Impact of the COVID-19 pandemic on emergency transport times for patients with urological diseases

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Abstract. The coronavirus disease 2019 (COVID-19) pandemic disrupted global healthcare systems. The present study aimed to determine the impact of lockdown restrictions on the time required to transport patients with urological diseases with fever to the hospital during the early stages of the COVID-19 pandemic. The present retrospective, observational study analyzed information about the transport of 2,811 patients with urological emergencies to hospitals retrieved from a prefectural database, an emergency medical and disaster information system. Differences in emergency transport in terms of duration were analyzed using Student's t-tests. Bivariate associations before and after the onset of COVID-19 were assessed using simple linear and multiple regression analyses. The results indicated a significant association between the mean transport duration and fever in these patients before quarantine (β=5.57; 95% confidence interval, 1.93-9.21). The duration of emergency transport for patients with urological diseases with fever in significantly increased. This was attributed to lifestyle changes brought about by the COVID-19 pandemic.

Introduction

The ongoing coronavirus disease 2019 (COVID-19) pandemic has significantly affected social, economic, educational and political systems (1,2). Social and economic impacts were identified in each country (3). Global measures to prevent the spread of COVID-19, such as school closures and the cancelation of public gatherings, substantially reduced the movement of the population at both the local and national levels (4,5). Healthcare services experienced an increase in workload due to the high incidence of patients with COVID-19 (6), apart from changes in patient presentation at emergency departments. For instance, changes in societal behaviors due to lockdowns and restrictions have led to fewer vehicle-related emergencies (7). However, psychological stress caused by the measures to prevent the spread of COVID-19 has been reported in numerous countries (8-10). Patients who required emergency department consultations were more likely to need acute hospital care (11,12).

Despite these findings, the impact of COVID-19 on emergency transport remains unclear. Studies conducted in Japan have associated the pandemic with increased intervals between patient collection and arrival at an emergency department (13), as well as the amount of time required to respond to and arrive at scenes (13,14). However, little is known about changes in emergency transport according to conditions.

Emergency transportation is often required for febrile urological conditions, such as acute pyelonephritis (15) and urinary tract infections (UTIs) (16). However, fever is a primary symptom of COVID-19 infection (17); thus, its manifestation in a patient requiring emergency care can prolong the wait for a response and admission, even when patients do not have severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection (18). A previous study on the association between COVID-19 and urological diseases found a decrease in the number of patients treated with antibiotics; however, there was no evidence of an increase in complications, such as pyelonephritis (19). The impact of COVID-19 on urology services has been examined (20-24); however, the effects of the pandemic on the emergency transport time for patients with urological diseases remain unclear.

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Abbreviations: SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; UTIs, urinary tract infections

Key words: patients with urological diseases, transport, ambulance, emergency, fever, coronavirus disease, pandemic

The present study aimed to determine the impact of lockdown restrictions on the time required to transport patients with urological diseases with fever to the hospital during the early stages of the COVID-19 pandemic.

Patients and methods

Study design and setting. Japan has a national fire and ambulance service provided by local governments and funded by taxpayers. It is available free of charge to anyone, anytime, anywhere, by calling the emergency telephone number 119. The municipal government oversees the management of fire departments. The National Fire and Disaster Management Agency, Ministry of Internal Affairs and Communications, and Prefectural Governments provide guidance and advice to municipal fire departments. The present study was conducted in Kochi City, Japan, which is the largest metropolitan area in Kochi Prefecture, with an estimated population of 320,000 individuals. Kochi Prefecture had 15 fire departments in 2021, and Kochi City had a fire brigade headquarters and 10 fire/ambulance stations.

