





## Original Article

# Impact of medical reimbursement revision on ambulance transport of self-inflicted injury patients: a nationwide study in Japan

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**Aim:** Self-inflicted injury, as one reason to visit the emergency department, is an important issue in emergency medicine around the world. However, the impact of changes in social systems, such as medical reimbursement revision, on ambulance transport for self-inflicted injury remains unclear. The aim of this study was to assess the impact of medical reimbursement revision on the emergency transport of self-inflicted injury patients using nationwide ambulance records.

**Methods:** This was a retrospective observational study from April 2012 to March 2016. We analyzed nationwide ambulance records in Japan, and included self-inflicted injury, drug poisoning, and drug overdose patients transported to hospitals by ambulance. The primary outcome of this study was age-adjusted number of self-inflicted injury patients transported by ambulance in each month per 1 million standard populations. To assess the impact of the medical reimbursement revision in 2014, we calculated the  $R^2$ , regression coefficients and 95% confidence interval (CI) using interrupted time series analysis.

**Results:** This study included 148,873 patients. The  $R^2$  for the interrupted time series model was 0.821. The regression coefficient for the time trend before the medical reimbursement revision was 0.167 (95% CI, 0.090 to 0.244;  $p < 0.001$ ), that for the time trend after the medical reimbursement revision was  $-0.226$  (95% CI,  $-0.327$  to  $-0.125$ ,  $p < 0.001$ ), and that of the medical reimbursement revision was  $-2.165$  (95% CI,  $-3.730$  to  $-0.601$ ,  $p = 0.008$ ).

**Conclusion:** In Japan, the medical reimbursement revision in April 2014 helped to decrease the number of self-inflicted injury patients transported to hospitals by ambulance.

**Key words:** Epidemiology, health policy, medical reimbursement, prehospital care, self-inflicted injury

## INTRODUCTION

SELF-inflicted injury, as one reason to visit the emergency department (ED), is an important issue in emergency medicine around the world.<sup>1–4</sup> In the UK, the number of ED visits due to adversity-related injury including self-

harm accounted for 4.3% of the population among adolescents aged 10–19 years; among them, those among girls accounted for approximately half of all ED visits.<sup>5</sup>

Recently, the number of patients transported by ambulance has been increasing in Japan.<sup>6</sup> Emergency medical

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service (EMS) personnel at the scene assess the patient's condition, select a medical institution where the patient can be treated appropriately, and transport the patient to hospital. However, it is sometimes difficult to select a medical institution for patients with a mental disorder and/or self-inflicted injury.<sup>7</sup> Complications of psychiatric disorders were also reported as a factor associated with low-acuity ambulance use.<sup>8</sup> Okumura *et al.*<sup>9</sup> reported that the annual rate of drug overdose admission was 17.0 per 100,000 population, 68% of these patients took high doses of psychotropic drugs, and 36.5% of these patients were admitted to an intensive care unit. Unnecessary intensive care unit admission of stable drug overdose patients could cause patient overflow and high medical costs.

Japan has a universal health-care system, and medical fees for medical institutions are set by the Japanese government and revised every 2 years.<sup>10</sup> According to the medical reimbursement revision implemented in April 2014, reimbursement to emergency medical institutions increased for emergency admissions of patients with mental disorders. In addition, concurrent prescriptions of multiple psychiatric drugs were restricted.<sup>11</sup> However, the impact of these institutional revisions on the emergency transport of self-inflicted injury patients has never been clarified.

Japan has a total population of 120 million,<sup>12</sup> of whom approximately 6 million patients are transported by ambulance per year.<sup>6</sup> The EMS in Japan is a public service, and EMS personnel record all ambulance activities at each fire station after the dispatch, and the records are collected in the Fire and Disaster Management Agency (FDMA).<sup>13</sup> The purpose of this study was to assess the impact of the medical reimbursement revision implemented in 2014 on the emergency transport of self-inflicted injury patients using nationwide ambulance records.

## METHODS

### Study design and settings

**T**HIS WAS A retrospective observational study over the 4-year study period from April 2012 to March 2016. We analyzed all ambulance records provided by the FDMA. The reasons for the ambulance call were divided into acute illness, falls and other injury, motor vehicle accident, industrial accident, sports-related accident, self-inflicted injury, assault, fire accident, water-related accident, natural disaster, and others. Self-inflicted injury includes drug poisoning, drug overdose, and various types of trauma. We included self-inflicted injury patients transported to medical institutions by ambulance. We excluded patients transported in Tokyo from this study due to insufficient data.

