Incidence and mortality of patients transported by ambulance during the first surge of the COVID-19 pandemic in Osaka Prefecture, Japan

Yusuke Katayama (orion13@hp-emerg.med.osaka-u.ac.jp)
Osaka University
Kenta Tanaka
Osaka University
Tetsuhisa Kitamura
Osaka University
Taro Takeuchi
Osaka University
Shota Nakao
Rinku General Medical Center
Masahiko Nitta
Osaka Medical College
Taku Iwami
Kyoto University
Satoshi Fujimi
Osaka Prefectural Medical Center
Toshifumi Uejima
Kindai University
Yuuji Miyamoto
Otemae Hospital
Takehiko Baba
Baba Memorial Hospital
Yasumitsu Mizobata
Osaka City University
Yasuyuki Kuwagata
Kansai Medical University
Takeshi Shimazu
Osaka University
Tetsuya Matsuoka
Rinku General Medical Center

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Abstract

Background; Novel corona virus (COVID-19) outbreaks have spread worldwide. Although the COVID-19 pandemic affects the emergency medical service (EMS) system, which is one factor of primary care, little is known about its impact. This study aimed to reveal the impact of the COVID-19 pandemic on the EMS system and outcome of patients transported by ambulance.

Methods; This was a retrospective study with a study period from 1 January 2020 to 31 May 2020. We included patients transported by ambulance who were registered in a population-based registry of patients transported by ambulance. The endpoints of this study were the incident number of patients transported by ambulance each month and the number of deaths among these patients admitted to hospital each month. We calculated the incidence rate ratio (IRR) and 95% confidence interval (CI) using a Poisson regression model with year 2019 as the reference.

Results; From January to May 2019, 205,195 patients were transported, whereas from January to May 2020, 180,362 patients were transported, indicating a significant decrease in the number of emergency patients transported by ambulance (IRR: 0.88, 95% CI: 0.87–0.88). The number of deaths among emergency patients admitted to hospital was 5237 in January-May 2019 and remained unchanged at 5172 in January-May 2020 (IRR: 0.99, 95% CI: 0.95–1.03).

Conclusion; The first surge of the COVID-19 pandemic had no adverse effect on the EMS system in Osaka Prefecture, Japan.

1. Introduction

Outbreaks of infection by novel corona virus (COVID-19), which was confirmed in Wuhan, China in December 2019, have spread not only in China but also around the world. In Japan, the number of patients with COVID-19 exceeded 120,000 on 19 November 2020.[1] The characteristics of COVID-19 are that some of its symptoms, such as fever, cough, sore throat, and general malaise, are common with other upper respiratory tract infections, and some patients are asymptomatic.[2] However, severely affected patients, which account for approximately 20% of the patients with COVID-19, require intensive treatment such as ventilators and extracorporeal membrane oxygenation.

As the number of patients with COVID-19 increased especially in Europe and United States, the number of health care workers infected with COVID-19 also increased, placing aspects of the health care system such as emergency medicine and intensive care into a worldwide state of crisis.[3] The health care system in Japan is funded by public health insurance, and the emergency medical service (EMS) system, which handles all ambulance calls, is a free public service.[4] However, the impact of the COVID-19 pandemic on the EMS system has not been fully revealed, and little is known about the pandemic's impact on the incident number of emergency patients transported by ambulance and the number of deaths among emergency patients admitted to hospital.

Osaka Prefecture is the largest metropolitan area in western Japan, with a population of 8.8 million. The annual number of ambulance calls is about 500,000 in this area, and that of patients transported to hospital by ambulance is about 200,000.[5] After the first patient in Osaka Prefecture was confirmed to have COVID-19 on 23 January 2020, the cumulative number of patients with COVID-19 in the prefecture rose to 1732 by 31 May, which was considered the first surge of COVID-19.[6] At that time, we revealed the influence of the COVID-19 pandemic on the EMS system in Osaka city.[7] The purpose of the present study was to determine the impact of the COVID-19 pandemic on the incident number of emergency patients transported by ambulance and the number of deaths among emergency patients admitted to hospital.

2. Materials And Methods

2.1 Study design and settings

This was a retrospective descriptive study with a study period from 1 January 2020 to 31 May 2020. We included patients transported by ambulance whose cleaned data was recorded in the ORION (Osaka emergency information Research Intelligent Operation Network) system. Therefore, we excluded patients who were not registered in the ORION system or who had missing data.

In 2019, 8,823,452 people lived in the 1905-km^2 area of Osaka Prefecture.[8] Of that population, 4,235,996 people (48.0%) were male, and 2,382,016 people (27.0%) were elderly, aged 65 years old or more. ORION data are considered administrative records and the ORION data is anonymized without specific personal data, such as patient name, date of birth, and address.

