supplement Table 1. On scene time and time from scene to hospital arrival: multilevel linear regression analysis

Explanatory variable	On scene		From scene to hospital arrival	
	Estimate (95% CI)	P-value	Estimate (95% CI)	P-value
<b>Fixed effects</b>				
Intercept	9.9 (7.8, 11.9)	<0.001	12.8 (7.3, 18.4)	<0.001
Age				
≥15, <60	(ref)		(ref)	
≥60, <80	0.44 (0.18, 0.69)	<0.001	0.66 (0.40, 0.92)	<0.001
≥80	0.85 (0.58, 1.1)	<0.001	-0.007 (-0.29, 0.28)	0.96
Sex				
Female	(ref)		(ref)	
Male	-0.12 (-0.33, 0.093)	0.28	0.69 (0.47, 0.90)	<0.001
Season				
Spring (March-May)	(ref)		(ref)	
Summer (June-August)	-0.50 (-0.79, -0.20)	<0.001	-0.12 (-0.42, 0.18)	0.43
Autumn (September-November)	0.29 (-0.0030, 0.59)	0.052	0.11 (-0.19, 0.41)	0.48
Winter (December-February)	0.85 (0.56, 1.1)	<0.001	0.082 (-0.22, 0.38)	0.59
Day of the week				
Monday	(ref)		(ref)	
Tuesday	-0.074 (-0.46, 0.31)	0.71	-0.15 (-0.54, 0.24)	0.46
Wednesday	-0.0015 (-0.39, 0.39)	0.99	-0.062 (-0.46, 0.33)	0.76
Thursday	0.015 (-0.37, 0.40)	0.94	0.24 (-0.15, 0.64)	0.23
Friday	-0.11 (-0.49, 0.27)	0.58	0.022 (-0.37, 0.41)	0.91



1					
2					
3					
4					
5					
6		-0.040 (-0.42,			
7	Saturday	0.34)	0.83	0.75 (0.37, 1.1)	<0.01
8					
9		-0.032 (-0.41,			
10	Sunday	0.34)	0.87	1.2 (0.77, 1.5)	<0.001
11					
12	Time category at ambulance call				
13					
14	Noon (8-15)	(ref)		(ref)	
15	Early night (16-23)	0.87 (0.64, 1.1)	<0.001	0.93 (0.69, 1.2)	<0.001
16	Late night (0-7)	2.0 (1.7, 2.2)	<0.001	0.51 (0.22, 0.81)	<0.01
17					
18	Category of suspected illness				
19					
20	Abdominal pain	-1.2 (-1.9, -0.48)	<0.001	0.21 (-0.49,	0.55
21				0.92)	
22					
23	CPA	-4.6 (-1.2, 0.27)	0.22	-0.019 (-0.76,	0.96
24				0.72)	
25	Stroke	2.6 (1.9, 3.4)	<0.001	3.4 (2.6, 4.0)	<0.001
26	ACS	-1.6 (-2.5, -0.78)	<0.01	3.2 (2.3, 4.0)	<0.001
27	DOC	2.8 (1.8, 3.8)	<0.001	0.81 (-0.20, 1.8)	0.12
28	Trauma	1.5 (1.2, 1.8)	<0.001	2.0 (1.7, 2.4)	<0.001
29	Internal medicine	(ref)		(ref)	
30	Orthopedics except for Trauma	-0.74 (0.41, 1.1)	<0.001	1.6 (1.3, 2.0)	<0.001
31	Neurosurgery except for Stroke and				
32	DOC	3.2 (2.9, 3.6)	<0.001	4.1 (3.8, 4.5)	<0.001
33	Surgery except for Abdominal pain	0.43 (-0.26, 1.1)	0.22	-0.32 (-1.0, 0.38)	0.37
34	Cardiology except for ACS	-0.14 (-0.84, 0.56)	0.69	4.2 (3.5, 4.9)	<0.001
35					
36	Person calling ambulance				
37					
38	Family or self	(ref)		(ref)	
39	Witness	2.0 (1.7, 2.2)	<0.001	-0.85 (-1.1, -0.58)	<0.001
40	Welfare facility	-1.2 (-1.7, -0.74)	<0.001	0.28 (-0.23, 0.79)	0.29
41					
42	Emergency status at request call				
43					
44	Less urgency	(ref)		(ref)	
45	Urgency	0.64 (0.30, 0.97)	<0.01	-0.055 (-0.39,	0.75
46				0.28)	
47	Emergency	-0.0071 (-0.47,	0.98	-0.013 (-0.46,	0.96
48		0.45)		0.48)	
49	Resuscitation	-0.015 (-1.4, 1.4)	0.98	-1.3 (-2.7, 0.20)	0.092
50	During assessment	-1.4 (-1.6, -1.1)	<0.001	-0.24 (-0.52, -	0.11
51				0.41)	
52					
53					
54					
55					
56					
57					
58					
59					
60					