In 2015, the total population of Japan was 127.09 million in a total area of 377,975 km<sup>2</sup>, of which 13.51 million lived in Tokyo.<sup>12</sup> Among this population, the proportion of male individuals was 48.7%, and the number of people aged 65 years or older was 26.6%. In 2017, there were 179,090 medical institutions in Japan,<sup>14</sup> including tertiary care hospitals that can treat severely ill patients, such as those with sepsis and severe trauma. Emergency medical service ambulances in Japan mainly transport to emergency medical institutions including tertiary care hospitals, and they were dispatched approximately 6.3 million times in 2018.<sup>6</sup>

This study was approved by the Ethics Committee of Osaka University Graduate School of Medicine (Approval No. 19219). As the ambulance records were anonymized, the necessity of obtaining informed consent from the patients was waived. This manuscript was written based on the STROBE statement to assess the reporting of cohort and cross-sectional studies.<sup>15</sup>

### Emergency medical service system in Japan

The EMS system in Japan was previously described in detail.<sup>13</sup> It is operated solely by local fire departments and is activated by a 1-1-9 call from anywhere in Japan.<sup>16</sup> In 2019, there were 726 fire department headquarters with 6,364 ambulances throughout Japan.<sup>6</sup> Life support is provided on a 24/7/365 basis. Usually, each ambulance has a crew of three emergency providers including at least one Emergency Life-Saving Technician, a highly trained prehospital emergency care provider.<sup>6</sup> The EMS personnel at the scene select hospitals for patient transport, including tertiary care hospitals, which have the capability to manage patients with life-threatening conditions. Local medical control councils, consisting of emergency physicians and experts in each area in Japan, have an important role in securing the quality of care provided by EMS personnel in prehospital settings and carrying out follow-up assessments of EMS procedures.<sup>17</sup>

Designated emergency hospitals are open and staffed 24 h/day by emergency physicians and are certified by prefectural governments. Tertiary care hospitals are also certified by prefectural governments based on their expertise and ability to provide the highest quality of care for serious acute illnesses and severe trauma.<sup>18</sup> In 2018, there were 2,874 designated emergency hospitals in Japan, of which 289 were tertiary care hospitals.<sup>19</sup>

### Outcomes

The primary outcome of this study was age-adjusted number of self-inflicted injury patients transported by ambulance in each month per 1 million standard populations. We

calculated the number of self-inflicted injury patients transported by ambulance. To adjust for changes in age structure over time, the age-adjusted number of self-inflicted injury patients transported by ambulance per 1 million populations in each month was calculated based on the following formula, using the age group in 2012 as the standard:

$$M_n = \frac{1,000,000}{P} \sum_{i=1}^k \{R_{ni} \times N_i\},$$

where  $M_n$  is the age-adjusted number of self-inflicted injury patients transported by ambulance in each month ( $=n$ ) per 1 million standard populations,  $R_{ni}$  is the rate of self-inflicted injury patients transported by ambulance per unit population in each age group ( $=i$ ; <15 years, 15–64 years, and  $\geq 65$  years) of the observation population in each month ( $=n$ ),  $N_i$  is the population of each age group ( $=i$ ) in the standard population (2012) and  $P$  is the total population of Japan in 2012.

## Statistical analysis

To assess the impact of the 2014 medical reimbursement revision on emergency transport of self-inflicted injury patients, we calculated the  $R^2$ , regression coefficients, and 95% confidence interval (CI) for the regression model using interrupted time series (ITS) analysis. The ITS model has been previously described in detail.<sup>20</sup> We assumed that financial factors, such as medical reimbursement to hospitals, would have an immediate impact on patient acceptance by hospitals after the change in medical reimbursement. Therefore, the variables included in the ITS model were the

change over time before the medical reimbursement revision, seasonality, presence of the medical reimbursement revision in 2014, and the change over time after the medical reimbursement revision. We defined the change over time as the number of months since the start of the study periods and medical reimbursement revision, whereas seasonality was defined as successive months such as January and February. For the presence or absence of medical reimbursement revisions, we defined April 2014 onwards as operating under the new medical reimbursement revision.