Therefore, the requirement of obtaining patient informed consent was waived.
This study was approved by the Ethics Committee of Osaka University Graduate School of Medicine (approval no.
15003). This manuscript was written based on the STROBE statement to assess the reporting of cohort and cross-sectional studies.[9] All methods in this study have ben carried out in accordance with the declaration of Helsinki.

2.2 COVID-19 pandemic in Osaka Prefecture

We previously revealed the characteristics and outcome of patients with COVID-19 in Osaka Prefecture.[6] Those patients in Osaka Prefecture suspected of having COVID-19 based on their medical and travel history were transferred to a hospital that specializes in the management of COVID-19 for PCR testing. When a COVID-19 outbreak was reported in places such as bars and live music venues, the staff in each public health centre in charge followed up on the people involved, and data on the individuals with positive PCR test results were collected to determine whether they were asymptomatic. All patients with positive PCR test results for COVID-19 were reported to the public health centres in accordance with the Infectious Disease Control Law.[10] In Osaka Prefecture, the first patient with COVID-19 was identified on 23 January, and by 31 May, 31,152 PCR tests had been conducted and the number of patients with

COVID-19 was 1782. In Japan, due to an increase in the number of patients with COVID-19, the Japanese government declared a state of emergency based on the Law on 7 April 2020.

2.3 EMS system and hospitals in Osaka Prefecture and Japan

The EMS system is basically the same as that used in other areas of Japan, as previously described.[4] In Osaka Prefecture, EMS systems such as ambulance dispatch systems are operated by each local government, and ambulances are dispatched by calling 1-1-9. In 2019, the EMS system was operated by 27 fire departments (242 ambulances) and 24 fire control stations.[11] In 2016, there were 523 medical institutions (107,005 beds) in Osaka Prefecture,[12] of which 288 are emergency medical hospitals including 16 critical care centres that are designated to accept patients with life-threatening emergency diseases such as severe trauma and sepsis. Since the introduction of the ORION system, EMS personnel at the scene have selected the appropriate hospital for emergency patients rather than a dispatcher.

2.4 ORION system

Information on the system configuration of ORION was previously described in detail.[5, 13] The EMS personnel at the scene operate the ORION smartphone app for each emergency patient. All of the data input into the cell phone app, such as vital signs and time of the call to the hospital for acceptance, are also recorded. The cell phone app data are accumulated in the ORION cloud server, and in cooperation with the dispatched EMS personnel, data managers at each fire department directly input or upload the ambulance record of each emergency patient so that it can be connected with the app data. Furthermore, the operators of each hospital also directly input or upload the patient's hospital data, such as diagnoses and outcomes, after hospital acceptance. The results of aggregated data in the ORION system are fed back to every fire department and emergency hospital. The Department of Public Health of Osaka Prefecture can also analyse the effects of health policy on the emergency medical system using these collected data. The ORION system has been in place in all fire departments and emergency hospitals in Osaka Prefecture since January 2016.

2.5 Data collection and quality control

The ORION system checks for errors in the input in-hospital data, and the staff of each emergency hospital can correct them, if necessary. Through these tasks, cell phone app data, ambulance records, and the in-hospital data such as diagnosis and prognosis can be comprehensively registered for each patient transported by an ambulance. The registered data are cleaned by the Working Group to analyze the emergency medical care system in Osaka Prefecture. Among the collected and cleaned data, we excluded inconsistent data that did not contain all of the cell phone app data, ambulance records, and in-hospital data such as diagnosis and prognosis. In addition, we also excluded patients whose sex as registered by the fire department did not match that registered by the hospital or whose sex identifier was missing. We also excluded patients whose age input by the fire department and that by the hospital differed by 3 years or more. When this difference was present, we defined the age input by the hospital as the patient's true age.[5]

2.6 Endpoints

The primary endpoints of this study were the incident number of patients transported by ambulance in each month of the study period, and the number of deaths among emergency patients admitted to hospital in each month.

2.7 Statistical analysis

First, we calculated the number of patients transported by ambulance by reason for ambulance call on a monthly basis from January to May 2020. As a control, we calculated the same data on a monthly basis from January to May 2019. Reason for ambulance call was divided into 'fire accident', 'natural disaster', 'water accident', 'traffic accident involving car, ship, or aircraft', 'injury, poisoning, and disease due to industrial accident', 'disease and injury due to sports', 'other injury', 'trauma due to assault', 'acute disease', 'interhospital transport', and 'others'.[5,13] To evaluate the impact of the COVID-19 pandemic on the EMS system, we calculated the incidence rate of the number of emergency patients transported by ambulance. We also calculated the incidence rate ratio (IRR) and its 95% confidence interval (CI) using a Poisson regression model with the year 2019 as the reference. We categorized the patients by age group (children [0–19 years old], adult [20–64 years old], and elderly [65 years old and over]) and also calculated their respective IRR and 95% CI values. Next, we calculated the number of deaths among emergency patients admitted to hospital by reason for ambulance call in each month, and similarly calculated the IRR and its 95% CI values. The offset for calculating the IRR was set to the population of Osaka Prefecture in 2019 (8,823,452 people).[8] The death of emergency patients admitted to hospital was defined from the outcome at 21 days after hospital admission. In addition, in a subgroup analysis, we selected the patients transported by ambulance whose reason for ambulance call was 'acute disease' and similarly calculated the IRR and 95% CI values. Statistical analyses were performed using STATA version 16.0 MP software (StataCorp LP, College Station, TX, USA).

