Impact of increased reimbursement for ambulance transportation on hospital acceptance in Japan: a difference-in-difference study

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ABSTRACT

Objective Emergency medical services (EMS) often face difficulties in finding accepting hospitals in Japan. The universal medical insurance system in Japan increased the reimbursement for ambulance transportation acceptance at night and on Sundays and holidays from 1 April 2015. This study investigated the effect of the reimbursement increase on the number of EMS calls, and transportation time from arrival at the scene to arrival at the hospital.

Design A difference-in-difference study. The treatment group consisted of people who called an ambulance at night while the control group consisted of people who called an ambulance during the daytime.

Setting The national ambulance records of the Fire and Disaster Management Agency in Japan from 1 April 2015 to 31 December 2016.

Participants 7,625,463 ambulance dispatches were eligible for inclusion.

Primary and secondary outcome measures The changes in EMS calls, transportation time and the number of ambulance transports per 1000 population in one month in a comparison of daytime and night-time transport.

Results The treatment effect (night-time vs daytime) on the number of EMS calls was −0.013 (95% CI, −0.023 to −0.004), which was significant. The transportation time decreased slightly by 0.080 min (95% CI, −0.157 to −0.004). No impact was observed on the number of ambulance transports per 1000 population per month (0.00: 95% CI, −0.008 to 0.002).

Conclusion An increase in reimbursement for ambulance transportation acceptance was associated with a decrease in the number of EMS calls. Further strategies for decreasing the number of EMS calls are needed to avoid delays in the treatment of emergency patients with critical illness.

INTRODUCTION

Emergency department (ED) overcrowding has become a global health issue.1-3 Crowding is not an isolated ED issue, but rather a symptom of overall hospital and healthcare system crowding.3 In Japan, the situation in which a request for the acceptance of an emergency patient is rejected by one hospital after another, as well as ED overcrowding, are major public health concerns.4 It is caused by the increasing number of ambulance dispatches, the lack of emergency medical resources in each hospital and a unique emergency medicine system in Japan.5 In the Japanese emergency medicine system, physicians working in hospital EDs can decide whether to accept a transport request from emergency medical service (EMS) personnel.6-8 In fact, EDs often decline patients due to limited resources, such as unavailability of hospital beds or absence of suitable specialists to treat the patient’s symptoms.7 One criterion used by the Fire and Disaster Management Agency (FDMA) to define difficulty in hospital acceptance is ≥4 phone calls by EMS personnel to hospitals until the patient is accepted.6 The proportion of ≥4 phone calls by EMS personnel to hospitals until acceptance was 3.1% (166,734/5,293,830 patients) in 2020.5 A greater number of phone calls from ambulances to hospitals leads to delays in hospital arrival times,6-8 potentially causing critical delays in transporting the patient to a hospital. The time required for transporting patients to a hospital after ≥5 phone calls was found to be 16 min longer compared with that with 1 phone call.6,9,10

In Japan, the Ministry of Health, Labour and Welfare increased the reimbursement for ambulance transportation acceptance
(an incentive payment to hospitals for accepting ambulance transfers at night and on Sundays/holidays) from 2000 yen/transfer to 6000 yen/transfer on 1 April 2016. This increase was only applicable to the first hospital visit. Since the patients themselves needed to partially cover the ambulance transportation fee as copayment, this increase in medical cost may act as a potential barrier to ED visits. However, the increase may provide a financial incentive for EDs to accept more patients. Thus, an increase in the reimbursement for ambulance transportation acceptance might increase the chances of accepting requests from on-scene EMS personnel.

We hypothesised that the increase in the reimbursement for ambulance transportation acceptance would decrease the number of EMS calls, decrease the transportation time from arrival at the scene to arrival at the hospital and discourage ED visits by ambulance. The aim of this study was to estimate the effect of the increase in the reimbursement for ambulance transportation acceptance on the number of EMS calls, and the transportation time from arrival at the scene to arrival at the hospital, by using a difference-in-difference regression (DID) model.