We divided patient location into urban area and rural area and assessed the impact of medical reimbursement revision in each area. We defined the prefectures with a population density of more than 1,000/km<sup>2</sup> (Saitama, Chiba, Kanagawa, Aichi, Osaka, and Fukuoka) as urban areas and the remaining areas as rural areas.<sup>12</sup> Next, we divided the patients into those transported to hospitals inside the fire department's jurisdiction and those transported to hospitals outside of the fire department's jurisdiction. A statistically significant difference was defined as a  $p$  value of 0.05 or less. We used the SPSS package version 23.0J for statistical analysis.

## RESULTS

TABLE 1 shows the characteristics of the patients in this study. This study included 148,873 patients, of whom the number before the medical reimbursement revision (April 2012–March 2014) was 78,591 and that after the medical reimbursement revision (April 2014–March 2016) was 70,282. The patients comprised 54,535 male individuals (36.6%), 89,788 female individuals (60.3%), and 4,550 with unknown gender (3.1%). There were 61,895

**Table 1.** Demographic characteristics of self-inflicted injury patients transported by ambulance

	Total ( $n = 148,873$ )	Before (April 2012–March 2014) ( $n = 78,591$ )	After (April 2014–March 2016) ( $n = 70,282$ )
Age, years, median (IQR)	42 (29–57)	41 (29–56)	42 (30–58)
Gender, $n$ (%)			
Male	54,535 (36.6)	27,817 (35.4)	26,718 (38.0)
Female	89,788 (60.3)	46,588 (59.3)	43,200 (61.5)
Unknown	4,550 (3.1)	4,186 (5.3)	364 (0.5)
Area			
Urban area	61,895 (41.6)	32,667 (41.6)	29,228 (41.6)
Rural area	86,978 (58.4)	45,924 (58.4)	41,054 (58.4)
Transport to the jurisdictional area			
Inside area	118,847 (79.8)	62,476 (79.5)	56,371 (80.2)
Outside area	30,026 (20.2)	16,115 (20.5)	13,911 (19.8)

Abbreviation: IQR, interquartile range.

patients (41.6%) in urban areas and 86,978 patients (58.4%) in rural areas. The number of patients transported to hospitals inside the area of the fire department's jurisdiction was 118,847 (79.8%) and that transported to hospitals outside the area of the fire department's jurisdiction was 30,026 (20.2%).

Figure 1 shows the number of self-inflicted injury patients transported by ambulance for each month, and the number of patients calculated by the ITS model. The  $R^2$  for the ITS model was 0.821 (Table 2). The regression coefficient for the time trend before the medical reimbursement revision was 0.167 (95% CI, 0.090 to 0.244;  $p < 0.001$ ), that for the time trend after the medical reimbursement revision was  $-0.226$  (95% CI,  $-0.327$  to  $-0.125$ ;  $p < 0.001$ ), and that of the medical reimbursement revision was  $-2.165$  (95% CI,  $-3.730$  to  $-0.601$ ;  $p = 0.008$ ).

