

Association of a telephone triage service for emergency patients with better outcome: a population-based study in Osaka City, Japan

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Objective Telephone triage service in emergency care has been introduced in many countries, and it is important to determine the effect of telephone triage service on the outcome of emergency patients. The aim of this study was to evaluate the effect of telephone triage service on the outcome of emergency patients using propensity score.

Methods design, settings, and participants This was a retrospective study with a study period from January 2016 to December 2019. We included all patients transported by ambulances of the Osaka Municipal Fire Department during study period.

Exposure Telephone triage service.

Outcome measures and analysis The main outcome of this study was unfavorable outcome following use of the telephone triage service. In this study, unfavorable outcome was defined as patients who were admitted, transferred, or died after care in the emergency department. Propensity scores were calculated using a logistic regression model with 12 variables that were present before the telephone triage service was used or were indicative of the patient's condition. Data analyses were not only propensity score matching but also a multivariable logistic regression model and regression model with propensity score as a covariate.

Main results The number of patients eligible for analyses was 707 474. Of these patients, 8008 (1.0%) used the telephone triage services and 699 466 patients (99.0%) did not use it. The number of patients with an unfavorable

outcome was 407 568 (57.6%) in the total cohort. Of them, 2305 patients (28.8%) used the telephone triage service and 297 601 patients (42.5%) did not use it. For propensity score matching, 8008 patients were matched from each group. Use of the telephone triage service was inversely associated with unfavorable outcome in a multivariate logistic regression model with propensity score as a covariate [adjusted odds ratio (OR) 0.874; 95% confidence interval (CI), 0.831–0.919] and propensity score matching (crude OR, 0.875; 95% CI, 0.818–0.936).

Conclusions This study revealed that the use of the telephone triage service in Osaka city, Japan was associated with better outcomes of patients transported by ambulance. *European Journal of Emergency Medicine* 29: 262–270 Copyright © 2022 The Author(s). Published by Wolters Kluwer Health, Inc.

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Introduction

Although the emergency medical service (EMS) system is essential to society, unnecessary ambulance use and frequent ambulance use are public health problems [1–4]. In Japan, anyone can request an ambulance for free, and thus, the number of ambulance dispatches has increased in recent years [5]. As a result, the time from ambulance

call to hospital arrival is being prolonged [5], which causes problems such as difficulty in hospital acceptance due to the increased numbers of patients transported by ambulance [6]. This may hinder the dispatch of ambulances to patients with true emergencies such as stroke or acute myocardial infarction.

Telephone triage service in emergency care has been introduced in many countries such as the United Kingdom and Australia, where nurses use software to assess the urgency of a caller and provide necessary services such as ambulance dispatch or sending a doctor [7–9]. In Japan,

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the telephone triage service in emergency care was introduced in some areas such as Tokyo in 2007 and Osaka in 2009. The telephone triage service in Osaka has been described in detail previously [10]. Similar to that in other countries, a telephone triage nurse assesses the urgency of the caller with software and dispatches an ambulance or directs the caller to an available medical facility based on the triage result. In Japan, anyone can not only call for an ambulance but also use the telephone triage service for free. Although some people may be hesitant to call for an ambulance because it can arrive at the scene with its siren blaring, the telephone triage service can be used without anyone noticing. As a result, patients may have a better prognosis after using the telephone triage service in the early stage of disease, even if their condition is severe. The impact of telephone triage services on patient prognosis has been studied in some studies [11,12], but its impact has not been fully revealed. If it can be shown that the telephone triage service contributes to the prognosis of emergency patients, telephone triage services could be introduced in more places around the world.

The telephone triage service in Osaka city in Japan was introduced in 2009, and the annual number of ambulance dispatches is approximately 250 000 [13]. Nurses working in the telephone triage service in Osaka receive telephone calls from people and judge the urgency of the patient's chief complaints and symptoms using software based on a telephone triage protocol in Japan. Our software records information such as sex and age group of the patients, beginning to end time of the telephone triage, chief complaints and signs during telephone triage, results of telephone triage, and whether an ambulance was dispatched. And then, the Osaka prefectural government established a population-based registry system (ORION) for emergency patients transported by ambulance, which collects patient information from ambulance call to hospital discharge [10]. In this study, we merged dataset of telephone triage dataset and the ORION registry, and evaluated the effect of the telephone triage service for emergency patients on their outcome using analysis methods combined with propensity score matching.

Materials and methods

Study design, setting, and populations

This was a retrospective observational study whose study period was 4 years from January 2016 to December 2019. Osaka city is the largest metropolitan area in western Japan, covering an area of 225.3 km² with a population of 2.75 million [14]. This study was approved by the Ethics Committee of Osaka University Graduate School of Medicine (approval number: 16070). This report was written based on the Strengthening the Reporting of Observational Studies in Epidemiology statement to assess the reporting of cohort and cross-sectional studies [15].

Setting and selection of patients

In Japan, the telephone triage service and ambulance calls are public services, and anyone can use these services for free. We included cases for which ambulances were dispatched from the Osaka Municipal Fire Department (OMFD) in this study and excluded cases in which more than one patient was transported by ambulance or cases with missing data. We were provided with anonymized data for analysis from the OMFD, and therefore, the necessity to obtain informed consent from the patients was waived.

Exposure

The telephone triage service in Osaka prefecture has been described in detail previously [10]. A telephone triage nurse assesses the urgency of a caller's symptoms using software based on the Japanese telephone triage protocol, which is categorized by each of 98 chief complaints [16], and the urgency of callers is judged by selecting signs and symptoms related to these chief complaints. Similar to telephone triage services in the USA, Canada, and the UK [9,17–20], telephone triage nurses call for ambulances and provide information on available medical facilities based on the results of the telephone triage [21]. Our software records the data about telephone triage such as sex, age group of patients, beginning to end time of telephone triage, chief complaint and signs, urgency of telephone triage, and whether an ambulance was dispatched.