3. Results

Figure 1 shows the patient flow in this study. Among the 180,362 patients registered in the ORION registry from January to May 2020, 77,735 patients were hospitalised, and 5172 patients were dead at 21 days after hospital admission. In contrast, among the 205,195 patients registered in the ORION system from January to May 2019, 83,851 patients were hospitalised, and 5237 patients were dead at 21 days after hospital admission.

Table 1 shows the number of emergency patients transported by ambulance and the IRR (95% CI) for each month during study period. The number of emergency patients transported by ambulance from January to May 2020 (n = 180,362) was significantly decreased from that transported from January to May 2019 (n = 205,195) (IRR: 0.88, 95% CI: 0.87–0.88). The most common reason for an ambulance call was 'acute disease' for 34,230 patients in 2019 and 30,849 patients in 2020. During the study period, the reasons for an ambulance call for which the number of emergency patients transported by ambulance decreased were 'traffic accident involving car, ship, or aircraft' (IRR: 0.82, 95% CI: 0.80–0.84), 'injury, poisoning, and disease due to industrial accident' (IRR: 0.79, 95% CI: 0.73–0.85), 'disease and injury due to sport' (IRR: 0.37, 95% CI: 0.33–0.42), 'other injury' (IRR: 0.92, 95% CI: 0.90–0.93), 'trauma due to assault’ (IRR: 0.91, 95% CI: 0.84–0.99), ‘acute disease’ (IRR: 0.88, 95% CI: 0.87–0.89), and ‘interhospital transport’ (IRR: 0.87, 95% CI: 0.85–0.90). By month, the greatest decrease in the number of emergency patients transported by ambulance was in April (IRR: 0.77, 95% CI: 0.76–0.78), followed by May (IRR: 0.78, 95% CI: 0.77–0.79). In the subgroup analysis by age group, the number of emergency patients transported by ambulance decreased among children during study period (IRR: 0.88, 95% CI: 0.87–0.88). However, for adults and the elderly, the number of emergency patients transported by ambulance decreased after March 2020 compared to that in 2019.

Table 1
The number of emergency patients registered in the Osaka Emergency Information Research Intelligent Operation Network System

Reason for ambulance call		January	February	March	April	May	Total
Fire accident	2019	61	38	43	37	37	216
	2020	59	45	31	23	33	191
	IRR	0.97	1.18	0.72	0.62	0.89	0.88
	(95%CI)	(0.66–1.41)	(0.75–1.87)	(0.44–1.17)	(0.35–1.07)	(0.54–1.47)	(0.72–1.08)
Natural disaster	2019	0	0	0	0	0	0
	2020	8	0	0	0	0	8
	IRR	NA	NA	NA	NA	NA	NA
	(95%CI)	NA	NA	NA	NA	NA	NA
Water accident	2019	5	3	6	2	2	18
	2020	3	4	2	6	3	18
	IRR	0.60	1.33	0.33	3.00	1.50	1.00
	(95%CI)	(0.09–3.08)	(0.23–9.10)	(0.03–1.86)	(0.54–30.39)	(0.17–17.96)	(0.49–2.04)
Traffic accident involving car, ship, or aircraft	2019	2,620	2,510	2,997	3,248	3,026	14,401
	2020	2,632	2,574	2,672	1,887	2,097	11,862
	IRR	1.00	1.03	0.89	0.58	0.69	0.82
	(95%CI)	(0.95–1.06)	(0.97–1.08)	(0.85–0.94)	(0.55–0.62)	(0.66–0.73)	(0.80–0.84)
Injury, poisoning, and disease due to industrial accident	2019	348	321	370	365	374	1778
	2020	279	317	274	282	250	1402
	IRR	0.80	0.99	0.74	0.77	0.67	0.79
	(95%CI)	(0.68–0.94)	(0.84–1.16)	(0.63–0.87)	(0.66–0.90)	(0.57–0.79)	(0.73–0.85)
Disease and injury due to sport	2019	135	166	232	232	252	1017
	2020	142	144	50	23	16	375
	IRR	1.05	0.87	0.22	0.10	0.06	0.37
	(95%CI)	(0.82–1.34)	(0.69–1.09)	(0.16–0.29)	(0.06–0.15)	(0.04–0.11)	(0.33–0.42)