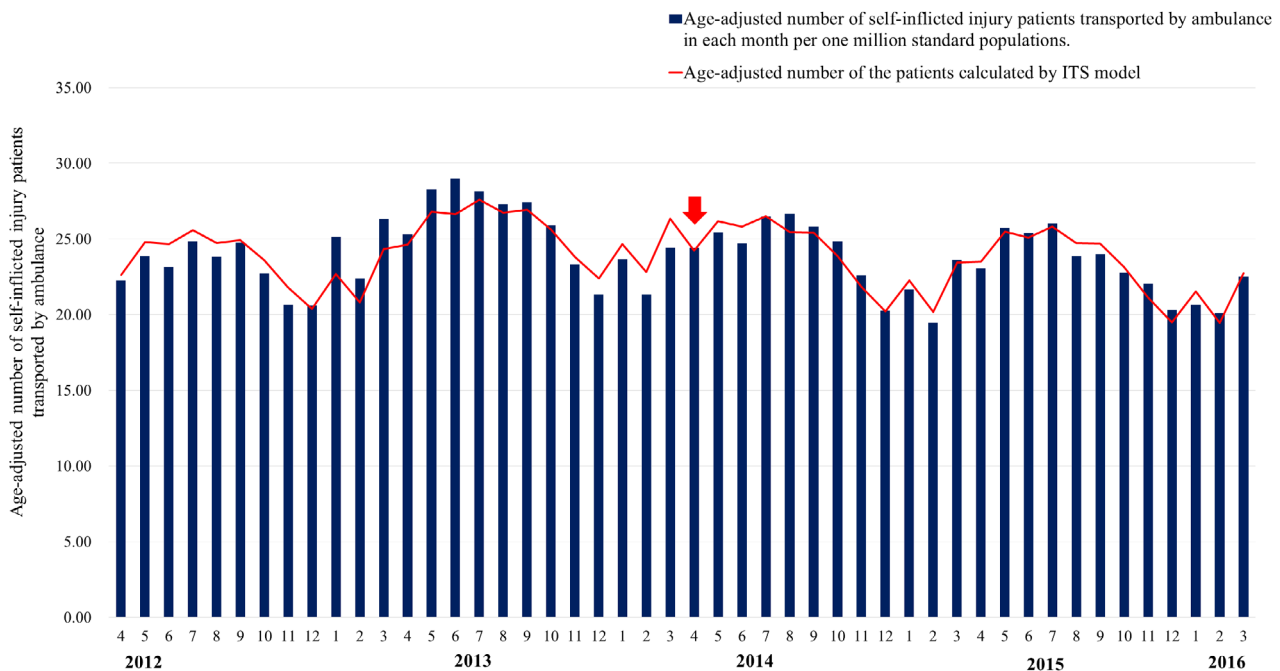
Figure 2 shows the results of the subgroups divided into urban areas and rural areas. The  $R^2$  of the ITS model in urban areas was 0.688 (Table 2). The regression coefficient for the time trend after the medical reimbursement revision was  $-0.145$  (95% CI,  $-0.211$  to  $-0.079$ ;  $p < 0.001$ ), and that of the medical reimbursement revision was  $-1.353$  (95% CI,  $-2.377$  to  $-0.330$ ;  $P = 0.011$ ). In contrast, the  $R^2$  of the ITS model in rural areas was 0.901. The regression coefficient for the time trend after the medical reimbursement revision was  $-0.087$  (95% CI,  $-0.130$  to  $-0.045$ ;

$p < 0.001$ ), and that of the medical reimbursement revision was  $-0.831$  (95% CI,  $-1.492$  to  $-0.170$ ;  $p = 0.015$ ).

Figure 3 shows the results of the subgroups divided into the patients transported to hospitals inside and outside the fire department's jurisdiction. The  $R^2$  of the ITS model in patients transported to hospitals inside the fire department's jurisdiction was 0.837 (Table 2). The regression coefficient for the time trend after the medical reimbursement revision was  $-0.168$  (95% CI,  $-0.245$  to  $-0.091$ ;  $p < 0.001$ ), and that of the medical reimbursement revision was  $-1.485$  (95% CI,  $-2.673$  to  $-0.297$ ;  $p = 0.016$ ). In contrast, the  $R^2$  of the ITS model in patients transported to hospitals outside the fire department's jurisdiction was 0.712. The regression coefficient for the time trend after the medical reimbursement revision was  $-0.058$  (95% CI,  $-0.087$  to  $-0.029$ ;  $p < 0.001$ ), and that of the medical reimbursement revision was  $-0.679$  (95% CI,  $-1.123$  to  $-0.234$ ;  $p = 0.004$ ).

## DISCUSSION

**I**N THIS STUDY, we showed that the number of self-inflicted injury patients transported by ambulance decreased due to the medical reimbursement revision relating to the emergency transport of patients with mental disorders and restrictions on concurrent prescriptions of multiple psychiatric drugs. This study revealed the impact of a policy