MATERIALS AND METHODS

Study design and participants

This study analysed the national ambulance records of the FDMA in Japan from 1 April 2015 to 31 December 2016. These data include all ambulance transports throughout Japan except those for Tokyo prefecture, because fire stations in Tokyo are managed by an organisation independent of the national government and are not included in the FDMA database. This study included all patients referred to an ambulance and transported to a hospital. We excluded patients who were transported between hospitals, those whose type of incident was unspecified (others) and those who had missing data. The requirement for informed patient consent was waived.

Setting

Japan has an area of 378,000 km² and is divided into 47 prefectures with a population of approximately 126 million in 2020. The EMS system in Japan has been described elsewhere. There were 724 fire stations with dispatch centres in 2020, and the EMS at these fire stations was provided by municipal governments. In accordance with the protocol established by each municipal fire department, EMS ambulance crews at the scene or emergency dispatchers select an appropriate emergency hospital according to the medical urgency or patient's symptoms.

Data collection

Chronological factors (date and time), patient age and severity, location, type of incident and prefecture were extracted from the available data. Severity is classified into four categories: cardiac pulmonary arrest, severe, moderate and mild. Severe patients were those expected to be hospitalised for over 3 weeks, and moderate patients were those expected to be hospitalised for 3 weeks or less. If patients were not likely to require hospitalisation, they were categorised as mild. Location was classified into five categories: home, public space, workplace, road and others. The types of incidents were classified into 10 categories: diseases, fire accidents, natural disasters, water-related accidents, motor vehicle accidents, industrial accidents, sports-related accidents, falls and other injuries, assault and self-inflicted injuries. We defined seven geographical regions (Hokkaido-Tohoku, Kanto, Chubu, Kansai, Chugoku, Shikoku and Kyushu-Okinawa) on the basis of previous studies.

Outcome measures

The outcomes were the number of EMS calls to hospitals before acceptance from a destination hospital, transportation time from arrival at the scene to arrival at the hospital and the number of transports per 1000 population in one month.

Statistical analysis

To confirm the effect of the increase in the reimbursement for ambulance transportation acceptance at night, we conducted a DID regression model to estimate the differences in the number of EMS calls, transportation time and number of ambulance transports between daytime and night-time. To implement a DID analysis, we collapsed the original individual-level data into prefecture-level monthly data from April 2015 to December 2016. Targeting the period immediately before and after the 2016 revision enhances the internal validity of the results because a longer analysis period may introduce other policy influences (eg, fee schedule revisions in 2014 and 2018) as confounding factors. The treatment group consisted of people who called an ambulance at night because these people were affected by the increase in the reimbursement for ambulance transportation acceptance in April 2016. Accordingly, other people who called an ambulance during the daytime were categorised into the control group. Night-time was defined as the period from 18:00 to 7:59, since some hospitals continued their operation time until 18:00. Given the logistical difficulty of identifying, excluding and analysing daytime data from Sundays and holidays in each year, we did not include data from the daytime on Sundays and holidays. Eventually, we constructed balanced panel data, which consisted of two units (night-time vs daytime) for the 46 prefectures during the 21 months before and after April 2016. The sample size was 1932 (ie, 2×46×21). Using this data set, we estimated the following equation:

\[
y_{im} = \beta_1 Treat_{im} + X_{im}\beta_2 + \theta_1 + Month_m + \epsilon_{im}
\]

where \(y_{im}\) is an outcome variable such as the standardised number of EMS calls and mean transportation time in a time-prefecture unit \(i\) in month \(m\), \(Treat\) was a binary variable that took a value of 1 for night-time transportation during the period since April 2016, \(X_{im}\) was a
vector of time-varying covariates for time-prefecture unit $i$ in month $m$, $\theta$ is a fixed effect for time-prefecture unit $i$, Month is a monthly dummy variable during the study period and $\epsilon_{im}$ is an error term. In this equation, the coefficient of Treat, namely $\beta_1$, was expected to capture the effects of the increase in reimbursement for ambulance transportation acceptance in April 2016.