Outcomes

The main outcome of this study was unfavorable outcome. We defined unfavorable outcome as patients who were admitted, transferred, or died after care in the emergency department. The secondary outcome was the 21-day prognosis of patients who were admitted to the hospital after care in the emergency department. Secondary outcome was categorized as 'continuation to hospitalization', 'hospital discharge', 'inter-hospital transfer', 'death', and 'unknown'.

Measurements

The merged dataset has been described in detail previously [10]. Key parameters such as age, sex, and date and time of ambulance dispatch were used to identify patient data from the ORION registry. Age differences of up to 2 years and time differences of ambulance dispatch of up to 5 min were allowed. All data that did not match between two datasets were excluded from this study.

Data analysis

We calculated propensity scores using a logistic regression model with 12 variables that were present before the telephone triage service was used or were indicative of the patient's condition. The variables used to calculate the propensity score were age, sex, year, month, day of

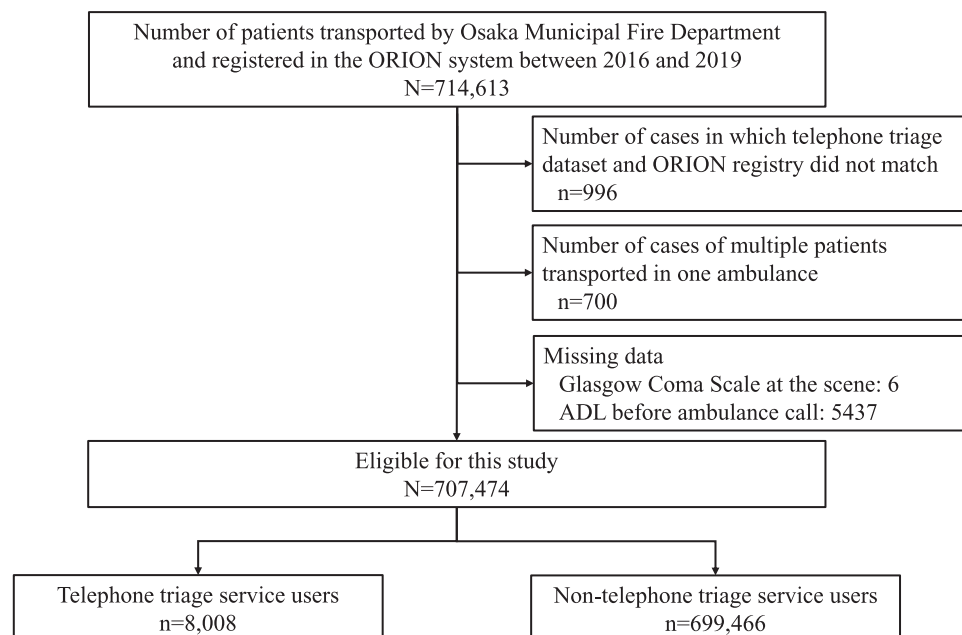
the week, time of day, weekend and holiday, reasons for ambulance call, patient's background, Glasgow Coma Scale (GCS) at the scene, activity of daily living (ADL), location of occurrence, and distinct area of Osaka. The time of day was categorized into 24 1-h increments. Reasons for ambulance call were categorized according to the standard of the OMF D as follows: 'fire accident', 'natural disaster', 'water accident', 'traffic accident by car', 'traffic accident by ship', 'traffic accident by aircraft', 'injury due to industrial accident', 'poisoning and acute disease due to industrial accident', 'acute disease and injury during sports', 'acute disease and injury while watching sports', 'asphyxia', 'gas poisoning not due to industrial accident and self-injury', 'other injury', 'assault', 'self-induced drug abuse and gas poisoning', 'self-induced injury', 'acute disease', 'gynecological disease including childbirth', 'inter-hospital transfer', and 'other'. Administrative districts were classified into 24 areas defined by Osaka city. Location of occurrence was classified as 'home', 'work place', 'public space', 'public transportation', 'road, highway and railroad', 'sea, pools and rivers', 'other indoor areas', and 'other outdoor areas'. Patient background was defined as 'past history of mental illness', 'drinking', 'homeless', 'need for nursing care', 'living in nursing home', 'drug addiction', 'past problems with medical institution', 'suicide attempt', 'difficulty in hospital acceptance', 'pediatric trauma', 'pregnant woman', and 'living alone' based on the definitions set by the Osaka prefectural government. ADLs were classified into four groups based on the Glasgow-Pittsburgh

Cerebral Performance and Overall Performance Category: 'Good; CPC 1', 'Moderate disability; CPC 2', 'Severe Disability; CPC 3 and 4', and 'Unknown' [22]. One-to-one pair matching between cases for which an ambulance was dispatched via the telephone triage service and cases without telephone triage service was performed by nearest-neighbor matching without replacement, with the use of a caliper width equal to 0.2 of the SD of the logit of the propensity score. Covariate balances before and after matching were checked by comparison of the standardized mean difference (SMD). An SMD of <0.1 was considered to show a negligible imbalance between the two groups [23]. To ensure the robustness of this analysis, we used not only propensity score matching but also a multivariable logistic regression model and regression model with propensity score as a covariate. The variables entered into the multivariable logistic regression model were the 12 variables used in the calculation of propensity score, and telephone triage service. In addition, we divided the age groups into children (0–14 years old), adults (15–64 years old), and the elderly (65 years old and over) and assessed them in the same way. All tests were two-tailed, and *P* values of <0.05 were considered statistically significant. All statistical analyses were performed using SPSS ver 25.0J (IBM Corp. Armonk, New York, USA).

Results

Figure 1 shows patient flow in this study, in which 714,613 patients were transported to medical institutions by

Fig. 1



Patient flow in this study.