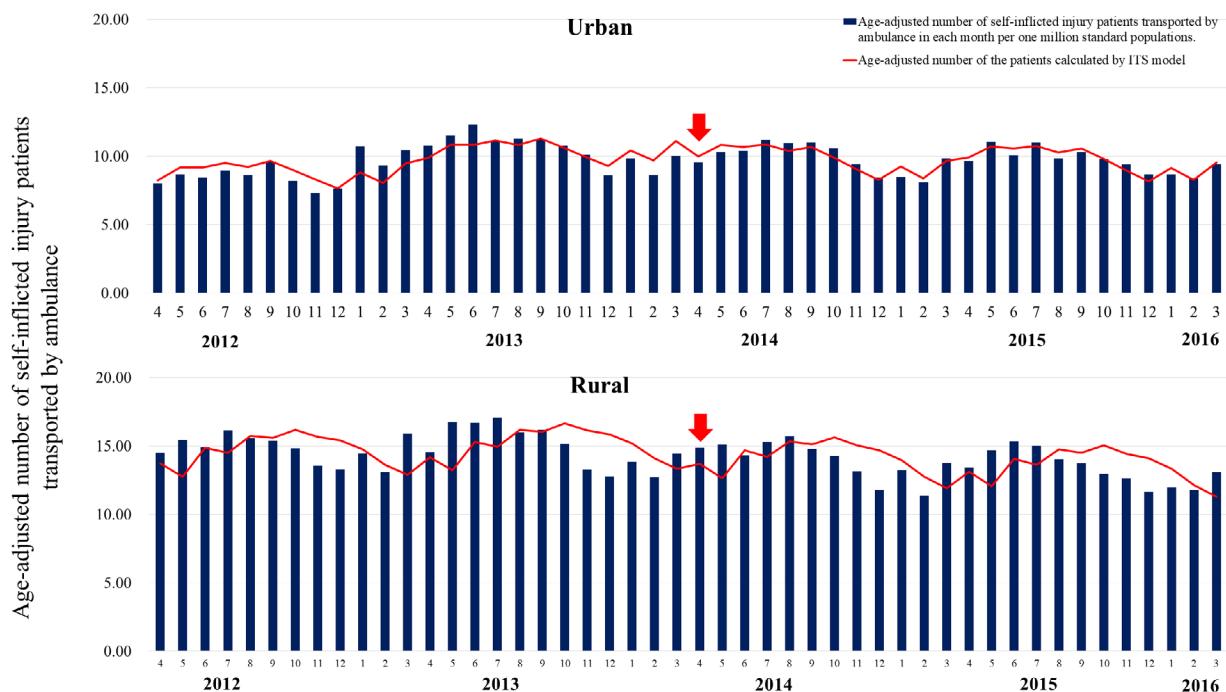


**Fig. 1.** Bar graph shows age-adjusted number of self-inflicted injury patients in Japan transported by ambulance in each month per 1 million standard populations. Line graph shows age-adjusted number of patients calculated by the interrupted time series. Red arrow indicates April 2014, when medical reimbursement revisions were implemented.

**Table 2.** Results of interrupted time series analysis to detect the association between medical reimbursement revision and number of self-inflicted injury patients transported by ambulance

Object	Time trend before medical reimbursement revision (change per month)			Time trend after medical reimbursement revision (change per month)			Impact of the medical reimbursement revision			Adjusted R <sup>2</sup>			
	Regression coefficient <sup>a</sup>	95% CI	p-value	Regression coefficient <sup>a</sup>	95% CI	p-value	Regression coefficient <sup>a</sup>	95% CI	p-value				
All	0.167	0.090	0.244	<0.001	-0.226	-0.327	-0.125	<0.001	-2.165	-3.730	-0.601	0.008	0.821
Subgroup													
Urban	0.136	0.086	0.187	<0.001	-0.145	-0.211	-0.079	<0.001	-1.353	-2.377	-0.330	0.011	0.688
Rural	0.037	0.005	0.070	0.027	-0.087	-0.130	-0.045	<0.001	-0.831	-1.492	-0.170	0.015	0.901
Transportation to hospitals inside fire department's jurisdiction	0.122	0.063	0.180	<0.001	-0.168	-0.245	-0.091	<0.001	-1.485	-2.673	-0.297	0.016	0.837
Transportation to hospitals outside fire department's jurisdiction	0.045	0.023	0.067	<0.001	-0.058	-0.087	-0.029	<0.001	-0.679	-1.123	-0.234	0.004	0.712

Abbreviation: CI, confidence interval.  
<sup>a</sup>Regression model was adjusted for seasonal effects.