Data sources. The present retrospective, observational study analyzed information downloaded from the public Kochi-Iryo-Net database that was established in 2015 as part of the Kochi prefectural emergency medical and disaster information system (https://www.kochi-iryo.net/) (25). The database contains information about fire and ambulance dispatches and crew details, dates and times of calls, destination medical institutions, and distance between patients from the fire department. Upon arrival at the destination (medical institution), an attending doctor recorded pertinent information regarding institution names, locations where patients were collected, types and degrees of conditions or urgency in the institutional medical record database. The Kochi Prefectural Government then integrated this information into the Kochi-Iryo-Net database. The data that support the findings of the present study are available from the Kochi Prefecture database. However, these data are not publicly available. However, these data are not publicly available as they report the surveillance conducted by Kochi Prefecture Healthcare Policy Division Department for monitoring emergency medical care. The requirement for written informed consent from the selected participants was waived by the Ethical Review Committee of Kochi University School of Medicine in 2020 (No. 2020-116) due to the retrospective, observational nature of the study. The present study was approved by and complied with the Ethical Guidelines for Medical and Biological Research Involving Human Subjects of the Ministry of Education, Culture, Sports, Science and Technology; Ministry of Health, Labour and Welfare; Ministry of Economy, Trade and Industry, and the Declaration of Helsinki (2013 amendment).

Variables. The duration of the chaotic and quarantine periods was an exposure factor, and the outcome was urological disease. Other variables comprised sex, age (0-69, 70-79 and ≥80 years) and disease severity (mild, moderate, severe and fatal). Disease severity was defined as fatal, severe, moderate, mild, or other when mortality was confirmed at the time of the initial diagnosis, or by hospitalization for >3, <3 weeks, no diagnosis by a physician, and not diagnosed by a or transported to other locations, respectively.

An overview of the data collection and analyzed time frames is presented in Fig. 1. Data were collected between January 1, 2019 and December 31, 2020. The new coronavirus infection became a designated infectious disease on February 1, 2020. Thus, data were defined as pre-pandemic from January 1, 2019 to January 31, 2020. Data were analyzed after the pandemic between February 1, 2020 and December 31, 2020. The pre-quarantine period was defined as when the first patient was diagnosed with COVID-19 on February 29, 2020 and a state of emergency was initially declared in Kochi Prefecture on April 15, 2020. Quarantine began on April 16 and lasted until May 14, 2020.

Information about patients entered into the Kochi-Iryo-Net database had to contain disease classifications and up to three specified injuries or diseases. Patients with urological diseases with pyelonephritis or UTIs were further classified as having fever (n=1,255), and all others were classified as not having a fever (n=1,556). According to previous research, the annual incidence of hospitalization due to urinary tract stones in Japan is estimated at 6.8 males and 12.4 females per 10,000 individuals in the population (26).

Statistical analysis. The elapsed time between an incoming telephone call and the moment when an ambulance arrived at a hospital was defined as the total transport time and was compared before and after the start of the COVID-19 pandemic. After verifying the normality of the data with the Shapiro-Wilk test, between-group differences in total transport time were analyzed using the Mann-Whitney U-test. Categorical variables were analyzed using Chi-squared tests. If the expected frequencies were too low (>20% of the cells had an expected count of <5), Fisher's exact tests were conducted instead of the Chi-squared tests. Bivariate associations before and after the COVID-19 pandemic started were assessed using simple linear and multiple regression analyses. Values with two-tailed $P<0.05$ were considered to indicate statistically significant differences. All data were analyzed using Stata/MP v.16.0 (StataCorp LLC.).

Results

The present study limited the analysis to patients with urological diseases between 2019 and 2020, who were listed in the Kochi-Iryo-Net database. Among these patients, 10 patients with a transport time >1,000 min (n=10) were excluded from the study as previously described (27); the transport time exceeding 1,000 min usually does not exceed 180 min one-way, even if the patient was transported from the eastern or western edge of Kochi Prefecture to the center of the prefecture. Although there were rare cases in which the transport time was extended due to disease, the time exceeding 1,000 min was considered an anomaly due to an error in the entry of the transport time. Data derived from 2,811 transported patients were finally analyzed.