Table 1 Patient characteristics among the total cohort and the propensity score-matched cohort

| | All patients | | | Propensity-score matched patients | | |
|--|---|--|-------|---|---|-------|
| | Telephone triage service users (N=8008) | Non-telephone triage service users (N=699 466) | SMD | Telephone triage service users (N=8008) | Non-telephone triage service users (N=8008) | SMD |
| Age, mean (SD) | 43.4 (27.9) | 59.0 (25.7) | 0.582 | 43.4 (27.9) | 43.7 (27.8) | 0.011 |
| Male, n (%) | 3691 (46.1%) | 362 254 (51.8%) | 0.114 | 3691 (46.1%) | 3736 (46.7%) | 0.011 |
| Year, n (%) | | | | | | |
| 2016 | 1757 (21.9%) | 161 505 (24.0%) | 0.028 | 1757 (21.9%) | 1787 (22.3%) | 0.009 |
| 2017 | 1927 (24.1%) | 170 230 (24.5%) | 0.006 | 1927 (24.1%) | 1883 (23.5%) | 0.013 |
| 2018 | 2090 (26.1%) | 183 263 (25.8%) | 0.002 | 2090 (26.1%) | 2124 (26.5%) | 0.010 |
| 2019 | 2234 (27.9%) | 184 468 (25.7%) | 0.034 | 2234 (27.9%) | 2214 (27.6%) | 0.006 |
| Month, n (%) | | | | | | |
| January | 576 (7.2%) | 61 772 (8.8%) | 0.060 | 576 (7.2%) | 570 (7.1%) | 0.003 |
| February | 521 (6.5%) | 53 687 (7.7%) | 0.046 | 521 (6.5%) | 503 (6.3%) | 0.009 |
| March | 612 (7.6%) | 56 480 (8.1%) | 0.016 | 612 (7.6%) | 616 (7.7%) | 0.002 |
| April | 598 (7.5%) | 54 664 (7.8%) | 0.013 | 598 (7.5%) | 612 (7.6%) | 0.007 |
| May | 650 (8.1%) | 55 719 (8.0%) | 0.006 | 650 (8.1%) | 617 (7.7%) | 0.015 |
| June | 679 (8.5%) | 55 568 (7.9%) | 0.019 | 679 (8.5%) | 651 (8.1%) | 0.013 |
| July | 746 (9.3%) | 64 440 (9.2%) | 0.004 | 746 (9.3%) | 743 (9.3%) | 0.001 |
| August | 809 (10.1%) | 63 428 (9.1%) | 0.035 | 809 (10.1%) | 825 (10.3%) | 0.007 |
| September | 636 (7.9%) | 55 768 (8.0%) | 0.001 | 636 (7.9%) | 633 (7.9%) | 0.001 |
| October | 716 (8.9%) | 57 627 (8.2%) | 0.025 | 716 (8.9%) | 743 (9.3%) | 0.012 |
| November | 700 (8.7%) | 56 961 (8.1%) | 0.022 | 700 (8.7%) | 702 (8.8%) | 0.001 |
| December | 765 (9.6%) | 63 352 (9.1%) | 0.017 | 765 (9.6%) | 793 (9.9%) | 0.012 |
| Day of the week, n (%) | | | | | | |
| Sunday | 1442 (18.0%) | 100 708 (14.4%) | 0.098 | 1442 (18.0%) | 1380 (17.2%) | 0.020 |
| Monday | 1119 (14.0%) | 103 870 (14.8%) | 0.025 | 1119 (14.0%) | 1164 (14.5%) | 0.016 |
| Tuesday | 1090 (13.6%) | 98 271 (14.0%) | 0.013 | 1090 (13.6%) | 1071 (13.4%) | 0.007 |
| Wednesday | 1027 (12.8%) | 95 742 (13.7%) | 0.025 | 1027 (12.8%) | 966 (12.1%) | 0.023 |
| Thursday | 1123 (14.0%) | 97 437 (13.9%) | 0.003 | 1123 (14.0%) | 1142 (14.3%) | 0.007 |
| Friday | 1007 (12.6%) | 100 990 (14.4%) | 0.055 | 1007 (12.6%) | 1066 (13.3%) | 0.022 |
| Saturday | 1200 (15.0%) | 102 448 (14.6%) | 0.010 | 1200 (15.0%) | 1219 (15.2%) | 0.007 |
| Weekend and holiday, n (%) | 3069 (38.3%) | 232 659 (33.3%) | 0.106 | 3069 (38.3%) | 3017 (37.7%) | 0.013 |
| Time of day, n (%) | | | | | | |
| 0:00–0:59 | 392 (4.9%) | 21 471 (3.1%) | 0.093 | 392 (4.9%) | 374 (4.7%) | 0.011 |
| 1:00–1:59 | 330 (4.1%) | 17 671 (2.5%) | 0.089 | 330 (4.1%) | 309 (3.9%) | 0.013 |
| 2:00–2:59 | 274 (3.4%) | 15 331 (2.2%) | 0.075 | 274 (3.4%) | 266 (3.3%) | 0.006 |
| 3:00–3:59 | 224 (2.8%) | 13 731 (2.0%) | 0.055 | 224 (2.8%) | 240 (3.0%) | 0.012 |
| 4:00–4:59 | 237 (3.0%) | 13 078 (1.9%) | 0.071 | 237 (3.0%) | 231 (2.9%) | 0.004 |