The number of request call	4.6 (4.6, 4.7)	<0.001	1.6 (1.6, 1.7)	<0.001
Random effects, variance [SD]				
Intercept	12.7 [3.6]		96.9 [9.8]	
AIC	288,604		290,048	
Radj2	0.44		0.31	

SD: standard deviation, ACS: acute coronary syndromes, CPA: Cardiopulmonary arrest,  
 DOC: disturbance of consciousness, request call: request call to hospital for transportation

Supplement Table 2. Time from call to hospital arrival without variable "the number of request call " : multilevel linear regression analysis

Explanatory valuable	From Call to hospital arrival	
	Estimate (95% CI)	P-value
Fixed effects		
Intercept	42.1 (36.1, 48.0)	<0.001
Age		
≥15, <60	(ref)	
≥60, <80	-0.21 (-0.69, 0.75)	0.039
≥80	-0.44 (-0.95, 0.081)	0.098
Sex		
Female	(ref)	
Male	0.71 (0.32, 1.1)	<0.001
Season		
Spring (March-May)	(ref)	
Summer (June-August)	-0.93 (-1.5, -0.38)	<0.001
Autumn (September-November)	0.19 (-0.37, 0.74)	0.50
Winter (December-February)	1.68 (1.1, 2.2)	<0.001
Day of the week		
Monday	(ref)	
Tuesday	0.030 (-0.69, 0.75)	0.93
Wednesday	0.18 (-0.55, 0.90)	0.63
Thursday	0.52 (-0.20, 1.2)	0.16
Friday	0.097 (-0.61, 0.81)	0.79
Saturday	1.8 (1.1, 2.5)	<0.001
Sunday	2.8 (2.1, 3.5)	<0.001
Time category at ambulance call		
Noon (8-15)	(ref)	
Early night (16-23)	4.6 (4.1, 5.0)	<0.001
Late night (0-7)	7.1 (6.6, 7.6)	<0.001
Category of suspected illness		
Abdominal pain	2.0 (0.75, 3.3)	<0.01
CPA	1.5 (0.18, 2.9)	0.026
Stroke	7.6 (6.1, 9.0)	<0.001

1			
2			
3			
4			
5			
6	ACS	-0.87 (-2.4, 0.71)	0.28
7	DOC	5.9 (4.1, 7.8)	<0.001
8	Trauma	4.3 (3.6, 4.9)	<0.001
9	Internal medicine	(ref)	
10	Orthopedics except for Trauma	3.8 (2.2, 4.9)	<0.001
11	Neurosurgery except for Stroke and DOC	5.9 (7.6, 9.0)	<0.001
12	Surgery except for Abdominal pain	0.47 (3.6, 4.9)	0.47
13	Cardiology except for ACS	3.5 (2.2, 4.9)	<0.001
14	Person calling ambulance		
15	Family or self	(ref)	
16	Witness	1.1 (0.59, 1.6)	<0.001
17	Welfare facility	-1.7 (-2.6, -0.72)	<0.001
18	Emergency status at request call		
19	Less urgency	(ref)	
20	Urgency	0.96 (0.071, 1.3)	0.029
21	Emergency	0.69 (-0.17, 1.6)	0.12
22	Resuscitation	-2.4 (-5.0, 0.31)	0.083
23	During assessment	-3.2 (-3.6, -2.6)	<0.001
24	The number of request call		
25			
26	Random effects, variance [SD]		
27	Intercept	109.5 [10.5]	
28			
29	AIC	336,767	
30	Radj2	0.11	
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			
41			
42			
43			
44			
45			
46	SD: standard deviation, ACS: acute coronary syndromes, CPA: Cardiopulmonary arrest,		
47	DOC: disturbance of consciousness, request call: request call to hospital for transportation		
48			
49			
50			
51			
52			
53			
54			
55			
56			
57			
58			
59			
60			

