


Original Article

Impact of non-pharmaceutical interventions for the COVID-19 pandemic on emergency department patient trends in Japan: a retrospective analysis

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Aim: The coronavirus disease (COVID-19) pandemic massively impacted emergency department (ED) visits. The unavailability of specific therapies or vaccines has made non-pharmaceutical interventions (NPIs) an alternative strategy for COVID-19. We assessed the impact of NPIs (nationwide school closures and state of emergency) on ED visits during the COVID-19 pandemic in Japan.

Methods: This retrospective study compared the trends in ED visits from 1 January to 25 May, 2020 (during the pandemic) with the average during 2015–2019 (before the pandemic). The primary end-point was the change in the number of ED visits during the COVID-19 pandemic with those from before the pandemic, with the NPI application stratified across four periods in 2020: Period 0 (1–15 January), no COVID-19 cases detected in Japan; Period I (16 January–1 March), initial COVID-19 outbreak; Period II (2 March–15 April), nationwide school closures; Period III (16 April–25 May), state of emergency.

Results: Compared with before the pandemic, the number of walk-in ED visits significantly decreased by 23.1%, 12.4%, and 24.0% (4,047 versus 3,111; 3,211 versus 2,813; and 3,384 versus 2,573; $P < 0.001$ for all) in Periods I, II, and III, respectively. The number of ambulance ED visits during the pandemic significantly increased by 8.3% in Period I (1,814 versus 1,964, $P = 0.002$), whereas there was no significant change in Periods II and III with 2.7% and $-3.1%$ (1,547 versus 1,589 and 1,389 versus 1,346; $P = 0.335$ and $P = 0.284$, respectively).

Conclusions: The application of an NPI during the COVID-19 pandemic could have significantly reduced patient attendance in the ED.

Key words: COVID-19, emergency department, non-pharmaceutical intervention, severe acute respiratory syndrome coronavirus 2, state of emergency

INTRODUCTION

THE CORONAVIRUS DISEASE (COVID-19) has resulted in an ongoing pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).¹ As this is a new virus that was previously undetected in humans, there is no pre-existing herd immunity. Moreover, as there are no therapeutics or

vaccines available, non-pharmaceutical interventions (NPIs) are reported to be an alternative strategy for COVID-19. Based on the experience in China, social distancing, which is one of the NPIs, could reduce the human-to-human transmission of the novel coronavirus,^{2,3} thereby impeding the spread of COVID-19, and could ultimately help control the number of infections.⁴

In Japan, the first confirmed COVID-19 case was reported on 16 January, 2020. The Japanese government initiated the implementation of outbreak responses and measures for pandemic preparedness, and NPIs, such as social distancing, travel restrictions, and school closures, to curtail the spread of COVID-19. Despite these measures, the number of confirmed COVID-19 cases continued to rise. Therefore, the government declared a state of emergency for all prefectures on 16 April, 2020, which involves a temporary system of

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rules to deal with an extremely dangerous situation, and, consequently, the number of COVID-19 patients and mortality rates have decreased.⁵

Non-pharmaceutical interventions have an enormous impact on people's lives, including hospital visits. To avoid being near others, people must stay at home as much as possible. Furthermore, unless there are relevant symptoms that match the medical history, hospital visits should be avoided because of the risk of contracting the infection following the visit.

Hospital visits for specific conditions have shown varying patterns, and several factors could affect both the positive and negative trends in condition-specific emergency department (ED) visits; nonetheless, the COVID-19 pandemic has had a massive impact on ED visits. Updated information on trends in the ED during the COVID-19 pandemic is useful for the management of COVID-19. Therefore, we aimed to assess the impact of NPIs for the COVID-19 pandemic in patients who visited the ED in Japan.

METHODS

Population and study design

THIS RETROSPECTIVE STUDY included all patients who visited the ED of Shonan Kamakura General Hospital (Kanagawa, Japan) between 1 January and 31 May in 2015, 2016, 2017, 2018, 2019, and 2020. To evaluate whether the application of NPIs for the COVID-19 pandemic influenced the epidemiological patterns in the ED, we compared the number of patients who visited the ED in 2020 (during the pandemic) and the average from 2015 to 2019 (before the pandemic).