| 5:00–5:59 | 216 (2.7%) | 14 371 (2.1%) | 0.042 | 216 (2.7%) | 217 (2.7%) | 0.001 |
| 6:00–6:59 | 242 (3.0%) | 17 510 (2.5%) | 0.032 | 242 (3.0%) | 238 (3.0%) | 0.003 |
| 7:00–7:59 | 294 (3.7%) | 23 028 (3.3%) | 0.021 | 294 (3.7%) | 319 (4.0%) | 0.016 |
| 8:00–8:59 | 305 (3.8%) | 32 053 (4.6%) | 0.039 | 305 (3.8%) | 325 (4.1%) | 0.013 |
| 9:00–9:59 | 282 (3.5%) | 40 512 (5.8%) | 0.108 | 282 (3.5%) | 280 (3.5%) | 0.001 |
| 10:00–10:59 | 269 (3.4%) | 40 896 (5.8%) | 0.119 | 269 (3.4%) | 258 (3.2%) | 0.008 |
| 11:00–11:59 | 244 (3.0%) | 38 824 (5.6%) | 0.124 | 244 (3.0%) | 238 (3.0%) | 0.004 |
| 12:00–12:59 | 248 (3.1%) | 38 070 (5.4%) | 0.116 | 248 (3.1%) | 247 (3.1%) | 0.001 |
| 13:00–13:59 | 294 (3.7%) | 37 834 (5.1%) | 0.084 | 294 (3.7%) | 280 (3.5%) | 0.009 |
| 14:00–14:59 | 317 (4.0%) | 35 602 (5.0%) | 0.054 | 317 (4.0%) | 310 (3.9%) | 0.005 |
| 15:00–15:59 | 271 (3.4%) | 34 826 (5.0%) | 0.080 | 271 (3.4%) | 266 (3.3%) | 0.003 |
| 16:00–16:59 | 322 (4.0%) | 35 045 (5.0%) | 0.048 | 322 (4.0%) | 324 (4.0%) | 0.001 |
| 17:00–17:59 | 333 (4.2%) | 37 163 (5.3%) | 0.054 | 333 (4.2%) | 344 (4.3%) | 0.007 |
| 18:00–18:59 | 398 (5.0%) | 37 056 (5.3%) | 0.015 | 398 (5.0%) | 419 (5.2%) | 0.012 |
| 19:00–19:59 | 518 (6.5%) | 35 514 (5.1%) | 0.060 | 518 (6.5%) | 505 (6.3%) | 0.007 |
| 20:00–20:59 | 553 (6.9%) | 34 021 (4.9%) | 0.087 | 553 (6.9%) | 540 (6.7%) | 0.006 |
| 21:00–21:59 | 517 (6.5%) | 31 792 (4.5%) | 0.084 | 517 (6.5%) | 543 (6.8%) | 0.013 |
| 22:00–22:59 | 504 (6.3%) | 28 832 (4.1%) | 0.098 | 504 (6.3%) | 483 (6.0%) | 0.011 |
| 23:00–23:59 | 424 (5.3%) | 25 235 (3.6%) | 0.082 | 424 (5.3%) | 452 (5.6%) | 0.015 |
| Reason for ambulance call | | | | | | |
| Fire accident | 3 (0.0%) | 267 (0.0%) | 0.000 | 3 (0.0%) | 3 (0.0%) | 0.000 |
| Natural disaster | 1 (0.0%) | 161 (0.0%) | 0.008 | 1 (0.0%) | 1 (0.0%) | 0.000 |
| Water accident | 0 (0%) | 75 (0.0%) | 0.015 | 0 (0%) | 0 (0%) | – |
| Traffic accident by car | 42 (0.5%) | 44 460 (6.4%) | 0.324 | 42 (0.5%) | 62 (0.8%) | 0.031 |
| Traffic accident by ship | 0 (0%) | 2 (0.0%) | 0.002 | 0 (0%) | 0 (0%) | – |
| Traffic accident by aircraft | 0 (0%) | 3 (0.0%) | 0.003 | 0 (0%) | 0 (0%) | – |
| Injury due to industrial accident | 17 (0.2%) | 5466 (0.8%) | 0.081 | 17 (0.2%) | 11 (0.1%) | 0.018 |
| Poisoning and acute disease due to industrial accident | 1 (0.0%) | 178 (0.0%) | 0.009 | 1 (0.0%) | 2 (0.0%) | 0.009 |
| Acute disease and injury during sports | 16 (0.2%) | 3444 (0.5%) | 0.050 | 16 (0.2%) | 18 (0.2%) | 0.005 |
| Acute disease and injury while watching sports | 0 (0%) | 92 (0.0%) | 0.016 | 0 (0%) | 0 (0%) | – |
| Asphyxia | 89 (1.1%) | 2588 (0.4%) | 0.087 | 89 (1.1%) | 82 (1.0%) | 0.009 |
| Gas poisoning not due to industrial accident and self-injury | 1 (0.0%) | 48 (0.0%) | 0.006 | 1 (0.0%) | 0 (0%) | 0.016 |
| Other injury | 610 (7.6%) | 104 043 (14.9%) | 0.231 | 610 (7.6%) | 613 (7.7%) | 0.001 |
| Assault | 14 (0.2%) | 6002 (0.9%) | 0.095 | 14 (0.2%) | 20 (0.2%) | 0.016 |
| Self-induced drug abuse and gas poisoning | 49 (0.6%) | 2968 (0.4%) | 0.026 | 49 (0.6%) | 44 (0.5%) | 0.008 |
| Self-induced injury | 2 (0.0%) | 1836 (0.3%) | 0.063 | 2 (0.0%) | 3 (0.0%) | 0.007 |