Supplement table 3. Time from Call to hospital arrival: multilevel linear regression analysis: with random effects to correct for patients clustering in the 3 areas

Explanatory variable	Estimate (95% CI)	P-value
Fixed effects		
Intercept	33.8 (24.9, 42.7)	0.016
Age		
≥15, <60	(ref)	
≥60, <80	1.3 (0.77, 1.6)	<0.001
≥80	1.1 (0.71, 1.6)	<0.001
Sex		
Female	(ref)	
Male	0.76 (0.43, 1.1)	<0.001
Season		
Spring (March-May)	(ref)	0.14
Summer (June-August)	-0.35 (-0.81, 0.11)	0.026
Autumn (September-November)	0.53 (0.064, 0.99)	<0.01
Winter (December-February)	0.89 (0.43, 1.3)	<0.001
Day of the week		
Monday	(ref)	
Tuesday	-0.30 (-0.90, 0.30)	0.33
Wednesday	-0.054 (-0.66, 0.55)	0.86
Thursday	0.34 (-0.26, 0.95)	0.27
Friday	-0.12 (-0.72, 0.48)	0.7
Saturday	0.85 (0.26, 1.4)	<0.01
Sunday	1.1 (0.55, 1.7)	<0.001
Time category at ambulance call		
Noon (8-15)	(ref)	
Early night (16-23)	1.8 (1.4, 2.1)	<0.001
Late night (0-7)	2.6 (2.2, 3.1)	<0.001
Category of suspected illness		
Abdominal pain	-1.2 (-2.3, -0.13)	0.028
CPA	1.3 (0.17, 2.4)	0.024
Stroke	5.6 (4.5, 6.8)	<0.001
ACS	0.66 (-0.66, 2.0)	0.33
DOC	2.9 (1.4, 4.5)	<0.001

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

Trauma	4.3 (3.8, 4.8)	<0.001
Internal medicine	(ref)	
Orthopedics except for Trauma	3.0 (2.5, 3.5)	<0.001
Neurosurgery except for Stroke and DOC	7.3 (6.7, 7.9)	<0.001
Surgery except for Abdominal pain	0.25 (-0.83, 1.3)	0.65
Cardiology except for ACS	4.4 (3.3, 5.5)	<0.001
Person calling ambulance		
Family or self	(ref)	
Witness	-0.34 (-0.75, -0.065)	0.10
Welfare facility	-1.7 (-2.5, -0.93)	<0.001
Emergency status at request call		
Less urgency	(ref)	
Urgency	1.2 (0.71, 1.7)	<0.001
Emergency	0.24 (-0.48, 0.96)	0.51
Resuscitation	-1.0 (-3.3, 1.2)	0.36
During assessment	-3.9 (-4.4, -3.5)	<0.001
The number of request call	6.3 (6.2, 6.4)	<0.001
Random effects, variance [SD]		
Intercept	61.2 [7.8]	
z-score	6.8	
AIC	323,132	
Radj2	0.40	

SD: standard deviation, ACS: acute coronary syndromes, CPA: Cardiopulmonary arrest,  
DOC: disturbance of consciousness, request call: request call to hospital for transportation

Supplement table 4. Difference between the areas of time from call to hospital arrival: multilevel linear regression analysis

Explanatory variable	Urban area (n = 32,657)		Eastern rural area (n = 7,661)		Southern rural area (n = 3,345)	
	Estimate (95%CI)	P-value	Estimate (95%CI)	P-value	Estimate (95%CI)	P-value
Fixed effects						
Intercept	26.1 (24.5, 29.3)	<0.001	32.5 (20.5, 44.5)	0.023	36.1 (20.9, 51.3)	0.022
Age						
≥15, <60	(ref)		(ref)		(ref)	
≥60, <80	1.2 (0.79, 1.60)	<0.001	1.90 (1.0, 2.8)	<0.001	-0.84 (-3.4, 1.7)	0.52
≥80	0.89 (0.46, 1.33)	<0.001	1.22 (0.27, 2.2)	<0.01	1.2 (-1.4, 3.9)	0.36
Sex						
Female	(ref)		(ref)		(ref)	
Male	0.31 (-0.021, 0.64)	0.066	0.31 (-0.40, 1.0)	0.39	4.2 (2.3, 6.2)	<0.001
Season						
Spring (March-May)	(ref)		(ref)		(ref)	
Summer (June-August)	-0.85 (-1.3, -0.39)	<0.001	-0.023 (-1.0, 0.98)	0.96	2.3 (-0.50, 5.0)	0.110
Autumn (September-November)	0.16 (-0.31, 0.63)	0.50	0.82 (-0.18, 1.8)	0.11	3.6 (0.81, 6.4)	0.012
Winter (December-February)	0.68 (0.22, 1.1)	<0.01	1.67 (0.68, 2.7)	<0.01	2.8 (0.027, 5.5)	0.049
Day of the week						
Monday	(ref)		(ref)		(ref)	