The identification assumption of this DID model was that the outcome trend of the treatment group was parallel to that of the control group in the absence of the 2016 reform. In order to statistically validate the assumption, we implemented event study analysis. If the trend between the treatment and control group was parallel during the pre-intervention period in our data, it seemed reasonable to postulate that they would be also parallel during the post-intervention periods in the absence of the reform. In the event study analysis, we estimated the following equation:

$$y_{im} = \sum_{m=-11, m\neq 0}^{9} \beta_mD_{im} + X_{im}\beta_2 + \theta + \text{Month} + \epsilon_{im},$$

where $D_{im}$ is a binary variable that took a value of 1 for night-time transportation in prefecture unit $i$ in month $m$. The notation of month is standardised at 1 in April 2016. The reference month is set at 0 (ie, March 2016).

In the online supplemental figure 1, we confirmed the robustness of these results for an alternative identification strategy, namely single intermittent time series analysis. To serially correlate time series data, SEs were clustered at the prefecture level. In the subgroup analyses, we stratified the model according to severity or seven geographical regions. The data were analysed using Stata V.14 (College Station, Texas, USA). All tests were two-tailed, and $p$ values <0.05 were significant.

**Patient and public involvement**

No patients or public were involved in this study design, conduct or analysis.

**RESULTS**

Between April 2015 and December 2016, 8,498,432 ambulances were dispatched. Of these, 7,625,463 ambulance dispatches were eligible for inclusion in the study.

**Patient characteristics**

Descriptive statistics are summarised in table 1. By age group, 39.0% of ambulance transports were performed for persons aged 65–84 years. In addition, patients with mild conditions accounted for half of the ambulance transports. Sudden illnesses accounted for 70.3% of emergency calls, while the remaining 29.7% were due to other reasons such as falls and other injuries. The number of ambulance transports per 1000 population in one month was 0.420, and the number of EMS calls to hospitals before obtaining acceptance from destination hospitals was 1.267 (table 2).

**Findings obtained before and after the increase in the reimbursement for ambulance transportation acceptance**

Using the standard procedure for DID analysis, we graphically checked the trends of the main outcomes before and after the increase in reimbursement for ambulance transportation acceptance. Figure 1A shows the results for the number of transports per 1000 population. In this figure, the number of transports was standardised by the average value of each group for clarity. The trends for the treatment group (night-time transportation) before April 2016 were similar to those for the control group (daytime transportation), showing that the trends were parallel in the absence of the intervention. The trends for the treatment and control groups have not changed since April 2016. Thus, we did not find any evidence that the April 2016 rate increase changed the number of transports.

Next, in figure 1B, we compared the trend in the number of EMS calls in the treatment and control groups. In this figure, the trends are similar enough in the absence of the increased reimbursement for ambulance transportation acceptance up to April 2016; however, after April 2016, only the treatment group saw a slight decrease in the number of EMS calls. This finding suggests that an increase in reimbursement for ambulance transportation acceptance reduces the number of EMS calls. Finally, a similar figure was shown for the transport time trends. Figure 1C confirms that the reimbursement increase in April 2016 did not have a clear impact on transportation times.

The results of event study analysis are shown in the right side of figure 1. We found that the trend of night-time transportation during the pre-intervention period deviated from that of daytime transportation in some months, but the magnitude was not so large (figure 1A). The trend of EMS calls in night-time was sufficiently parallel to that in daytime during pre-intervention period, indicating that our parallel trend assumption was plausible on this outcome (figure 1B). More importantly, we found significant reduction of EMS calls only after April 2016. It was hard to discern whether the trend was parallel before April 2016, but the estimates in 7–9 months after the 2016 reform were negative and significant (figure 1C).