(Continued)

Table 1 (Continued)

| | All patients | | | Propensity-score matched patients | | |
|--|---|---|-------|---|---|-------|
| | Telephone triage service users (N=8008) | Non-telephone triage service users (N=699466) | SMD | Telephone triage service users (N=8008) | Non-telephone triage service users (N=8008) | SMD |
| Acute disease | 7037 (87.9%) | 476322 (68.1%) | 0.492 | 7037 (87.9%) | 6981 (87.2%) | 0.021 |
| Gynecological disease including childbirth | 126 (1.6%) | 6129 (0.9%) | 0.063 | 126 (1.6%) | 133 (1.7%) | 0.007 |
| Inter-hospital transfer | 0 (0%) | 45382 (6.5%) | 0.373 | 0 (0%) | 35 (0.4%) | 0.094 |
| Other | 0 (0%) | 0 (0.0%) | – | 0 (0%) | 0 (0%) | – |
| Patient background | | | | | | |
| History of mental illness | 280 (3.5%) | 31875 (4.6%) | 0.054 | 280 (3.5%) | 294 (3.7%) | 0.009 |
| Drinking alcohol | 155 (1.9%) | 40046 (5.7%) | 0.198 | 155 (1.9%) | 143 (1.8%) | 0.011 |
| No fixed address | 0 (0%) | 1211 (0.2%) | 0.059 | 0 (0%) | 1 (0.0%) | 0.016 |
| Use of nursing care insurance | 343 (4.3%) | 87412 (12.5%) | 0.300 | 343 (4.3%) | 321 (4.0%) | 0.014 |
| Drug abuse | 51 (0.6%) | 2432 (0.3%) | 0.041 | 51 (0.6%) | 46 (0.6%) | 0.008 |
| Past problems with medical institution | 2 (0.0%) | 374 (0.1%) | 0.014 | 2 (0.0%) | 5 (0.1%) | 0.018 |
| Suicide attempt | 11 (0.1%) | 1444 (0.2%) | 0.017 | 11 (0.1%) | 12 (0.1%) | 0.003 |
| Currently in a nursing home | 18 (0.2%) | 15474 (2.2%) | 0.182 | 18 (0.2%) | 17 (0.2%) | 0.003 |
| Difficulty in hospital acceptance | 0 (0%) | 311 (0.0%) | 0.030 | 0 (0%) | 1 (0.0%) | 0.016 |
| Pediatric trauma | 99 (1.2%) | 7365 (1.1%) | 0.017 | 99 (1.2%) | 104 (1.3%) | 0.006 |
| Pregnant woman | 32 (0.4%) | 2274 (0.3%) | 0.012 | 32 (0.4%) | 32 (0.4%) | 0.000 |
| Living alone | 157 (2.0%) | 24190 (3.5%) | 0.092 | 157 (2.0%) | 168 (2.1%) | 0.010 |
| Glasgow Coma Scale at the scene | | | | | | |
| 3 | 22 (0.3%) | 12864 (1.8%) | 0.153 | 22 (0.3%) | 24 (0.3%) | 0.005 |
| 4 | 5 (0.1%) | 1049 (0.1%) | 0.027 | 5 (0.1%) | 5 (0.1%) | 0.000 |
| 5 | 3 (0.0%) | 959 (0.1%) | 0.034 | 3 (0.0%) | 2 (0.0%) | 0.007 |
| 6 | 28 (0.3%) | 5922 (0.8%) | 0.064 | 28 (0.3%) | 39 (0.5%) | 0.021 |
| 7 | 30 (0.4%) | 5039 (0.7%) | 0.047 | 30 (0.4%) | 27 (0.3%) | 0.006 |
| 8 | 22 (0.3%) | 3345 (0.5%) | 0.033 | 22 (0.3%) | 22 (0.3%) | 0.000 |
| 9 | 41 (0.5%) | 5852 (0.8%) | 0.040 | 41 (0.5%) | 41 (0.5%) | 0.000 |
| 10 | 85 (1.1%) | 10242 (1.5%) | 0.036 | 85 (1.1%) | 93 (1.2%) | 0.010 |
| 11 | 122 (1.5%) | 13625 (1.9%) | 0.033 | 122 (1.5%) | 102 (1.3%) | 0.021 |
| 12 | 62 (0.8%) | 7637 (1.1%) | 0.033 | 62 (0.8%) | 54 (0.7%) | 0.012 |
| 13 | 80 (1.0%) | 13002 (1.9%) | 0.072 | 80 (1.0%) | 82 (1.0%) | 0.002 |
| 14 | 278 (3.5%) | 54016 (7.7%) | 0.186 | 278 (3.5%) | 262 (3.3%) | 0.011 |
| 15 | 7230 (90.3%) | 565914 (80.9%) | 0.269 | 7230 (90.3%) | 7255 (90.6%) | 0.011 |
| Activity of daily living | | | | | | |
| Good | 7694 (96.1%) | 608824 (87.0%) | 0.329 | 7694 (96.1%) | 7712 (96.3%) | 0.012 |
| Mild and Moderate disability | 282 (3.5%) | 71162 (10.2%) | 0.266 | 282 (3.5%) | 256 (3.2%) | 0.018 |
| Severe disability | 29 (0.4%) | 17048 (2.4%) | 0.177 | 29 (0.4%) | 35 (0.4%) | 0.012 |
| Unknown | 3 (0.0%) | 2432 (0.3%) | 0.071 | 3 (0.0%) | 5 (0.1%) | 0.011 |
| Place | | | | | | |
| Home | 7203 (90.1%) | 376520 (53.8%) | 0.877 | 7203 (90.1%) | 7136 (89.1%) | 0.027 |
| Work place | 173 (2.2%) | 20819 (3.0%) | 0.052 | 173 (2.2%) | 175 (2.2%) | 0.002 |
| Public place | 338 (4.2%) | 184162 (26.3%) | 0.646 | 338 (4.2%) | 398 (5.0%) | 0.036 |
| Public transportation | 12 (0.1%) | 4627 (0.7%) | 0.081 | 12 (0.1%) | 10 (0.1%) | 0.007 |
| Road, highway, and railroad | 227 (2.8%) | 104044 (14.9%) | 0.434 | 227 (2.8%) | 240 (3.0%) | 0.010 |
| Sea, pools, and rivers | 0 (0%) | 196 (0.0%) | 0.024 | 0 (0%) | 0 (0%) | – |
| Other indoor areas | 10 (0.1%) | 1532 (0.2%) | 0.023 | 10 (0.1%) | 4 (0.0%) | 0.025 |
| Other outdoor areas | 45 (0.6%) | 7566 (1.1%) | 0.058 | 45 (0.6%) | 45 (0.6%) | 0.000 |
| Area | | | | | | |
| Kita-ku | 521 (6.5%) | 54681 (7.8%) | 0.051 | 521 (6.5%) | 529 (6.6%) | 0.004 |
| Miyakojima-ku | 368 (4.6%) | 23803 (3.4%) | 0.061 | 368 (4.6%) | 355 (4.4%) | 0.008 |
| Fukushima-ku | 195 (2.4%) | 14770 (2.1%) | 0.022 | 195 (2.4%) | 194 (2.4%) | 0.001 |
| Konohana-ku | 168 (2.1%) | 18619 (2.7%) | 0.037 | 168 (2.1%) | 171 (2.1%) | 0.003 |
| Chuo-ku | 453 (5.7%) | 45601 (6.5%) | 0.036 | 453 (5.7%) | 444 (5.5%) | 0.005 |
| Nishi-ku | 304 (3.8%) | 23723 (3.4%) | 0.022 | 304 (3.8%) | 281 (3.5%) | 0.015 |
| Minato-ku | 184 (2.3%) | 18666 (2.7%) | 0.024 | 184 (2.3%) | 201 (2.5%) | 0.014 |
| Taisho-ku | 146 (1.8%) | 16438 (2.4%) | 0.037 | 146 (1.8%) | 145 (1.8%) | 0.001 |
| Tennoji-ku | 260 (3.2%) | 19543 (2.8%) | 0.026 | 260 (3.2%) | 249 (3.1%) | 0.008 |
| Naniwa-ku | 246 (3.1%) | 24027 (3.4%) | 0.020 | 246 (3.1%) | 263 (3.3%) | 0.012 |
| Nishiyodogawa-ku | 224 (2.8%) | 21678 (3.1%) | 0.018 | 224 (2.8%) | 219 (2.7%) | 0.004 |
| Yodogawa-ku | 507 (6.3%) | 40975 (5.9%) | 0.020 | 507 (6.3%) | 510 (6.4%) | 0.002 |
| Higashiyodogawa-ku | 445 (5.6%) | 40367 (5.8%) | 0.009 | 445 (5.6%) | 468 (5.8%) | 0.012 |
| Higashinari-ku | 267 (3.3%) | 17910 (2.6%) | 0.046 | 267 (3.3%) | 295 (3.7%) | 0.019 |
| Ikuno-ku | 314 (3.9%) | 31353 (4.5%) | 0.028 | 314 (3.9%) | 307 (3.8%) | 0.005 |
| Asahi-ku | 245 (3.1%) | 18955 (2.7%) | 0.021 | 245 (3.1%) | 250 (3.1%) | 0.004 |
| Joto-ku | 477 (6.0%) | 33390 (4.8%) | 0.053 | 477 (6.0%) | 487 (6.1%) | 0.005 |
| Tsurumi-ku | 287 (3.6%) | 20830 (3.0%) | 0.034 | 287 (3.6%) | 291 (3.6%) | 0.003 |
| Abeno-ku | 346 (4.3%) | 22328 (3.2%) | 0.059 | 346 (4.3%) | 309 (3.9%) | 0.023 |
| Suminoe-ku | 384 (4.8%) | 30550 (4.4%) | 0.020 | 384 (4.8%) | 376 (4.7%) | 0.005 |
| Sumiyoshi-ku | 439 (5.5%) | 32595 (4.7%) | 0.037 | 439 (5.5%) | 435 (5.4%) | 0.002 |
| Higashiumiyoshi-ku | 398 (5.0%) | 29731 (4.3%) | 0.034 | 398 (5.0%) | 396 (4.9%) | 0.001 |
| Hirano-ku | 582 (7.3%) | 45447 (6.5%) | 0.030 | 582 (7.3%) | 564 (7.0%) | 0.009 |
| Nishinari-ku | 248 (3.1%) | 53345 (7.6%) | 0.202 | 248 (3.1%) | 269 (3.4%) | 0.015 |
| Outside Osaka City | 0 (0%) | 141 (0.0%) | 0.020 | 0 (0%) | 0 (0%) | – |