1							
2							
3							
4		-0.16 (-		-1.2 (-		-0.55 (-	
5	Tuesday	0.77,	0.60	2.5,0.080)	0.066	4.1, 3.0)	0.76
6		0.44)					
7							
8		0.028 (-		0.028 (-		-2.1 (-	
9	Wednesday	0.59,	0.93	1.30, 1.4)	0.97	5.7, 1.5)	0.26
10		0.64)					
11							
12							
13		0.48 (-		0.11 (-1.2,		-0.93 (-	
14	Thursday	0.13, 1.1)	0.12	1.4)	0.87	4.6,	0.62
15						2.7)	
16							
17		-0.080 (-		-0.68 (-		0.41 (-	
18	Friday	0.69,	0.80	2.0, 0.62)	0.31	3.2, 4.0)	0.82
19		0.53)					
20							
21		0.62		0.11 (-1.2,		3.6	
22	Saturday	(0.024,	0.042	1.4)	0.87	(0.12,	0.044
23		1.2)				7.1)	
24							
25		0.70		0.99 (-		4.3	
26	Sunday	(0.10,	0.022	0.30, 2.3)	0.13	(0.88,	0.014
27		1.3)				7.6)	
28							
29							
30							
31	Time category at						
32	ambulance call						
33							
34	Noon (8-15)	(ref)		(ref)		(ref)	
35							
36	Early night (16-23)	1.7 (1.3,	<0.001	2.6 (1.8,	<0.001	4.2 (2.0,	<0.001
37		2.1)		3.4)		6.4)	
38							
39	Late night (0-7)	2.8 (2.3,	<0.001	3.1 (2.1,	<0.001	4.8 (2.0,	<0.001
40		3.3)		4.1)		7.5)	
41							
42	Category of suspected						
43	illness						
44							
45	Abdominal pain	-0.73 (-	0.21	-1.5 (-3.6,	0.15	2.0 (-4.1,	0.53
46		1.9, 0.42)		0.55)		8.0)	
47							
48	CPA	-1.2 (-2.4,	0.046	4.6 (2.3,	<0.001	-0.087 (-	0.98
49		-0.023)		6.8)		6.5, 6.4)	
50							
51	Stroke	6.4 (5.1,	<0.001	5.9 (3.8,	<0.001	9.9 (3.3	<0.01
52		7.7)		8.0)		16.6)	
53							
54							
55	ACS	0.26 (-	0.73	2.1 (-0.21,	0.076	10.1	<0.01
56		1.2, 1.8)		4.4)		(3.5,	
57						16.6)	
58							
59	DOC	3.8 (2.1,	<0.001	4.4 (1.9,	<0.001	4.7 (-6.1,	0.40
60		5.5)		7.0)		15.5)	