Institution

Shonan Kamakura General Hospital is a 629-bed tertiary care hospital in the Kanagawa Prefecture, where the Diamond Princess was berthed.⁶ The ED of our hospital receives 14,754 ambulance visits and 28,895 walk-in visits per year, the highest number of ambulance visits in Japan. The Japan Triage and Acuity Scale (JTAS) is used to assess the urgency of all patients before a doctor examines them. The JTAS is the Japanese version of the Canadian Triage and Acuity Scale, which assigns an acuity level of 1–5 (1 being the most urgent).⁷

The ED patients comprise trauma and non-trauma patients and pediatric cases, which include all pediatric trauma cases regardless of age, non-trauma patients aged 16 years and older, and non-trauma patients up to 15 years of age. All ED patients are examined by emergency physicians, and the

treatment might be provided by physicians from other specialties as needed.

Emergency medical system in Japan

In Japan, there are few family physicians or primary care physicians, and patients who become unwell due to acute illness or trauma are free to visit the ED. The ED of our hospital is open all day, and patients can visit the ED regardless of the type and severity of their condition. In Japan, anyone can call for and make use of the free ambulance service. All adult residents in Japan are covered by Japan's national health insurance program, and patients who visit the ED bear only 10–30% of the total cost of care.

Data sources

The data-gathering process commences when patients arrive at the ED. Information is registered in the medical records by the medical staff who are involved in patient care. For the purposes of this study, the following data were retrieved: patient characteristics, including demographic data, such as age, sex, reasons for visiting the ED, use of ambulance, triage level based on the JTAS, number of admissions, and number of patients with COVID-19 and influenza. The patients were diagnosed clinically or with the rapid antigen test for influenza. The samples of symptomatic patients suggested of having COVID-19 are tested using polymerase chain reaction and loop-mediated isothermal amplification for SARS-CoV-2. From March 2020, in-hospital testing for SARS-CoV-2 was carried out at this study center.

Non-pharmaceutical interventions

The NPIs were gradually enforced as a more rigorous countermeasure by the Japanese government to enable COVID-19 containment. After the first COVID-19 outbreak in Japan, the government enforced mask-wearing, social distancing, and travel restrictions. However, the uncontrolled spread of COVID-19 led to the nationwide closure of schools on 2 March 2020 and the declaration of a state of emergency for all prefectures on 16 April.

Outcome measures

The primary end-point was the change in the number of the patients who visited the ED by ambulance and as walk-ins during the pandemic with the application of NPIs and before the pandemic. The secondary end-point was the change in the rate by the sex, admissions, triage

Table 1. Baseline clinical characteristics of patients visiting an emergency department (ED) in Japan before (2015–2019) and during (1 January–31 May, 2020) the COVID-19 pandemic