Reason for ambulance call		January	February	March	April	May	Total
Other injury	2019	7,116	5,753	6,317	6,401	6,157	31,744
	2020	6,931	6,140	5,911	5,001	5,169	29,152
	IRR	0.97	1.07	0.94	0.78	0.84	0.92
	(95%CI)	(0.94–1.01)	(1.03–1.11)	(0.90–0.97)	(0.75–0.81)	(0.81–0.87)	(0.90–0.93)
Trauma due to assault	2019	268	207	232	232	224	1163
	2020	251	221	228	170	190	1060
	IRR	0.94	1.07	0.98	0.73	0.85	0.91
	(95%CI)	(0.79–1.12)	(0.88–1.30)	(0.81–1.18)	(0.60–0.90)	(0.70–1.03)	(0.84–0.99)
Self-induced injury	2019	197	195	245	216	254	1107
	2020	265	217	250	183	250	1165
	IRR	1.35	1.11	1.02	0.85	0.98	1.05
	(95%CI)	(1.11–1.63)	(0.91–1.36)	(0.85–1.22)	(0.69–1.04)	(0.82–1.18)	(0.97–1.14)
Acute disease	2019	34,240	25,757	26,545	26,371	27,525	140,438
	2020	30,849	25,615	24,168	21,291	21,587	123,510
	IRR	0.90	0.99	0.91	0.81	0.78	0.88
	(95%CI)	(0.89–0.91)	(0.98–1.01)	(0.89–0.93)	(0.79–0.82)	(0.77–0.80)	(0.87–0.89)
Interhospital transport	2019	2,897	2,445	2,626	2,732	2,553	13,253
	2020	2,895	2,449	2,360	1,918	1,951	11,573
	IRR	1.00	1.00	0.90	0.70	0.76	0.87
	(95%CI)	(0.95–1.05)	(0.95–1.06)	(0.85–0.95)	(0.66–0.74)	(0.72–0.81)	(0.85–0.90)
Other	2019	14	9	13	11	13	60
	2020	9	7	8	11	11	46
	IRR	0.64	0.78	0.62	1.00	0.85	0.77
	(95%CI)	(0.25–1.59)	(0.25–0.35)	(0.22–1.60)	(0.39–2.54)	(0.34–2.05)	(0.51–1.14)
Total	2019	47,901	37,404	39,626	39,847	40,417	205,195

Reason for ambulance call		January	February	March	April	May	Total
	2020	44,323	37,733	35,954	30,795	31,557	180,362
	IRR	0.93	1.01	0.91	0.77	0.78	0.88
	(95%CI)	(0.91–0.94)	(0.99–1.02)	(0.89–0.92)	(0.76–0.78)	(0.77–0.79)	(0.87–0.88)
Children aged 0–19 years old	2019	5,108	3,603	3,937	4,407	4,565	21,620
	2020	4,198	3,211	2,762	2,262	2,287	14,720
	IRR	0.82	0.89	0.70	0.51	0.50	0.68
	(95%CI)	(0.79–0.86)	(0.85–0.93)	(0.67–0.74)	(0.49–0.54)	(0.48–0.53)	(0.67–0.70)
Adults aged 20–64 years old	2019	13,926	11,520	12,826	12,783	13,120	64,175
	2020	13,442	11,617	11,614	10,001	10,402	57,076
	IRR	0.97	1.01	0.91	0.78	0.79	0.89
	(95%CI)	(0.94–0.99)	(0.98–1.03)	(0.88–0.93)	(0.76–0.80)	(0.77–0.81)	(0.88–0.90)
Elderlies aged > = 65 years old	2019	28,867	22,281	22,863	22,657	22,732	119,400
	2020	26,683	22,905	21,578	18,532	18,868	108,566
	IRR	0.92	1.03	0.94	0.82	0.83	0.91
	(95%CI)	(0.91–0.94)	(1.01–1.05)	(0.93–0.96)	(0.80–0.83)	(0.81–0.85)	(0.90–0.92)
IRR: incident rate ratio, CI: confidence interval, NA: not assessment.							
IRR is for 2020 versus 2019.							

Table 2 shows the number of deaths among emergency patients admitted to hospital and the IRR (95% CI) for each month. The number of deaths among emergency patients admitted to hospital was 5237 in January-May 2019 and remained essentially unchanged at 5172 in January-May 2020 (IRR: 0.99, 95% CI: 0.95–1.03). There was no statistically significant change in the number of deaths among emergency patients admitted to hospital for each reason for an ambulance call between 2019 and 2020, and no statistically significant differences were identified between 2019 and 2020 for each month. In subgroup analysis by age group, there was no increase of the number of deaths of emergency patients admitted to hospital among children (IRR: 0.84, 95% CI: 0.45–1.09), adults (IRR: 0.93, 95% CI: 0.83–1.04), and the elderly (IRR: 1.00, 95% CI: 0.96–1.04).