As illustrated in Fig. 2, the emergency transport time was the long during March and April, 2020 for patients with urological diseases with fever during the entire study period compared to 2019. As shown in Fig. 3, the amount of time required to deliver patients with urological diseases without fever in the case of an emergency to a hospital during 2019 and 2020 did not markedly vary throughout the study period.

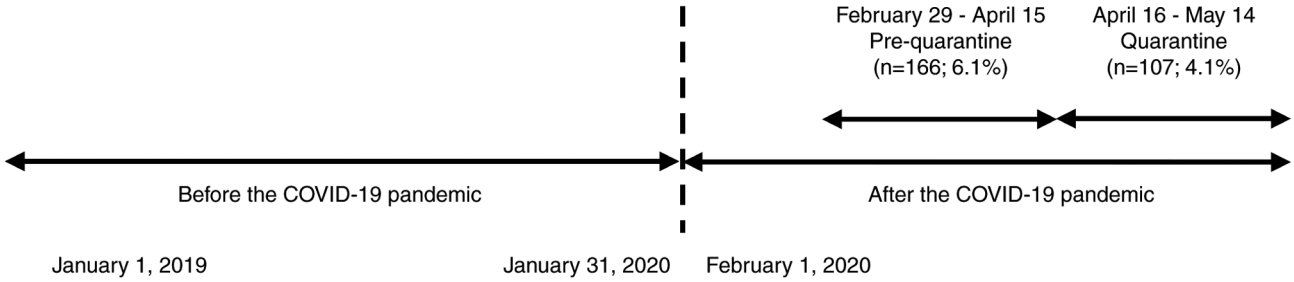

Figure 1. Components of the study period.

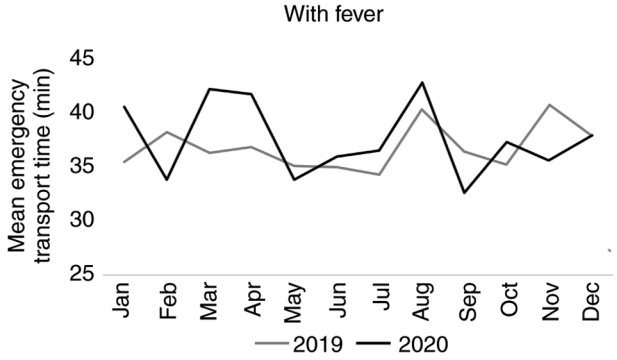

Figure 2. Mean emergency transport time for patients with urological diseases with fever.

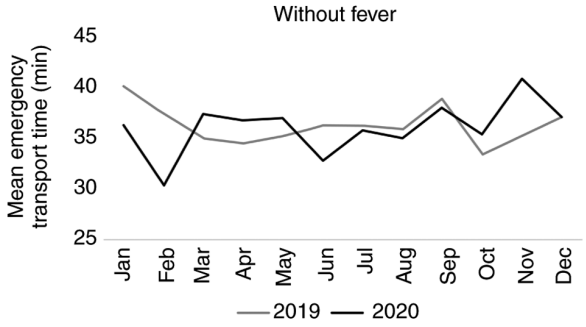

Figure 3. Mean duration of emergency transport of patients with urological diseases without fever during the period between 2019 and 2020.

Of the total number of patients with urological diseases (n=2,811) included in the present study, 1,255 patients had urologic diseases with fever, and 1,556 patients had no fever. The pre-quarantine (February 29 to April 15, 2020) and quarantine (April 16 to May 14, 2020) demographics of the patients are presented in Table I. It was found that 75 (45.2%), 91 (54.8%) at pre-quarantine, and 49 (45.8%) and 58 (54.2%) patients during quarantine with urological diseases with and without fever, respectively, were transported by an ambulance during these respective time periods.

As demonstrated in Table II, the mean duration of emergency transport was longer for patients with urological diseases with fever than without fever before, compared with during the quarantine period and after the COVID-19 pandemic began.

The results of simple linear and multiple regression analyses are presented in Table III. The mean pre-quarantine transport times were significantly associated with fever [β=5.35; 95% confidence interval (CI), 1.69-9.01; P<0.05] and remained significant after adjusting for sex, age and urgency (β=5.57; 95% CI, 1.93-9.21; P<0.05).