EMS, emergency medical service; IQR, interquartile range; SMD, standardized mean difference.

Table 2 Unfavorable outcome of emergency patients transported by ambulance with or without telephone triage service

| | Total | Telephone triage service used | Telephone triage service not used | Crude OR (95% CI) | Adjusted OR (95% CI) |
|---|-----------------|-------------------------------|-----------------------------------|---------------------|----------------------|
| All patients | (N=707 474) | (N=8008) | (N=699 466) | | |
| Unfavorable outcome | 299 906 (42.4%) | 2305 (28.8%) | 297 601 (42.5%) | | |
| Univariate logistic regression model | | | | 0.546 (0.520–0.573) | – |
| Multivariate logistic regression model* | | | | – | 0.853 (0.809–0.899) |
| Regression model with propensity score as covariate | | | | – | 0.874 (0.831–0.919) |
| Propensity score-matched patients | (N=16 016) | (N=8008) | (N=8008) | | |
| Unfavorable outcome | 4836 (30.2%) | 2305 (28.8%) | 2531 (31.6%) | 0.875 (0.818–0.936) | – |

CI, confidence interval; OR, odds ratio.

ORs were calculated for patients with versus without telephone triage service

*Adjusted for age, sex, calendar year, month, day of the week, time zone, holiday including weekend, reason for ambulance call, administrative district, and accident location.