Table 2
The number of death among hospitalized emergency patients registered in the ORION system

Reason for ambulance call		January	February	March	April	May	Total
Fire accident	2019	3	1	0	2	2	8
	2020	4	3	1	1	1	10
	IRR	1.33	3.00	NA	0.50	0.50	1.25
	(95%CI)	(0.23–0.910)	(0.24-157.49)	NA	(0.01–9.60)	(0.01–9.60)	(0.44–3.64)
Natural disaster	2019	0	0	0	0	0	0
	2020	0	0	0	0	0	0
	IRR	NA	NA	NA	NA	NA	NA
	(95%CI)	NA	NA	NA	NA	NA	NA
Water accident	2019	0	0	0	0	1	1
	2020	0	0	0	1	0	1
	IRR	NA	NA	NA	NA	NA	1.00
	(95%CI)	NA	NA	NA	NA	NA	(0.01–78.50)
Traffic accident involving car, ship, or aircraft	2019	8	7	9	11	7	42
	2020	8	8	13	6	7	42
	IRR	1.00	1.14	1.44	0.55	1.00	1.00
	(95%CI)	(0.33–3.06)	(0.36–3.70)	(0.57–3.83)	(0.17–1.61)	(0.30–3.34)	(0.64–1.57)
Injury, poisoning, and disease due to industrial accident	2019	2	0	1	0	3	6
	2020	3	1	0	4	0	8
	IRR	1.50	NA	NA	NA	NA	1.33
	(95%CI)	(0.17–17.96)	NA	NA	NA	NA	(0.41–4.66)
Disease and injury due to sport	2019	0	1	0	0	0	1
	2020	1	0	0	0	0	1
	IRR	NA	NA	NA	NA	NA	1.00
	(95%CI)	NA	NA	NA	NA	NA	(0.01–78.50)

Reason for ambulance call		January	February	March	April	May	Total
Other injury	2019	73	57	33	50	36	249
	2020	61	41	47	36	35	220
	IRR	0.84	0.72	1.42	0.72	0.97	0.88
	(95%CI)	(0.58–1.19)	(0.47–1.09)	(0.89–2.29)	(0.46–1.13)	(0.59–1.59)	(0.73–1.06)
Trauma due to assault	2019	0	0	0	2	0	2
	2020	0	1	0	0	0	1
	IRR	NA	NA	NA	NA	NA	0.50
	(95%CI)	NA	NA	NA	NA	NA	(0.01–9.60)
Self-induced injury	2019	8	6	7	15	13	49
	2020	8	10	11	8	11	48
	IRR	1.00	1.67	1.57	0.53	0.85	0.98
	(95%CI)	(0.33–3.06)	(0.55–5.58)	(0.56–4.78)	(0.20–1.34)	(0.34–2.05)	(0.64–1.49)
Acute disease	2019	1,112	829	870	770	767	4,348
	2020	1,028	911	880	753	742	4,314
	IRR	0.92	1.10	1.01	0.98	0.97	0.99
	(95%CI)	(0.85–1.01)	(1.00-1.21)	(0.92–1.11)	(0.88–1.08)	(0.87–1.07)	(0.95–1.04)
Interhospital transport	2019	119	117	86	110	98	530
	2020	138	92	104	97	93	524
	IRR	1.16	0.79	1.21	0.88	0.95	0.99
	(95%CI)	(0.90–1.49)	(0.59–1.04)	(0.90–1.63)	(0.66–1.17)	(0.71–1.27)	(0.87–1.12)
Other	2019	0	0	0	1	0	1
	2020	0	1	0	0	2	3
	IRR	NA	NA	NA	NA	NA	3.00
	(95%CI)	NA	NA	NA	NA	NA	(0.24-157.49)
Total	2019	1,325	1,018	1,006	961	927	5,237

Reason for ambulance call		January	February	March	April	May	Total
	2020	1,251	1,068	1,056	906	891	5,172
	IRR (95% CI)	0.94	1.05	1.05	0.94	0.96	0.99
	(95%CI)	(0.87–1.02)	(0.96–1.14)	(0.96–1.15)	(0.86–1.03)	(0.88–1.05)	(0.95–1.03)
Children aged 0–19 years old	2019	9	2	4	7	3	25
	2020	5	8	4	3	1	21
	IRR (95% CI)	0.56	4.00	1.00	0.43	0.33	0.84
	(95%CI)	(0.15–1.85)	(0.80-38.67)	(0.19–5.37)	(0.07–1.88)	(0.01–4.15)	(0.45–1.56)
Adults aged 20–64 years old	2019	173	115	123	122	110	643
	2020	155	111	114	124	94	598
	IRR (95% CI)	0.90	0.97	0.93	1.02	0.85	0.93
	(95%CI)	(0.72–1.12)	(0.74–1.26)	(0.71–1.21)	(0.79–1.32)	(0.64–1.14)	(0.83–1.04)
Elderlies aged > = 65 years old	2019	1,143	901	879	832	814	4,569
	2020	1,091	949	938	779	796	4,553
	IRR (95% CI)	0.95	1.05	1.07	0.94	0.98	1.00
	(95%CI)	(0.88–1.04)	(0.96–1.16)	(0.97–1.17)	(0.85–1.03)	(0.89–1.08)	(0.96–1.04)
IRR: incident rate ratio, CI: confidence interval, NA: not assessment.							
IRR is for 2020 versus 2019.							