	2015	2016	2017	2018	2019	Average	COVID-19 pandemic	P-value: average versus pandemic
All ED visits	19,292	18,366	17,864	18,375	18,881	18,556	16,651	
Ambulance	5,137 (26.6)	5,276 (28.7)	5,558 (31.1)	5,832 (31.7)	6,034 (32.0)	5,567 (30.0)	5,785 (34.7)	<0.001 [†]
Walk-in	14,155 (73.4)	13,090 (71.3)	12,306 (68.9)	12,543 (68.3)	12,847 (68.3)	12,988 (70.0)	10,866 (65.3)	
Age group, years	n (%)							
<1	275 (1.4)	162 (0.9)	201 (1.1)	142 (0.8)	202 (1.1)	196 (1.1)	141 (0.8)	<0.001 [†]
1–17	3,788 (19.6)	3,511 (19.1)	2,918 (16.3)	2,941 (16.0)	3,014 (16.0)	3,234 (17.4)	1,785 (10.7)	
18–64	7,442 (38.6)	6,877 (37.5)	6,535 (36.6)	6,757 (36.8)	6,817 (36.1)	6,886 (37.1)	6,972 (41.9)	
65–84	5,540 (28.7)	5,505 (30)	5,700 (31.9)	5,794 (31.5)	5,897 (31.2)	5,687 (30.7)	5,156 (31.0)	
>85	2,243 (11.6)	2,297 (12.5)	2,510 (14.1)	2,741 (14.9)	2,951 (15.6)	2,548 (13.7)	2,597 (15.6)	
Gender	n (%)							
Male	9,529 (49.4)	9,003 (49.0)	8,772 (49.1)	8,895 (48.4)	9,139 (48.4)	9,058 (48.8)	8,136 (48.9)	0.990 [†]
Female	9,763 (50.6)	9,363 (51.0)	9,139 (50.9)	9,480 (51.6)	9,742 (51.6)	9,497 (51.1)	8,515 (51.1)	
Triage level (JTAS)	n (%)							
Level 1	168 (0.9)	185 (1.0)	179 (1.0)	205 (1.1)	218 (1.2)	191 (1)	355 (2.2)	<0.001 [†]
Level 2	1,090 (5.8)	1,269 (7)	1,260 (7.1)	1,588 (8.7)	1,656 (8.9)	1,373 (7.5)	1,745 (10.7)	
Level 3	4,568 (24.3)	3,908 (21.7)	3,761 (21.3)	3,934 (21.6)	4,695 (25.2)	4,173 (22.9)	4,575 (28.0)	
Level 4	11,612 (61.9)	11,330 (62.9)	11,281 (64.0)	11,146 (61.3)	10,874 (58.5)	11,249 (61.7)	8,776 (53.7)	
Level 5	1,324 (7.1)	1,331 (7.4)	1,153 (6.5)	1,300 (7.2)	1,153 (6.2)	1,252 (6.9)	890 (5.4)	
Admission	3,010	2,946	3,120	3,350	3,329	3,151	3,178	0.662 [§]
Patient types	n (%)							
Non-traumatic	12,053 (62.5)	11,558 (62.9)	11,689 (65.6)	12,219 (66.5)	12,445 (66.0)	11,993 (64.7)	12,058 (72.4)	<0.001 [†]
Traumatic	4,486 (23.3)	4,250 (23.1)	4,154 (23.3)	4,240 (23.1)	4,278 (22.7)	4,282 (23.1)	3,500 (21.0)	
Pediatric	2,753 (14.3)	2,560 (13.9)	1,972 (11.1)	1,916 (10.4)	2,143 (11.4)	2,269 (12.2)	1,091 (6.6)	

JTAS, Japan Triage and Acuity Scale.

[†] χ^2 -test.[‡]Mann–Whitney U-test.[§]Poisson regression analysis.