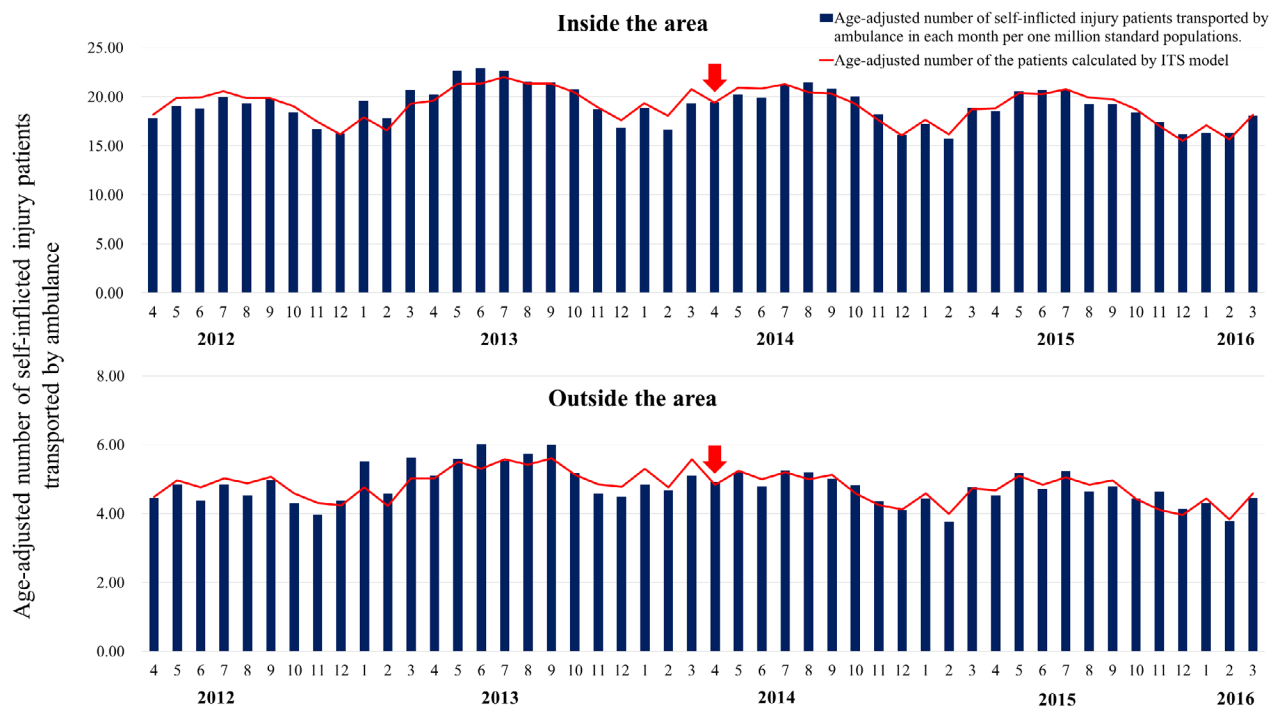
**Fig. 2.** Bar graphs show age-adjusted numbers of self-inflicted injury patients transported by ambulance in Japan in each month per 1 million standard populations, divided into urban areas and rural areas. Line graph shows age-adjusted number of patients calculated by the interrupted time series. Red arrow indicates April 2014, when medical reimbursement revisions were implemented.

such as medical reimbursement revision on patient transport by ambulance, which could be useful in planning various measures related to EMS systems around the world.

First, we used an ITS model to assess the impact of the medical reimbursement revision regarding emergency transport of patients with mental disorders by ambulance and the restriction of drug prescriptions, and the ITS model had a high  $R^2$  value in this study. Furthermore, the 2014 medical reimbursement revision was associated with a decrease in the number of self-inflicted injury patients transported to hospitals by ambulance. Many of the self-inflicted injury patients had comorbid mental disorders,<sup>6,21,22</sup> and a history of psychiatric diseases was one of the factors associated with the difficulty in hospital acceptance at the scene by EMS personnel in Japan.<sup>7</sup> In this study, we included patients who were transported to the hospital by ambulance not only for self-inflicted injuries but also for self-harm caused by drugs. Some patients with mental disorders take high doses of prescription drugs for suicidal purposes or severe sleep disturbance. As a result, these patients could fall into coma and be transported to hospitals by ambulance. Therefore, this medical reimbursement revision to limit the number of prescribed drugs might have had an impact on the emergency transport of self-inflicted patients by ambulance. In addition, the

number of self-inflicted injury patients transported to hospitals by ambulance had decreased before this medical reimbursement revision, which might have been influenced by measures taken for self-inflicted injury patients other than this medical reimbursement revision.