Table 3 summarises the results of the regression analysis. The coefficient of the interaction term of night-time transportation and the binary variable for the period after April 2016 was 0.00 (95% CI, −0.008 to 0.002), indicating no impact on the number of ambulance transports per 1000 population. The treatment effect on the number of EMS calls (night-time vs daytime) was −0.013 (95% CI, −0.023 to −0.004), which was significant. This result indicates that the increase in reimbursement for ambulance transportation acceptance in April 2016 reduced the number of EMS calls, as shown graphically in figure 1B. However, the point estimate (−0.013) did not show a large effect in comparison with the mean (1.267). Finally, the transportation time slightly decreased by 0.080 min. The online supplemental table 1 showed the covariates of the regression analysis.
In the online supplemental figure 1, we confirmed the robustness of these results for an alternative identification strategy, namely single intermittent time series analysis; while it was difficult to separate the seasonality of EMS transports from the gradually manifesting effects of the 2016 reform, we found a significant but very small reduction in the number of EMS calls, consistent with the main DID analysis. For detailed results, see online supplemental figure 1.

The categorisation of the results by patient severity is shown in online supplemental table 2. We found a significant reduction in the number of EMS calls in patients with severe and moderate conditions. Among patients with mild conditions, who accounted for half of the ambulance transportations, the reimbursement increase in April 2016 did not have a significant effect.

Finally, figure 2 presents the subsample results by seven regions for the number of EMS calls for which a robust
Figure 1  Trends and event study analysis on the main outcomes. (A) Number of transports per 1000 population in one month. (B) Number of EMS calls. (C) Transportation time. (Note) The raw data trends are plotted on the left and the event study analysis results are shown graphically on the right. The number of transports in (A) is standardised by the average value of each group for better clarity. EMS, emergency medical service.
effect of the April 2016 rate increase was found. The point estimate in the Kansai region (−0.039) suggests that the reimbursement increase in April 2016 induced hospitals to accept ambulance transportation in this region. However, owing to the small sample size in the subsample analysis, the 95% CI did not reject the null hypothesis. In other regions, such as Chubu and Kyushu, the point estimates were very close to zero, indicating that reimbursement had no effect.

**DISCUSSION**

Using data from a national ambulance database in Japan, we found that an increase in the reimbursement for ambulance transportation acceptance was associated with a decreased number of EMS calls and shortened transportation time from arrival at the scene to arrival at the hospital. We found that the increased reimbursement for ambulance transportation acceptance did not discourage ED visits by ambulances.

**Results in context**

An increase in the reimbursement for ambulance transportation acceptance was associated with a reduction in the number of EMS calls. This outcome could be attributed to the financial incentives hospitals received with reimbursement for ambulance transportation acceptance, and it could be an effective solution for the difficulties associated with hospital acceptance in Japan. Previous studies reported that older patient age, nighttime and weekends were associated with difficulty in hospital acceptance in Japan.6 8 10 Increasing the reimbursement

| Table 3 Multivariable association of number of transports, EMS calls and transportation times with the increase in the reimbursement for ambulance transportation acceptance |
|---------------------------------|---------------------------------|---------------------------------|
| Number of transports per 1000 persons in a month | Number of EMS calls | Transportation time (min) |
| Primary exposure | (95% CI) | (95% CI) | (95% CI) |
| Before the increase in the reimbursement for ambulance transportation acceptance | 1 (reference) | 1 (reference) | 1 (reference) |
| After the increase in the reimbursement for ambulance transportation acceptance | 0.00 (−0.008 to 0.002) | −0.013 (−0.023 to −0.004) | −0.080 (−0.157 to −0.004) |

*P value<0.05.
EMS, emergency medical service.
for ambulance transportation acceptance might be an effective solution to these difficulties. In particular, our results showed that an increase in the reimbursement for ambulance transportation acceptance decreased the number of EMS calls for severe and moderate patients, which is more important in emergency medicine. In addition, the findings showed a trend toward effectiveness in the Kansai region, where the emergency room system is generally fragile and hospitals have more difficulty accepting patients, which indicates that providing financial support to accepting hospitals would be one of the possible solutions for addressing the difficulty in hospital acceptance, especially in areas where the medical system is already overstretched.\(^8\)