Table 3 shows the number of emergency patients transported by ambulance due to acute disease by age group and the IRR (95% CI) for each month during the study period. The number of paediatric patients transported by ambulance during the study period significantly decreased (13,164 patients in January-May 2019 vs 8483 patients in January-May 2020; IRR: 0.64, 95% CI: 0.63–0.66). The number of adult patients transported by ambulance also significantly decreased (42,746 patients in January-May 2019 vs

38,671 patients in January-May 2020, IRR: 0.90, 95% CI: 0.89–0.92), as did that of the elderly patients transported by ambulance (84,528 patients in January-May 2019 vs 76,356 patients in January-May 2020, IRR: 0.90, 95% CI: 0.89–0.91).

Table 3
The number of emergency patients for acute disease registered in the ORION system

Acute disease		January	February	March	April	May	Total
Childen aged 0–19 years old	2019	3,629	2,273	2,219	2,451	2,592	13,164
	2020	2,837	1,968	1,496	1,158	1,024	8,483
	IRR	0.78	0.87	0.67	0.47	0.40	0.64
	(95%CI)	(0.74–0.82)	(0.81–0.92)	(0.63–0.72)	(0.44–0.51)	(0.37–0.42)	(0.63–0.66)
Adults aged 20–64 years old	2019	9,748	7,644	8,369	8,266	8,719	42,746
	2020	9,235	7,656	7,615	7,002	7,163	38,671
	IRR	0.95	1.00	0.91	0.85	0.82	0.90
	(95%CI)	(0.92–0.97)	(0.97–1.03)	(0.88–0.94)	(0.82–0.87)	(0.80–0.85)	(0.89–0.92)
Elderlies aged > = 65 years old	2019	20,863	15,840	15,957	15,654	16,214	84,528
	2020	18,777	15,991	15,057	13,131	13,400	76,356
	IRR	0.90	1.01	0.94	0.84	0.83	0.90
	(95%CI)	(0.88–0.92)	(0.99–1.03)	(0.92–0.96)	(0.82-.86)	(0.81–0.85)	(0.89–0.91)
IRR: incident rate ratio, CI: confidence interval.							
IRR is for 2020 versus 2019.							

Table 4 shows the number of deaths among emergency patients admitted to hospital due to acute disease by age group and IRR (95% CI) for each month. The number of deaths among emergency paediatric patients admitted to hospital due to acute disease was 11 in January-May 2019 and 11 in January-May 2020 (IRR: 1.00, 95% CI: 0.39–2.54). The number of deaths among emergency adult patients admitted to hospital due to acute disease was 509 in January-May 2019 and 469 in January-May 2020 (IRR: 0.92, 95% CI: 0.81–1.05), and that among emergency elderly patients admitted to hospital due to acute disease was 3828 in January-May 2019 and 3834 in January-May 2020 (IRR: 1.00, 95% CI: 0.96–1.05). No statistically significant differences were identified between 2019 and 2020 for each month or by age group.

Table 4
The number of death among hospitalized emergency patients for acute disease registered in the ORION system

Acute disease		January	February	March	April	May	Total
Childen aged 0–19 years old	2019	4	2	1	2	2	11
	2020	4	2	2	2	1	11
	IRR	1.00	1.00	2.00	1.00	0.50	1.00
	(95%CI)	(0.19–5.37)	(0.07–13.80)	(0.10-117.99)	(0.07–13.80)	(0.01–9.60)	(0.39–2.54)
Adults aged 20–64 years old	2019	143	84	107	96	79	509
	2020	124	89	87	94	75	469
	IRR	0.87	1.06	0.81	0.98	0.95	0.92
	(95%CI)	(0.68–1.11)	(0.78–1.44)	(0.61–1.09)	(0.73–1.32)	(0.68–1.32)	(0.81–1.05)
Elderlies aged > = 65 years old	2019	965	743	762	672	686	3,828
	2020	900	820	791	657	666	3,834
	IRR	0.93	1.10	1.04	0.98	0.97	1.00
	(95%CI)	(0.85–1.02)	(1.00-1.22)	(0.94–1.15)	(0.88–1.09)	(0.87–1.08)	(0.96–1.05)
IRR: incident rate ratio, CI: confidence interval.							
IRR is for 2020 versus 2019.							

4. Discussion

In this study, we used data from a large population-based patient registry to determine the number of emergency patients transported by ambulance and the number of deaths among these patients admitted to hospital in the first surge of the COVID-19 pandemic in Osaka Prefecture. Although the number of emergency patients transported by ambulance decreased in 2020 compared with 2019, the number of deaths among the emergency patients admitted to hospital in 2020 was similar to that in 2019. The results of this study, which used population-based data to reveal the impact of an emerging infectious disease pandemic on the EMS system, could be useful to plan health care systems and policies.