					10.0	
Trauma	1.8 (1.3, 2.3)	<0.001	8.1 (7.1, 9.2)	<0.001	(6.7, 13.2)	<0.001
Internal medicine	(ref)		(ref)		(ref)	
Orthopedics except for Trauma	1.5 (1.0, 2.0)	<0.001	4.5 (3.2, 5.7)	<0.001	9.2 (6.3, 12.1)	<0.001
Neurosurgery except for Stroke and DOC	6.6 (6.0, 7.1)	<0.001	9.1 (7.7, 10.5)	<0.001	11.5 (8.0, 14.9)	<0.001
Surgery except for Abdominal pain	-0.084 (-1.1, 0.98)	0.88	-0.33 (-3.3, 2.6)	0.82	-0.46 (-6.5, 5.6)	0.88
Cardiology except for ACS	4.4 (3.4, 5.4)	<0.001	5.5 (1.9, 9.1)	<0.01	9.2 (0.59, 17.8)	0.037
Person calling ambulance						
Family or self	(ref)		(ref)		(ref)	
Witness	0.35 (-0.068, 0.76)	0.10	0.98 (0.11, 1.8)	0.027	2.3 (-4.9, 4.9)	0.075
Welfare facility	-0.79 (-1.6, 0.021)	0.056	1.1 (-0.80, 3.1)	0.25	-7.3 (-10.8, -3.9)	<0.001
Emergency status at request call						
Less urgency	(ref)		(ref)		(ref)	
Urgency	0.84 (0.30, 1.4)	<0.01	1.7 (0.66, 2.8)	<0.01	-3.3 (-6.2, -0.35)	0.029
Emergency	-0.033 (-0.78, 0.72)	0.93	0.012 (-1.5, 1.5)	0.99	-2.7 (-6.7, 1.3)	0.19
Resuscitation	-0.99 (-3.2, 1.2)	0.37	-3.2 (-9.2, 2.7)	0.29	-5.5 (-19.4, 8.4)	0.44
During assessment	-1.2 (-1.7, -0.80)	<0.001	-1.9 (-2.8, -1.0)	<0.001	-3.6 (-6.3, -0.94)	<0.01

The number of request call (mean (SD))	6.2 (6.1, 6.3)	<0.001	6.5 (6.3, 6.7)	<0.001	6.7 (6.2, 7.2)	<0.001
Random effects, variance [SD]						
Intercept	8.5 [2.9]		81.7 [9.0]		126.4 [11.2]	
AIC	231,005		58,625		27,533	
Radj2	0.41		0.52		0.32	

SD: standard deviation, ACS: acute coronary syndromes, CPA: Cardiopulmonary arrest,  
 DOC: disturbance of consciousness, request call: request call to hospital for transportation

## STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract -p2, p4 in abstract and p9 in METHODS (b) Provide in the abstract an informative and balanced summary of what was done and what was found – p4
<b>Introduction</b>		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported -p7
Objectives	3	State specific objectives, including any prespecified hypotheses – p8
<b>Methods</b>		
Study design	4	Present key elements of study design early in the paper – p9
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection –p9-11
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants – p11 (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable – p12-13
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group –p9
Bias	9	Describe any efforts to address potential sources of bias – p9-10
Study size	10	Explain how the study size was arrived at – p9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why - p12
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding –p13 (b) Describe any methods used to examine subgroups and interactions –p14 (c) Explain how missing data were addressed –p11 (d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy – p13 (e) Describe any sensitivity analyses –p13

Continued on next page

**Results**

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed –p15 (b) Give reasons for non-participation at each stage –not applicable (c) Consider use of a flow diagram – no use
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders –p15-17 (b) Indicate number of participants with missing data for each variable of interest-p16 table 1 (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —Report numbers of outcome events or summary measures –p16
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included –p21-23 (b) Report category boundaries when continuous variables were categorized –p13 (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period – not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses –p21 and supplement table 1, supplement table 2, supplement table 3, supplement table 4

**Discussion**

Key results	18	Summarise key results with reference to study objectives – p23
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias –p27-28
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence –p28-29
Generalisability	21	Discuss the generalisability (external validity) of the study results –p28

**Other information**

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based –p30
---------	----	--

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

## Correction

Hanaki N, Yamashita K, Kunisawa S, *et al.* 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. *BMJ Open* 2016;6:e012194.

The baseline patient characteristics were compared using analysis of variance (ANOVA), not the Kruskal–Wallis test. Therefore the corrected Table 1 footnote should read:

\*P-value by ANOVA

†P-value by Student's t-test

SD: standard deviation, Qu: quartile, ACS: acute coronary syndromes, CPA: Cardiopulmonary arrest, DOC: disturbance of consciousness, request call: request call to hospital for transportation

The detailed information about each area are not available for disclosing, because of data sharing policy.

In [table 3](#) the column header “Time from call to hospital arrival” should read “Time for request call”. The corrected [Table 3](#) is shown below.

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

Hospital Displayed Admission Acceptability	Result	Number of request call n (%) N=79,693	Time for request call		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 ANOVA.

Request call: request call to hospital for transportation, SD: standard deviation, Qu: quartile.

**Open Access** This is an Open Access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

*BMJ Open* 2017;7:e012194corr1. doi:10.1136/bmjopen-2016-012194corr1



CrossMark