Table 3 Subgroup analysis by age group

| | Total | Telephone triage service used | Telephone triage service not used | Crude OR (95% CI) | Adjusted OR (95% CI) |
|---|-----------------|-------------------------------|-----------------------------------|---------------------|----------------------|
| Children, 0–14 years old | | | | | |
| All patients | (N=48 106) | (N=1613) | (N=46 493) | | |
| Unfavorable outcome | 9399 (19.5%) | 298 (18.5%) | 9101 (19.6%) | | |
| Univariate logistic regression model | | | | 0.931 (0.819–1.058) | – |
| Multivariate logistic regression model* | | | | – | 1.187 (1.039–1.357) |
| Regression model with propensity score as covariate | | | | – | – |
| Propensity score-matched patients | (N=3224) | (N=1612) | (N=1612) | | |
| Unfavorable outcome | 579 (18.0%) | 298 (18.5%) | 281 (17.4%) | 1.074 (0.897–1.286) | – |
| Adults, 15–64 years old | | | | | |
| All patients | (N=286 565) | (N=4046) | (N=282 519) | | |
| Unfavorable outcome | 80 507 (28.1%) | 911 (22.5%) | 79 596 (28.2%) | | |
| Univariate logistic regression model | | | | 0.741 (0.688–0.798) | – |
| Multivariate logistic regression model* | | | | – | 0.856 (0.792–0.924) |
| Regression model with propensity score as covariate | | | | – | 0.862 (0.800–0.929) |
| Propensity score-matched patients | (N=8092) | (N=4046) | (N=4468) | | |
| Unfavorable outcome | 1971 (24.4%) | 911 (22.5%) | 1060 (26.2%) | 0.819 (0.739–0.906) | – |
| Elderly, over 65 years old | | | | | |
| All patients | (N=372 803) | (N=2349) | (N=370 454) | | |
| Unfavorable outcome | 210 000 (56.3%) | 1096 (46.7%) | 208 904 (56.4%) | | |
| Univariate logistic regression model | | | | 0.676 (0.624–0.734) | – |
| Multivariate logistic regression model* | | | | – | 0.807 (0.741–0.879) |
| Regression model with propensity score as covariate | | | | – | 0.838 (0.772–0.910) |
| Propensity score-matched patients | (N=4698) | (N=2349) | (N=2349) | | |
| Unfavorable outcome | 2331 (49.6%) | 1096 (46.7%) | 1235 (52.6%) | 0.789 (0.704–0.885) | – |

CI, confidence interval; OR, odds ratio.

ORs were calculated for patients with versus without telephone triage service.

*Adjusted for age, sex, calendar year, month, day of the week, time zone, holiday including weekend, reason for ambulance call, administrative district, and accident location.

ambulances of the OMFd and registered in the ORION system during the study period. We excluded 996 patients in which telephone triage dataset and ORION registry, 700 patients, including those who were transported with other patients by only one ambulance and 5443 patients with missing data (ADLs: 5437 patients, GCS at the scene: 6 patients). Thus, the number of patients eligible for the analyses was 707 474. Of these patients, 8008 (1.0%) used the telephone triage service and 699 466 patients (99.0%) did not use it.

Table 1 shows the characteristics of the patients before and after propensity score matching. In the total cohort before propensity score matching, the patients who used the telephone triage service were younger, and the reasons for an ambulance call were more likely to be ‘acute illness’ and less likely to be ‘traffic accident by car’ and ‘other injury’. Regarding GCS at the scene, a higher

percentage of patients who used the telephone triage service had a GCS of 15 points, and a lower percentage had a GCS of 3 points. The location of occurrence for a large proportion of the patients was ‘home’ and for a small proportion was in a ‘public space’ or ‘road, highway and railroad’. For propensity score matching, 8008 patients were selected from each group, and the balance of each covariate improved between the two groups after matching. The area under the curve in the logistic regression model for propensity score calculation was 0.809.

Table 2 shows the proportion of unfavorable outcomes in the total cohort and the propensity score-matched cohort. The number of patients with an unfavorable outcome was 407 568 (57.6%) in the total cohort. Of them, 2305 patients (28.8%) used the telephone triage service and 297 601 patients (42.5%) did not use it. In the propensity score-matched cohort, the number of patients with

an unfavorable outcome was 4836 (30.2%), of whom 2305 patients (28.8%) used the telephone triage service and 2531 patients (31.6%) did not use it. The use of the telephone triage service was inversely associated with the occurrence of unfavorable outcome in a univariate logistic regression model (crude odds ratio [OR] 0.546; 95% confidence interval [CI], 0.520–0.573), multivariate logistic regression model (adjusted OR 0.853; 95% CI, 0.809–0.899), multivariate logistic regression model with propensity score as a covariate (adjusted OR 0.874; 95% CI, 0.831–0.919) and propensity score matching (crude OR 0.875; 95% CI, 0.818–0.936).

Table 3 shows the proportion of patients with an unfavorable outcome in the total cohort and propensity score-matched cohort by age group. Among children, the proportion of patients with an unfavorable outcome was 18.5% (298/1618) in those with telephone triage service and 4.0% (9101/46493) in those without telephone triage service. The univariate logistic regression model (crude OR 0.931; 95% CI, 0.819–1.058) and propensity score matching model (crude OR 1.074; 95% CI, 0.897–1.286) showed no relationship between telephone triage and unfavorable outcome, but the telephone triage service was associated with unfavorable outcome in the multivariable logistic regression model (adjusted OR 1.187; 95% CI, 1.039–1.357) and logistic regression model with propensity score as a covariate (adjusted OR 1.169; 95% CI, 1.026–1.331). Among adults, the proportion of patients with an unfavorable outcome was 22.5% (911/4406) in those with telephone triage service and 28.2% (79596/282519) in those without telephone triage service. The crude OR was 0.819 (95% CI, 0.736–0.906) in the propensity score-matched cohort. Among the elderly, the proportion of patients with an unfavorable outcome was 46.7% (1096/2349) in those with telephone triage service and 56.4% (208904/370454) in those without telephone triage service. The crude OR was 0.789 (95% CI, 0.704–0.885) in the propensity score-matched cohort.