Discussion

The present study examined the impact of the COVID-19 pandemic on the amount of time required for an ambulance to transport patients with urological diseases with or without fever in the case of an emergency in Kochi Prefecture, Japan. A significant pre-quarantine increase was observed in the emergency transport time for patients with urological diseases with fever. Urological diseases are adversely affected by even a 5-min delay, and longer waits for emergency transport can delay the appropriate and timely administration of treatment, as well as subsequent dispatches (28). Each fire station in Kochi Prefecture usually has two ambulances, and if a station is unable to respond to an emergency, an ambulance from a neighboring station will be dispatched. The survival of patients with serious illnesses is associated with prompt transport (29). To the best of our knowledge, this is the first study to find longer transport times during the spread of COVID-19 in a rural area in Japan.

This longer time was attributed to the implementation of infection control measures that were not previously required (30). Currently, these measures include hand disinfection, wearing protective clothing and mandatory reports of suspected infections (28,31). Other factors that likely contributed to the increased duration of emergency transport include the similarity between fever caused by a febrile urological state and COVID-19 (17,32,33), as well as delays caused by searching for a hospital that was appropriately equipped, willing to admit a patient with suspected COVID-19 and had a free bed. Numerous hospital beds were reserved for or were occupied by patients with COVID-19 (34).

The COVID-19 pandemic also changed the consultation policies of urologists, according to the findings of cue-expedited transport of patients with urological diseases (23,24,35). The frequency of admissions with urological complaints decreased, the pattern of referrals changed, the length of hospital stays decreased, more patients were discharged against medical advice, and the number of patients with irreversible urological complications or complications requiring surgery due to deferred treatment increased (35). Ansari *et al* (36) suggested that specific medical centers that could provide emergency services should be selected. Such measures are certainly useful, although they are difficult to implement in rural areas such as Kochi Prefecture, where medical resources are limited, in contrast to large cities,

Table I. Demographic characteristics of the patients throughout the COVID-19 pandemic.

Characteristic	All 2,811; n (%)	Pre-quarantine 166 (60.8), n (%)	Quarantine 107 (39.2), n (%)	P-value
Sex				
Male	1,507 (53.6)	83 (50.0)	63 (58.9)	0.36[a]
Female	1,304 (46.4)	83 (50.0)	44 (41.1)	
Age (years)				
0-69	764 (27.2)	39 (23.5)	29 (27.1)	0.55[a]
70-79	645 (23.0)	45 (27.1)	28 (26.2)	
≥80	1,402 (49.9)	82 (49.4)	50 (46.7)	
Severity				
Mild	898 (32.0)	55 (33.1)	33 (30.8)	0.96[b]
Moderate	1,329 (47.3)	78 (47.0)	54 (50.5)	
Severe	563 (20.0)	33 (19.9)	19 (17.8)	
Death	6 (0.2)	0 (0.0)	0 (0.0)	
Other	15 (0.5)	0 (0.0)	1 (0.9)	
Fever with urological disease				
No fever	1,556 (55.4)	91 (54.8)	58 (54.2)	0.96[a]
Fever[c]	1,255 (44.7)	75 (45.2)	49 (45.8)	

Data were analyzed using the [a]Chi-squared test or [b]Fisher's exact test. [c]Urinary tract infections, pyelonephritis.

Table II. Mean emergency transport time (min) in 2020 during the pre-quarantine and quarantine periods.

Patients with urological diseases, n=2,811	Pre-quarantine	P-value[a]	Quarantine	P-value[a]
No fever, n=1,556 (55.4%)	37.4 (14.1)	0.12	36.8 (12.9)	0.81
Fever, n=1,255 (44.7%)	41.9 (17.2)		37.7 (14.6)	

Data for the entire study period (January 1, 2019 to December 31, 2020) are shown as the means and standard deviations, mean (SD). [a]Data were analyzed using a Mann-Whitney U test.