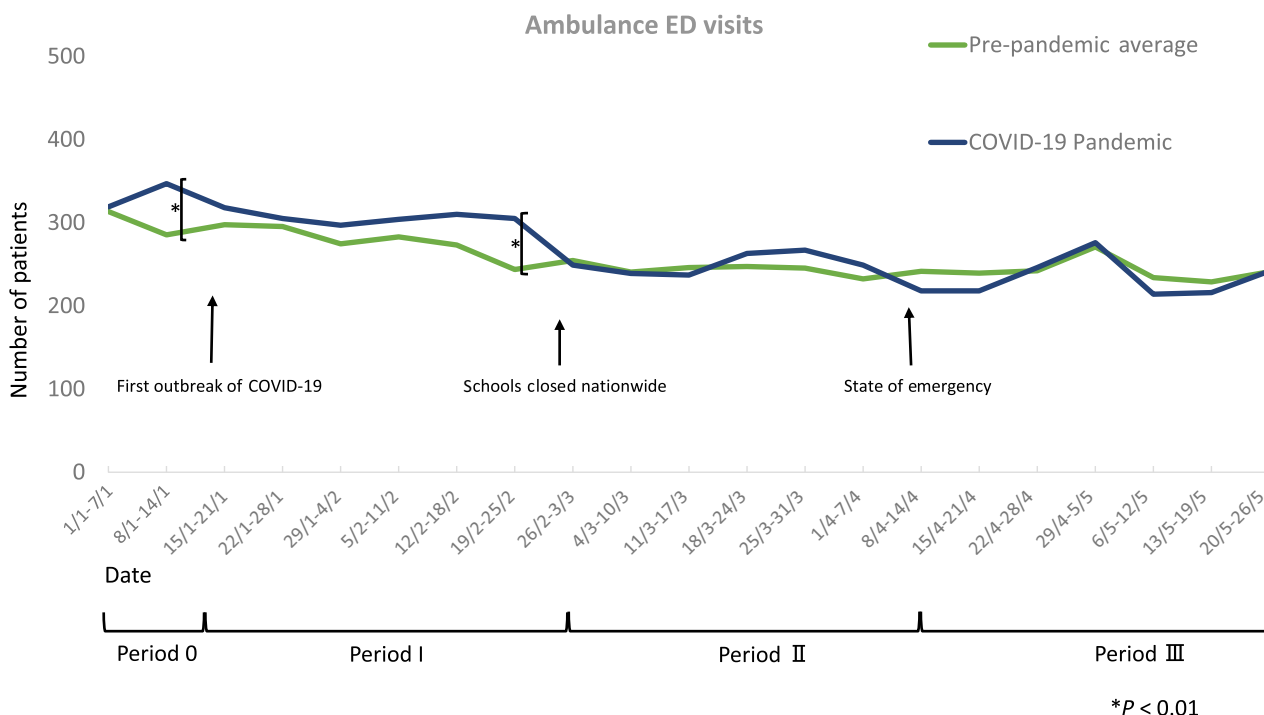


Fig. 1. Trends in ambulance-conveyed emergency department (ED) visits to Shonan Kamakura General Hospital (Kanagawa, Japan) before and during the coronavirus disease (COVID-19) pandemic. The blue line represents the trends during the coronavirus disease pandemic, and the green line represents the pre-pandemic trends (the average during 2015–2019). The analyses of the number of ED visits in the pandemic and pre-pandemic periods are compared using the Poisson regression analysis.

levels, age groups, and the types of patients. To clearly evaluate the influence of these NPIs, we divided the evaluation duration into four periods: Period 0 (1–15 January, 2020), no COVID-19 cases detected in Japan; Period I (16 January–1 March, 2020), initial COVID-19 outbreak; Period II (2 March–15 April, 2020), nationwide school closures; Period III (16 April–25 May, 2020), state of emergency.

Statistical analysis

To assess the statistical significance of the trend of ED visits between a pandemic period and a pre-pandemic period, we used the χ^2 -test for the proportions of ambulance visit, sex, and clinical specialty. Poisson regression was used to model the count variables between the COVID-19 pandemic period after the application of an NPI and the pre-pandemic period. Data are expressed as the mean \pm standard deviation. Differences with a *P*-value of less than 0.05 were considered significant. Data were analyzed using the SPSS version 24.0 software package (IBM, Armonk, NY, USA). Statistical analysis was undertaken by Statista (Kyoto, Japan).

RESULTS

Emergency department patient trends in the COVID-19 pandemic

TABLE 1 summarizes the epidemiological patterns and patient demographics. In total, 16,651 patients were examined in the ED from 1 January to 31 May, 2020; ambulance ED visits and walk-in ED visits were 5,785 and 10,866, respectively. The number of ED visits in the same period for each year between 2015 and 2019 was used as a control group and was 19,292, 18,366, 17,864, 18,375, and 18,881, respectively. Figures 1 and 2 show the trends in ambulance and walk-in ED visits.

Period 0 (1–15 January, 2020)

Compared with before the pandemic, the number of walk-in ED visits during the pandemic decreased by 4.2% in Period 0 (1,925 versus 1,844; *P* = 0.087). Compared with before the pandemic, the number of ambulance ED visits during the pandemic period significantly increased by 10.6% in Period 0 (644 versus 712; *P* = 0.019).