Similarly, an increase in the reimbursement for ambulance transportation acceptance decreased the transportation time from arrival at the scene to arrival at the hospital. Multiple factors can affect the time to hospital arrival, including patient age and distribution of hospital\(^6\)\(^,\)\(^7\)\(^,\)\(^17\) In prior studies, the transportation time from arrival at the scene to arrival at the hospital increased significantly and linearly with an increasing number of EMS calls.\(^6\)\(^,\)\(^10\) A prolonged prehospital time can lead to worse outcomes in patients with critical illnesses.\(^21\)\(^,\)\(^22\) The increase in the reimbursement for ambulance transportation acceptance has reduced the number of emergency calls by only 0.013 and the transport time by only 0.08 min, despite being statistically significant. However, it should be noted that the number of EMS calls also decreased for severe cases (-0.019 (-0.031 to -0.007)). We consider that our findings have a clinical significance, given that it is a novel study, addressing an important issue of our society.

The increase in the reimbursement for ambulance transportation acceptance did not discourage ED visits by ambulances. However, other studies in the USA and Korea showed that the institution of copayment for the use of the ED led to a reduction in such usage,\(^11\)\(^23\)\(^24\) and that the small amounts of copayment may be the reason for this reduction. In Japan, anyone can use an ambulance free of charge.\(^25\) In addition, patients had access to medical services at low copayment rates: 10% copayment for preschool patients and those aged 70–74 years and 30% copayment for everyone else.\(^26\) People who need public assistance use the ED at no cost.\(^27\) A previous study in Japan reported that income level was not a factor influencing the decision to call an ambulance.\(^25\) Another reason for not discouraging ED visits by ambulance is that patients who need an ambulance might more likely be in an emergency situation, and less likely to be aware of the costs. An increase in the emergency fee increases the proportion of urgent patients in the total emergency visits, by reducing ED visits by non-urgent patients.\(^11\)

An increase in emergency fees may act as a potential cost barrier to ED visits. However, cost-sharing for ED did not lead to higher rates of death or potentially unfavourable clinical events, including hospitalisations and intensive care unit admissions, in California.\(^20\) As mentioned above, people who need public assistance use the ED at no cost in Japan; therefore, this increase would have even less impact.

**Limitations**

The present study had some limitations. First, we handled Sundays/holidays in the same way as weekdays, despite the same conditions as night-time. However, the inclusion of daytime data on Sundays/holidays augmented the robustness of the main analysis because the difference between daytime and night-time would be smaller if we had included daytime data from Sundays/holidays. Second, one potential confounder could be other changes in the healthcare system that affect ambulance use during the study period. Third, reimbursement for ambulance transportation acceptance applies only to the first hospital visit. However, the number of frequent presenters to the ED in Japan is low; moreover, the rate of ambulance use is lower for frequent presenters.\(^29\) Fourth, we did not use all the data from the fiscal year 2016: January, February and March 2017. Although our analysis is robust, including the sensitivity analysis, it could be affected by other confounding factors if data were taken over a longer period of time. Fifth, our data consisted of national ambulance records from the FDMA in Japan. Therefore, our inferences may not be generalisable to other settings. Finally, this study did not determine the effect on improvement of patient prognosis.

**CONCLUSION**

The increase in reimbursement for ambulance transportation acceptance can decrease the number of EMS calls without discouraging emergency ambulance visits. Further strategies for decreasing the number of EMS calls are required to avoid worse outcomes in patients with critical illnesses.
Open access

is available upon request. The Japanese government owns the data, and interested researchers can contact the Ministry of Internal Affairs and Communications Fire and Disaster Management Agency Ambulance Service Planning Office. Phone number: +81-3-5253-7529. The data from the Japanese National Survey could be accessed by contacting the Ministry of Health Labour and Welfare (phone number: +81-3-5253-1111) for researchers who meet the criteria for access to confidential data. The data from Nihon Utimarc could be accessed by contacting https://www. utimarc.co.jp/mdb/index.html for researchers who meet the criteria for access to confidential data.

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