Table III. Simple linear and multiple regression analyses of the mean duration of emergency transport of patients with urological diseases.

			95% CI					95% CI		
Time point	β	SE	Lower value	Upper value	P-value	β[a]	SE	Lower value	Upper value	P-value
Pre-quarantine										
No fever	1.25	1.79	-2.26	4.76	0.49	1.18	1.79	-2.33	4.69	0.51
Fever	5.35	1.87	1.69	9.01	<0.05	5.57	1.86	1.93	9.21	<0.05
Quarantine										
No fever	0.61	2.22	-3.74	4.95	0.79	0.68	2.21	-3.66	5.02	0.76
Fever	0.83	2.29	-3.66	5.32	0.72	0.72	2.28	-3.76	5.19	0.75

[a]Adjusted for sex, age and severity. CI, confidence interval; SE, standard error.

such as Tokyo and Osaka, which have ample medical facilities. Even if such a system were developed, it is important to recognize that its functionality is likely to change during a period of social turmoil, such as a pandemic, as noted herein.

The measures implemented to prevent or reduce the spread of COVID-19, including self-quarantine, have had various effects on emergency care. Of course, the vast number of patients infected with COVID-19 severely strained medical services; however, the overall number of patients presenting at emergency departments decreased in numerous parts of the world (36-38). The various preventive measures implemented during the pandemic did not affect emergency medical services in six US level I trauma centers (39). Notably, the spread of COVID-19 affected the mortality of patients who were transported by ambulance in Osaka, Japan (40).

It is considered that the significant difference between patients who had urological diseases with and without fever should be noted.

Symptoms and infection status related to COVID-19 became confusing and stressful, particularly during the early stages of the pandemic when limited information was available (41-43). An urgent need emerged in Japan to create a process that would not strain the medical system (44,45). During this period, individuals tended to avoid medical clinics and hospitals due to fear of SARS-CoV-2 infection (46,47), and patients with mild symptoms and those who were younger (48,49) tended to not use emergency services (50-52). The period analyzed in the present study was a precursor to the subsequent major pandemic. The Ministry of Health, Labour and Welfare notified each prefecture that medical institutions accepting Class II infectious diseases would accept patients with COVID-19. On March 11, 2020, the Headquarters for the Promotion of Countermeasures against Infectious Diseases Caused by the New Type of Coronavirus, the Ministry of Health, Labour and Welfare, released guidelines regarding the treatment of persons with suspected COVID-19 (53). A new system was established in Kochi Prefecture on April 22, 2020. This included establishing a second medical institution that would accept persons with COVID-19 due to an increase in the demand to care for infected patients (53). It is considered that this system was responsible for the difference in transport times between the pre-quarantine and quarantine periods. The process that allocated patients with fever to designated medical institutions may have resulted in the smooth transportation of febrile patients with urological diseases after May, 2020. The present study did not identify confusion caused by circulating information about COVID-19, but rather uncovered the reason for the difference in the transport time between the pre-quarantine and quarantine periods.

The present study had certain limitations, which should be mentioned. The strength of the present study was the use of a large data set that accurately captured the number of patients transported throughout Kochi Prefecture. The medical record management system from which the dataset was obtained was designed to capture all relevant data upon the dispatch of emergency transportation. However, as the information related to the transportation service was entered by ambulance crews in real-time, the possibility of entering erroneous or misleading data into the database cannot be eliminated. For example, in some data-entry fields, a range of descriptions for the same illness can be entered that is dependent on the discretion of the person inputting the data (e.g., 'pyelonephritis' vs. 'acute pyelonephritis'). Currently, the classification of injuries and diseases is performed in a selective format with a check item; however, it is necessary to make modifications, such as using ICD-10 codes instead of a descriptive format for the accurate registration of injury and disease names.