Second, the subgroup analysis of urban versus rural areas showed that the number of self-inflicted injury patients transported by ambulance decreased before the medical reimbursement revision, and the number continued to decrease further following the medical reimbursement revision in both urban and rural areas. However, in urban areas excluding Tokyo, there was no significant change in the number of self-inflicted injury patients transported to hospitals by ambulance after the medical reimbursement revision. Several studies previously reported that self-inflicted injury patients were more common in urban areas.<sup>3,23</sup> Hence, we anticipated that this medical reimbursement revision would affect emergency transport of self-injured patients in urban areas, but we found no change after the revision. The reason for this is unclear, but our definition of urban areas at the “prefecture” level might have influenced this result. As we analyzed the ambulance records provided by the FDMA in this study, the regional information was recorded at the prefecture level and not at



**Fig. 3.** Bar graphs show age-adjusted numbers of self-inflicted injury patients transported by ambulance in Japan in each month per 1 million standard populations, divided according to transportation to hospitals inside and outside the fire department's jurisdiction. Line graph shows age-adjusted number of patients calculated by the interrupted time series. Red arrow indicates April 2014, when medical reimbursement revisions were implemented.

the city level. Detailed analysis of the impact at the city level would be necessary in the future.

Third, the number of self-inflicted injury patients transported to hospitals inside the jurisdiction of the fire departments decreased before and after the medical reimbursement revision. However, the number of self-inflicted injury patients transported to hospitals outside the jurisdiction of fire departments decreased only after the medical reimbursement revision. This result was a reflection of the fact that the medical reimbursement revision has improved the hospital acceptance of patients with mental disorders and that these patients were accepted more easily by nearby hospitals. Previous studies on readmissions and subsequent deaths in young self-harm patients have shown that the risk of death within 10 years was two to three times higher in these patients than in other young patients.<sup>24,25</sup> To prevent death and further harm to self-inflicted injury patients after hospital discharge, it is important to educate and follow the patients both during their hospitalization and after hospital discharge. Because it is easier for patients to visit a nearby hospital than a distant one, transporting the patients to nearby hospitals would be effective in facilitating their

subsequent follow-up. Such medical reimbursement revision makes it easier to transport patients to nearby hospitals, which could lead to regular follow-up of self-inflicted injury patients and the prevention of further self-harm or suicide.

### Limitations

There are several limitations in this study. First, the data in Tokyo, which is the largest city in Japan, was excluded in this study due to an insufficiency of data. In the ITS model, ensuring that the period before and after the event are the same makes the model robust. However, the data in Tokyo before 2014 were insufficient, and so we excluded all data from Tokyo in this study. Second, we analyzed only the ambulance records as data on the diagnosis made in hospital was not available. Therefore, we did not include all patients with psychiatric diseases in this study. Third, the ITS model is one of the regression discontinuity designs, which is a regression model that evaluates the effect of social changes at a certain point in time. Hence, the impact of factors other than medical reimbursement revision and the restriction on concurrent prescriptions of multiple psychiatric drugs could

not be assessed in this study. In addition, as this study used nationwide data, the effect of unique measures introduced in each region was not assessed. Fourth, changes in social programs other than the medical reimbursement revision in April 2014 and other factors might also have affected the present results. Finally, as this was an observational study, there could be some unknown confounding factors.

## CONCLUSION

**I**N JAPAN, THE medical reimbursement revision for emergency transport of patients with mental disorders and the restriction on concurrent prescriptions of multiple psychiatric drugs implemented in April 2014 helped to decrease the number of self-inflicted injury patients transported to hospitals by ambulance.

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## DISCLOSURE

Approval of the research protocol: The protocol was approved by the Ethics Committee of Osaka University as the corresponding institution.

Informed Consent: The requirement for informed consent of the patients was waived.

Registry and the registration no. of the study/trial: N/A.

Animal studies: N/A.

Conflict of interest: None.

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