Table 4 shows the outcomes of hospitalized patients transported by ambulance at 21 days after hospitalization. In the propensity score-matched cohort, of the 2232

hospitalized patients who used the telephone triage service, 363 patients (16.2%) remained hospitalized, 1731 patients (77.6%) were discharged home, and 41 patients (1.8%) died. In contrast, of the 2441 hospitalized patients who did not use the telephone triage service, 479 patients (19.6%) remained hospitalized, 1759 (72.1%) were discharged home, and 86 patients (3.5%) died.

Discussion

To the best of our knowledge, this is the first report to show the impact of a telephone triage service on the outcomes of patients transported to the emergency department by ambulance. We found that use of the telephone triage service for emergency patients, which was introduced in an urban area of Japan, was associated with a low proportion of unfavorable outcomes among patients transported by ambulance. In subgroup analyses, the telephone triage service was associated with a lower proportion of unfavorable outcomes in adults and the elderly but not in children. By using population-based data to evaluate the impact of the telephone triage service on the outcomes of emergency patients, this study may be useful for improving EMS systems around the world.

First, in this study, the proportion of unfavorable outcomes was lower in patients transported to hospitals who used the telephone triage service than in those transported who did not use it. In general, patients are not aware of the moment when they develop a disease. For example, patients with bacterial pneumonia are not aware of the moment of bacterial infection, and patients with cerebral infarction may not be aware of the moment of vascular occlusion. In fact, patients recognize the change in their physical condition only when they experience symptoms such as fever or hemiplegia. After that, they take the next action of visiting a medical institution or calling for ambulance to receive treatment. It is already known that the time from the onset of illness to visiting a medical institution and therapeutic intervention affects the prognosis of patients with various emergency illnesses [24–26]. However, people may be hesitant to take the next step due to lack of transportation to medical facilities or

Table 4 Outcome of emergency patients transported by ambulance at 21 days after hospital admission

| | Total | Telephone triage service used | Telephone triage service not used |
|-----------------------------------|-----------------|-------------------------------|-----------------------------------|
| All patients | (N=284694) | (N=2232) | (N=282462) |
| Continuation to hospitalization | 81 769 (28.7%) | 363 (16.2%) | 81 406 (28.8%) |
| Hospital discharge | 170 557 (59.9%) | 1731 (77.6%) | 168 826 (59.8%) |
| Inter-hospital transfer | 13 425 (4.7%) | 84 (3.8%) | 13 341 (4.7%) |
| Death | 15 605 (5.5%) | 41 (1.8%) | 15 564 (5.5%) |
| Unknown | 3338 (1.2%) | 13 (0.6%) | 3325 (1.2%) |
| Propensity score-matched patients | (N=4673) | (N=2232) | (N=2441) |
| Continuation to hospitalization | 842 (18.0%) | 363 (16.2%) | 479 (19.6%) |
| Hospital discharge | 3490 (74.7%) | 1731 (77.6%) | 1759 (72.1%) |
| Inter-hospital transfer | 177 (3.8%) | 84 (3.8%) | 93 (3.8%) |
| Death | 127 (2.7%) | 41 (1.8%) | 86 (3.5%) |
| Unknown | 37 (0.8%) | 13 (0.6%) | 24 (1.0%) |

fear of calling for an ambulance. In the telephone triage service, a triage nurse uses software to determine the urgency of symptoms via telephone and then arranges for an ambulance or provides advice on the patient's condition. As this is a public service that people can use simply by calling for free, they may be less reluctant to use it than to call for an ambulance or visit a medical institution on their own. As a result, patients with high urgency who required ambulance dispatch may have been able to receive medical care at an earlier stage, before they became seriously ill. This may have led to improve outcomes not only in the emergency department but also in the hospitalized patients.

Second, the telephone triage service was associated with better outcomes in adults and the elderly but not in children. This difference may be due to differences in the pathology of each age group. In a previous study, the most common condition in patients of age 0–5 years transported by ambulances via telephone triage was febrile convulsions, whereas it was cerebral infarction in adults and the elderly [10]. Children may be less likely to suffer serious injuries and illnesses that require hospitalization than adults and the elderly. Therefore, the effects of a telephone triage service may be less evident in children than in adults or the elderly.

The present propensity score-matched analysis showed a favorable outcome in that the proportion of patients who died or remained in the hospital was lower in those using the telephone triage service than in those not using it. This result may be linked to a reduction in medical costs. However, as no data on medical costs and salaries are included in the present study, we will evaluate the effect of the telephone triage service on the reduction of medical costs by using indicators such as quality-adjusted life years and incremental cost-effective ratios in the future.

This study has several limitations. First, we did not adjust for the patients' medical history and medications in this study. Second, we did not evaluate the difference made by use of the telephone triage service between more urgent conditions such as stroke and acute myocardial infarction and other conditions. We are currently evaluating the effects of telephone triage service in individual conditions such as stroke and acute coronary syndrome and will publish the results of our study in the future. Third, the outcome of cases for which no ambulance was dispatched as a result of the telephone triage service is unknown. In particular, a previous study already revealed the compliance of callers who were not following advice given after using telephone triage services [27], and these effects will be evaluated in the future. Fourth, in this study, we included only patients who used telephone triage service and whose data were merged. So, there is a selection bias that excluded patients whose data were not merged. Fifth, we adjusted for the level of consciousness, but not for other factors such as blood pressure, pulse

rate, and patient's chief complaints. Hence, the effect of telephone triage service is not fully revealed in urgent patients such as those with shock. Finally, because this study was an observational study, there may be unknown confounding factors in this study.

In conclusion, we found that the use of a telephone triage service was associated with better outcomes of patients transported by ambulance, especially among adults and the elderly.

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Conflicts of interest

There are no conflicts of interest.

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