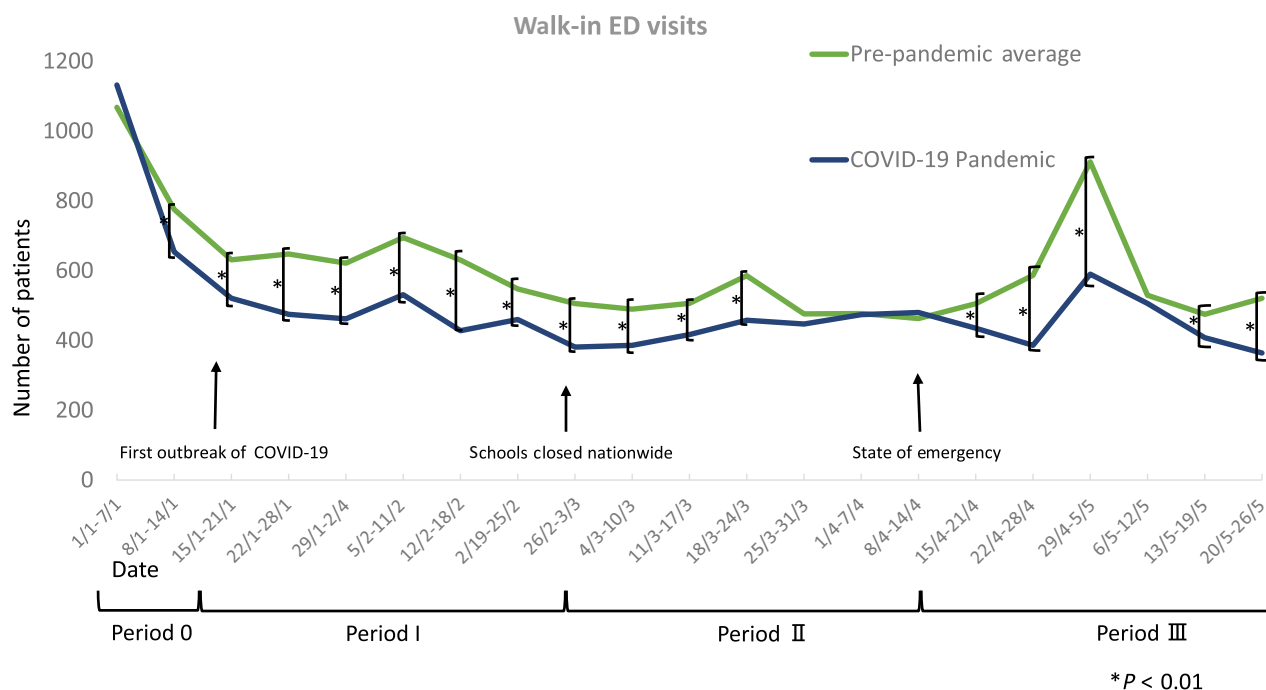


Fig. 2. Trends in walk-in emergency department (ED) visits to Shonan Kamakura General Hospital (Kanagawa, Japan) before and during the coronavirus disease (COVID-19) pandemic. The blue line represents the trends during the coronavirus disease pandemic, and the green line represents the pre-pandemic trends (the average during 2015–2019). The analyses of the number of ED visits in the pandemic and pre-pandemic periods are compared using the Poisson regression analysis.

Periods I–III (16 January–25 May, 2020)

Compared with before the pandemic, the number of walk-in ED visits during the pandemic significantly decreased by 23.1%, 12.4%, and 24.0% (4,047 versus 3,111; 3,211 versus 2,813; and 3,384 versus 2,573; $P < 0.001$ for all) in Periods I, II, and III, respectively. Compared with before the pandemic, the number of ambulance ED visits during the pandemic significantly increased by 8.3% in Period I (1,964 versus 1,814; $P = 0.001$), whereas there was no significant change in Periods II or III with an increase of 2.7% and -3.1% (1,547 versus 1,589 and 1,389 versus 1,346; $P = 0.335$ and $P = 0.284$, respectively).

Triage levels and hospital admissions

The rates of the JTAS-based triage levels before and during the pandemic were 1% and 2%, 8% and 11%, 23% and 28%, 62% and 54%, and 7% and 5% for level 1, 2, 3, 4, and 5, respectively. The χ^2 -test showed that the non-urgency rate (level 4 and 5) during the pandemic was significantly lower than before the pandemic ($P < 0.001$).