The number of emergency patients transported by ambulance decreased in 2020 compared with 2019, especially from March to May. As well, the number of emergency patients transported by ambulance due to acute disease as the reason for the ambulance call also decreased, especially in April and May. A previous study in Venice, northern Italy, comparing the number of ambulance dispatches in 2019 and 2020 found that the COVID-19 pandemic reduced the number of ambulance dispatches in 2020.[14] It was also reported that the number of emergency department visits decreased during the severe acute respiratory syndrome (SARS) pandemic that spread in 2003.[15–19] Thus, when an infectious disease spreads throughout a city or society, the number of emergency department visits may decrease as a result of people buying medicines from pharmacies for their own care and refraining from visiting the emergency department. In contrast, in Seine-Saint-Denis, which is a French department bordering Paris to the northeast and is a part of Greater Paris, Lapostolle et al. reported that the COVID-19 pandemic increased the number of calls for the Service d'Aide Medicale Urgente (SAMU), the number of mobile intensive care unit (MICU) dispatches, and the number of emergency department visits compared to the average of the previous five years.[20] Although the reason for the differences between their study and the present study is not clear, the SAMU in France provides several medical services that included medical advice, hospital transfer by a non-emergency transport ambulance, dispatch of a rescue vehicle or of a general practitioner to the patient's home or, in severe cases and/or when rapid prehospital care is required, a MICU, with an emergency physician, nurse, and special paramedic on board. Contrastingly, the only service provided by the EMS system in Japan is ambulance dispatch, and the differences in services provided by the SAMU in France versus the EMS system in Japan may have affected the difference in results. Further, Saberian et al. reported an increase in the number of EMS calls and ambulance dispatches after the first COVID-19 patient was identified on 18 February 2020 in Teheran, Iran.[21] The EMS system in Iran is similar to that in Japan in that the EMS personnel evaluate the patient at the scene and, if necessary, transport the patient to a hospital. The difference of results between the study in Japan and that in Iran, which operates a similar EMS system, may be due to the fact that Japanese people who used to call an ambulance even in cases not necessarily requiring an ambulance are now discouraged from visiting hospitals and clinics due the risk of COVID-19.

The number of emergency patients transported by ambulance due to sports injuries, industrial accidents, and traffic accidents also decreased in 2020 compared to 2019. In Japan, the Japanese government requested temporary closures of elementary, junior high, and high schools on 2 March,[22] and the temporary closure of these schools continued until 31 May 2020 in Osaka Prefecture. In addition, many sports gyms have refrained from operating as a result of COVID-19 outbreaks in some of these gyms. As a result of this reduction in opportunities for sports in schools and gyms, the number of emergency patients transported by ambulance due to sports injuries would likely have decreased. In Japan, although no explicit lockdown measures were taken by the government, the number of emergency patients transported by ambulance due to traffic accidents and industrial accidents may have also decreased because of the slowdown in socioeconomic activity due to the voluntary restraint of various companies. Subgroup analyses by age group showed a decrease in patients transported by ambulance among children starting in January and a decrease in patients transported by ambulance among adults and elderly after March. This result may be due to parents being less likely to visit the emergency department due to vigilance against an unknown infectious disease. In addition, as a result of school closures, they may not have visited emergency departments as a result of fewer cases of seasonal influenza in their children.

There was no change in the number of deaths among emergency patients admitted to hospital in 2020 compared with 2019. There were also no differences in the number of deaths among emergency patients admitted to hospital in the analyses by reason for ambulance call or by age group. Additionally, there were concerns that other acute illnesses might affect the prognosis of emergency elderly patients. However, no impact on their prognosis was identified in this study because the health care system and EMS system functioned effectively for the community as a whole. To maintain the level of medical treatment in future surges of the COVID-19 pandemic and other infectious disease pandemics, it will be necessary to establish a medical and health care system with a clear role for medical institutions.

This study has several limitations. First, although all fire departments and emergency medical institutions in Osaka Prefecture registered ambulance records and patient data in the ORION registry, the prognosis of patients transported to medical institutions outside Osaka Prefecture or by fire departments outside Osaka Prefecture is unknown. Second, no information was available on the detailed treatment of the patients in hospital that would have affected death after hospital admission. Third, although this study was analysed by reason for ambulance call, a detailed analysis of the impact of the COVID-19 pandemic on the EMS system by disease, such as out-of-hospital cardiac arrest, acute coronary syndrome, and pneumonia, will be performed and reported in the near future.

In conclusion, in Osaka Prefecture, Japan, the incidence of emergency patients transported by ambulance decreased during the first surge of the COVID-19 pandemic, but the mortality of emergency patients admitted to hospital did not change. The impact of the COVID-19 pandemic on EMS system will need to be monitored over the long term.