Moreover, the information was manually entered into the database via a tablet computer in each ambulance. This can lead to data entry errors, such as using a 12-h instead of a 24-h clock, resulting in data indicating that transport lasted for >1 day. Transport time is an important topic in the field of emergency care; therefore, future improvements to the system are required to address erroneous data input, such as the simplification of entry items, the standardization of entry formats, or a system of double-checks. In Japan, the operation of such a system is performed on a prefectural basis, and a separate document is submitted to the Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications, which has jurisdiction over firefighting, to ascertain the number of emergency cases transported. It is hoped that the same system can be operated in all prefectures in Japan in the future.

Emergency medical service teams consider a case to be difficult to accept 'after four or more calls for acceptance to medical institutions' or 'more than 30 min have elapsed since their arrival at the scene'(54). However, since the dataset used for the analysis did not include any information about the above, it could not be confirmed whether the patients who were transported by emergency medical services over a long period of time were difficult to accept. The ability to categorize 'difficult to accept' may further clarify how the field was disrupted during this period. Another limitation is that the body temperature of febrile patients with urological diseases could not be verified. Additionally, the data were from only one of 47 Japanese prefectures; thus, the present findings may not be generalizable to other prefectures. The aging rate in Kochi Prefecture is 35.8%, which is higher than the national average of 28.8% and the second highest in Japan. The percentage of the population aged ≥65 years in the total population of Kochi Prefecture is one in three of the prefecture's residents. As for the current situation of regional medical care in Kochi Prefecture, there are few large hospitals, and there is a lack of facilities to accept seriously ill patients. Of note, ~70% of the population of Kochi Prefecture is concentrated in the center where the medical school is located, while ~80% of physicians and nurses are concentrated. Doctors and hospitals responsible for regional medical care accept many patients with limited personnel and facilities (54). Therefore, they are unable to provide highly specialized medical care, and maintaining the medical system in mountainous areas is a challenge. While Japan is aging and its population is becoming increasingly concentrated in one area, it is considered that the changes that occurred in Kochi Prefecture, which has such regional challenges, suggest that similar confusion will occur in contingencies that occur in other prefectures in the future.

Delayed emergency transport is a life-threatening situation for patients. In the future, the authors aim to use data to confirm what types of occurrences increase transport times and what types of diseases tend to do so and to compare these data with data from other prefectures in Japan regarding emergency transport times.

The present study revealed that the measures, restrictions, lockdowns and lifestyle changes that limited the spread of COVID-19 affected emergency transport time in one prefecture in Japan during the quarantine period. Particularly, the increase

in transport duration was significant for patients with urological diseases with fever. These results suggested that similar delays may occur in future events when patients may develop symptoms akin to those of a disease that causes a pandemic.

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Availability of data and materials

The data supporting the present findings are under license from Kochi Prefecture and are not publicly available. The dataset is surveillance conducted by Kochi Prefecture Healthcare Policy Division Department, for monitoring emergency medical care and is not publicly available, although use may be permitted after ethical review.

Authors' contributions

MMinami was involved in the conceptualization and methodology of the study, and in the writing the original draft of the manuscript. MMiyauchi and ME were involved in the study methodology. KI and KN were involved in the study methodology, and supervised the study. MMinami and ME confirm the authenticity of all the raw data. All authors (MMinami, MMiyauchi, ME, AK, HF, SA, TK, KI, NS and KN) were involved in the interpretation of and in reporting the findings of the study. All authors were involved in the conceptualization of the study, contributed to, and have read and approved the final version of the manuscript.

Ethics approval and consent to participate

An opt-out recruitment was adopted to obtain consent in the present study on the Kochi-Iryo-Net's website. There was no objection from participants to use or provide the required information. This study was approved by the Ethical Review Committee of Kochi University School of Medicine in 2020 (no. 2020-116). The present study was approved by and complied with the Ethical Guidelines for Medical and Biological Research Involving Human Subjects of the Ministry of Education, Culture, Sports, Science and Technology; Ministry of Health, Labour and Welfare; Ministry of Economy, Trade and Industry, and the Declaration of Helsinki (2013 amendment).

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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