Furthermore, the number and rate of patients who needed admission before and during the pandemic were 3,151

(17.0%) and 3,178 (19.1%), respectively. On Poisson regression analysis of the influence of NPI on the admission rate, there was no significant difference between the overall admission rate before and during the pandemic ($P = 0.662$).

Influence of NPIs on the characteristics of patients who visited the ED

The sex-stratified analysis showed that the rate of male patients in the pre-pandemic period and during the pandemic period was 48.8% and 48.9%, respectively, with no significant difference (0.990). The age-stratified change in the rate of ED visits in the pandemic period was as follows: -0.3% , -6.7% , 4.8%, 0.3%, and 1.9% for <1 , 1–17, 18–64, 65–84, and ≥ 85 years, respectively. After the outbreak of the pandemic, the change in the rate of ED visits was the highest among patients in the age group of 1–17 years ($P < 0.001$).

The number of the types of patients in the pre-pandemic and pandemic periods was 11,993 and 12,058, 4,282 and 3,500, and 2,269 and 1,091 in non-trauma, trauma, and pediatric patients, respectively. A Poisson regression analysis showed that the rate of decrease in the ED visits in traumatic and pediatric patients between the pre-pandemic and pandemic periods was significant at 18.3% and 52.0%

($P < 0.001$ for both), respectively. However, there was no decrease in the rate of ED visits in non-trauma patients ($P = 0.588$).

COVID-19 and flu-infected patients in our hospital

The number of cases presenting to the ED and diagnosed with influenza infection from 1 January to 31 May was 1,364, 1,447, 1,688, and 519 in 2017, 2018, 2019, and 2020, respectively. There was a significant 65.4% decrease between before and during the pandemic ($P < 0.001$).

In total, there were 1,926 suggested COVID-19 cases in our hospital between March and May 2020, and they were tested for SARS-CoV-2; the samples from 55 patients (2.9%) tested positive (Figs. 3 and 4).

DISCUSSION

THIS IS THE first report on the influence of NPIs on patient trends in ED visits in Japan. Although our findings alone did not allow us to say that an NPI was the reason for the decline in ED visits, this study showed that the application of an NPI during the COVID-19 pandemic might have significantly reduced patient attendance in the ED. Between January and April 2020, reduced ED visits were observed in the USA.⁸ Our survey showed a similar trend in

Japan, which has a different emergency medical system. Japan has a universal health-care system, and nationwide, all citizens have equal access to medical care at the same cost. In Japan, citizens are free to visit the ED, although hospitals restrict reception occasionally. During the pandemic, some hospitals refused to treat patients who complained of fever and dyspnea. There is a report that the emergency medical service system in Osaka, Japan, has been facing difficulty in terms of hospital acceptance of patients transported to hospital for acute diseases.⁹ Our hospital has never restricted ED visits, and the response rate for ambulance transport is 100%. Therefore, the patient trends in the ED of our hospital are likely to reflect the realities of Japan, which is one of the strengths of our research.

This study revealed that the number of ED visits decreased during the application of NPIs. In particular, the number of walk-in ED visits significantly decreased in Periods I and III of the COVID-19 pandemic.¹⁰ The change in the number of patients in Period III depended on a declared state of emergency, which is part of the Japanese model without the enforcement of a strict lockdown.^{3,11} In this study, there was a significant reduction in the number of patients with less urgent triage levels. This suggests that the NPI might have reduced the number of non-urgent patients who do not normally require an ED visit. Reducing the number of inappropriate ED visits frees up more time for the additional tasks required to manage COVID-19 cases.¹²