Declarations

Ethics approval and consent to participate

Because the ORION data is anonymized without specific personal data, such as patient name, date of birth, and address, the requirement of obtaining patient informed consent was waived. The Ethics Committee of Osaka University Graduate School of Medicine approved the waiving of the need of informed consent in this study.

Consent for publication

Not applicable.

Availability of data and material

The data that support the findings of this study are available from Osaka Prefectural government but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the Osaka Prefectural government upon reasonable request and with permission of Osaka Prefectural government.

Competing interests

None declared.

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Author contributions

YKatayama, TK, SN, MN, SF, TU, YMiyamoto, TB, YMizobata, Yasuyuki Kuwagata, and TM conceived and designed the study. TI and TS supervised the study.

YKatayama, KT, TK, and TT performed and interpreted the statistical analyses. All authors were involved in data acquisition and analysis. YKatayama, KT, and TK prepared the manuscript and figures, with contributions from all authors.

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Figures

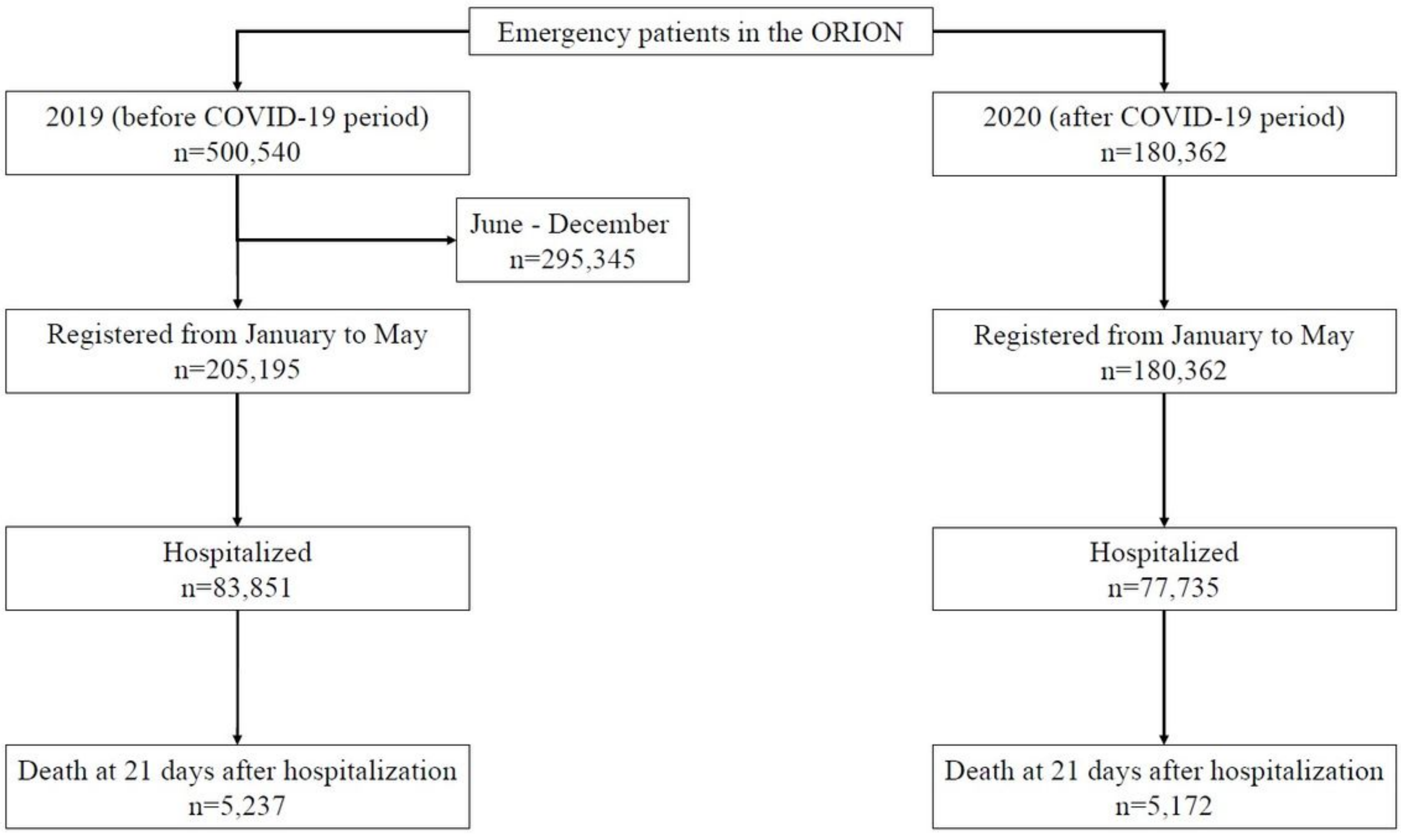

Figure 1

Patient flow in this study.