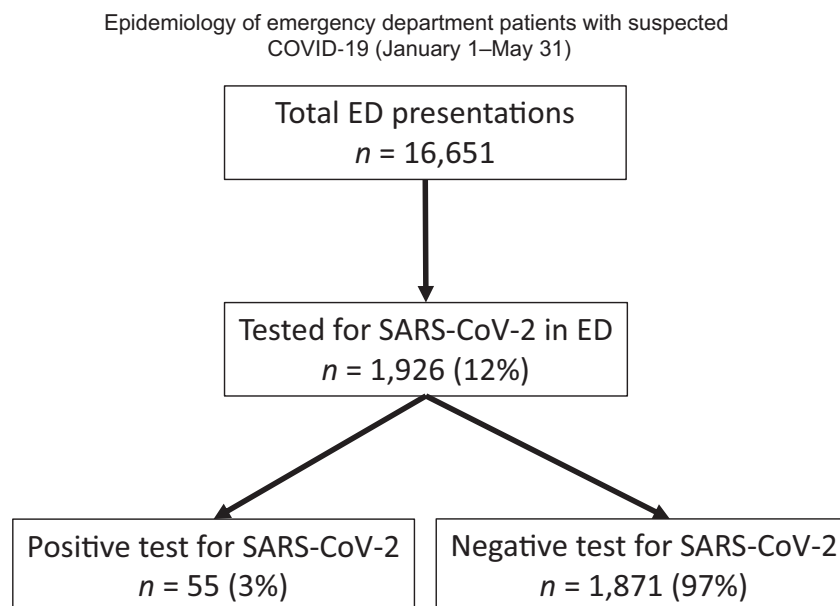


Fig. 3. Flowchart showing the proportion of patients who tested positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) among those suggested of having coronavirus disease (COVID-19) in the emergency department (ED) at Shonan Kamakura General Hospital (Kanagawa, Japan).

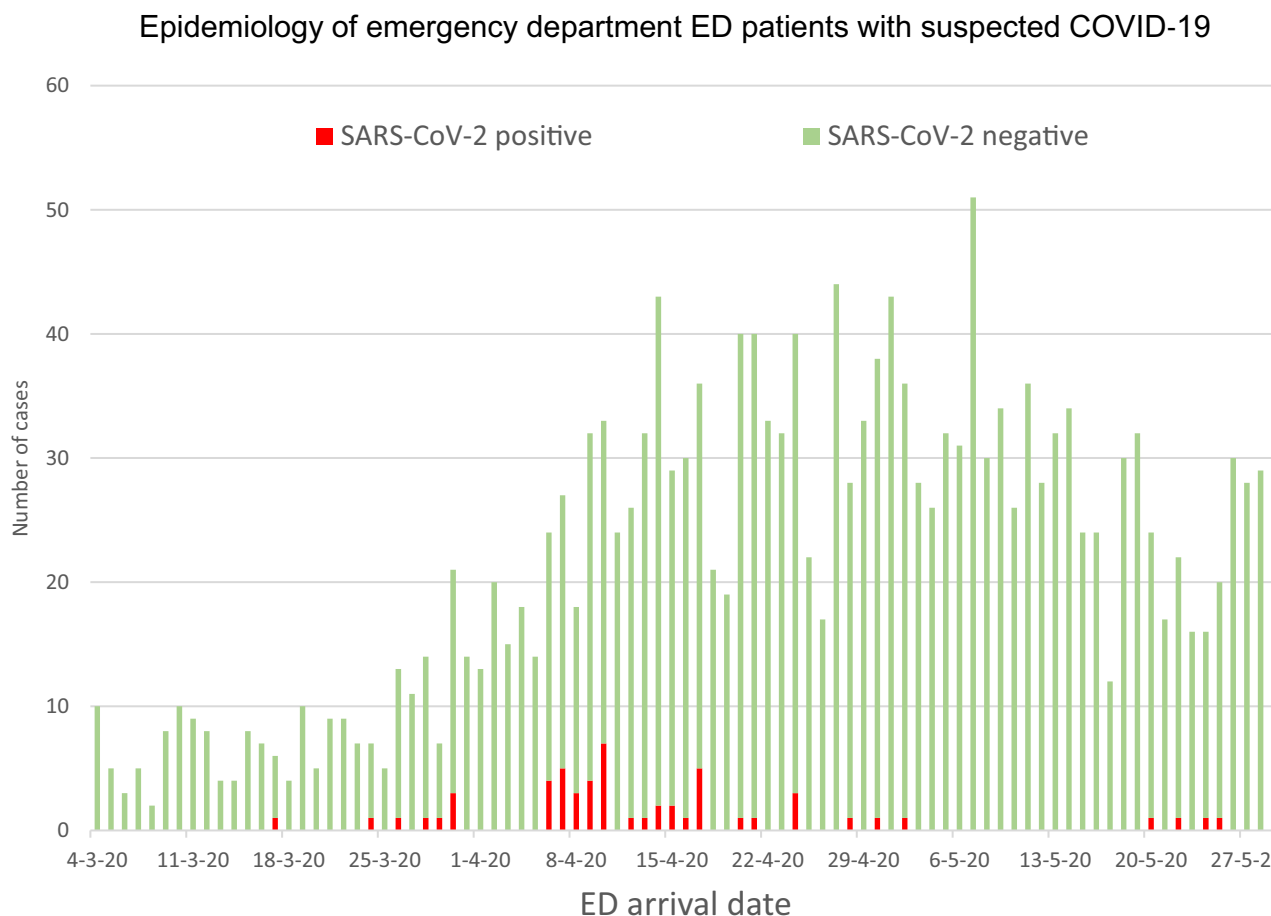


Fig. 4. Graph showing the incidence of suggested coronavirus disease (COVID-19) cases (by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) test result) at Shonan Kamakura General Hospital (Kanagawa, Japan) during the study period. ED, emergency department.

However, it is unclear whether the NPI influenced the trends of ED visits in Period I. Changes in the number of patients in Period I might depend not only on the NPI but also on the flu season. This could be a reason for the reduction of walk-in ED visits in Period 0, before the application of NPIs. There is no fixed date for the commencement of the flu season, although the weather in winter potentially triggers the influenza virus to become exponentially more active. For the past 3 years, flu activity has peaked at a time point between the months of December and February. In this study, there was a significant 65.4% decrease in flu-infected patients before and during the pandemic. Moreover, social distancing due to COVID-19 helped reduce the incidence of influenza. Sun *et al.* reported that the extensive application of NPIs, including mask-wearing and social distancing, in response to COVID-19 seems to be a major factor underlying the reduced influenza epidemic.¹³

Similar trends in the ED were seen after the SARS outbreak in Hong Kong. In 2003, an obvious and dramatic dip was reflected in patient behavior during the global SARS outbreak.¹⁴ The decrease in attendance after SARS in Hong Kong was predominantly reflected in trauma patients. The decrease in ED visits during the COVID-19 pandemic in Japan was evident not only in trauma patients but also in pediatric patients. In fact, the change in the rate of ED visits after the onset of the pandemic was the highest among patients aged 1–17 years, and the rate of decrease among pediatric patients was more than 52%. Researchers at the Children’s Hospital of Philadelphia (Philadelphia, PA, USA) reported a dramatic decline in the pediatric patient trends in the year of the COVID-19 pandemic.¹⁵ In particular, ED visits and hospitalizations for asthma patients appear to have decreased during the COVID-19 pandemic. Moreover, they found that the admission rate dramatically declined compared

with the pre-pandemic period, which could be attributed to the decreased opportunity for exposure to risk factors, such as respiratory viruses, allergens, and traffic-related air pollution, that exacerbate asthma symptoms.¹⁶

This study has some limitations. First, it should be noted that there exists a possibility of sample selection bias because of the single-center retrospective study design. Second, we did not compare patient trends across the region with our hospital. In this study, the number of ambulance ED visits has not decreased, but it might be that this does not indicate that the number of ambulance ED visits has not changed, but that local ambulance ED visits have been concentrated in our hospital. Finally, these results have limited generalizability and applicability at a national or global level.

CONCLUSIONS

THE APPLICATION OF an NPI during the COVID-19 pandemic could have significantly reduced patient attendance in the ED.

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DISCLOSURE

Approval of the research protocol: This study was approved by the Tokushukai Group Ethical Committee (TGE01518-024).

Informed consent: N/A.

Registry and the registration no. of the study: UMIN Clinical Trials Registry, UMIN000041073.

Animal studies: N/A.

Conflict of interest: None.

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