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Original Article

Impact of the COVID-19 pandemic on incidence and mortality of emergency cardiovascular diseases in Tokyo

Takeshi Yamamoto (MD, PhD, FJCC) [a,b,*], Kazumasa Harada (MD, PhD, FJCC) [b], Hideaki Yoshino (MD, PhD, FJCC) [b], Masato Nakamura (MD, PhD, FJCC) [b], Yoshinori Kobayashi (MD, PhD) [b], Tsutomu Yoshikawa (MD, PhD, FJCC) [b], Yasuhiro Maejima (MD, PhD) [b], Toshiaki Otsuka (MD, PhD) [b], Ken Nagao (MD, PhD, FJCC) [b], Morimasa Takayama (MD, PhD, FJCC) [a,b]

[a] Tokyo CCU Network Council, Tokyo, Japan
[b] Tokyo CCU Network Scientific Committee, Tokyo, Japan

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ABSTRACT

Background: The impact of the coronavirus disease 2019 (COVID-19) pandemic on the incidence and in-hospital mortality of emergency cardiovascular disease (CVD) has not been clarified in Japan.
Methods: We compared the number of admissions and in-hospital mortality for emergency CVD during the pandemic (from January to December 2020) with those of pre-pandemic periods (from January 2018 to December 2019), using quarterly data from the Tokyo Cardiovascular Care Unit Network. The incidence rate in 2020 is compared with the average incidence rate observed in the same quarter of 2018 and 2019 and is presented as an incidence rate ratio (IRR) with 95 % confidence interval (CI).
Results: The number of admissions for acute myocardial infarction during the pandemic was significantly lower than before the pandemic, with an IRR of 0.93 (95 % CI; 0.88–0.98). Similarly, the IRR for unstable angina was 0.78 (95 % CI; 0.72–0.83), for acute heart failure was 0.84 (95 % CI; 0.76–0.91), for acute aortic dissection was 0.88 (95 % CI; 0.78–0.98), and for ruptured aortic aneurysm was 0.75 (95 % CI; 0.62–0.88). In quarterly comparisons, the numbers of acute aortic diseases and emergency arrhythmia significantly decreased from July to September 2020, while those of other emergency CVDs significantly declined in the 2020 April–June period, which includes the first wave period in Japan. In-hospital mortality of emergency CVDs was unchanged from the pre-pandemic period, except for acute aortic dissection, which increased in odds ratio of 1.31 (95 % CI 1.10–1.57).
Conclusions: The COVID-19 pandemic significantly reduced the number of admissions for all emergency CVDs in all or part of the year. In-hospital mortality was unchanged from the pre-pandemic period, except for acute aortic dissection, which increased.

Introduction

Coronavirus disease 2019 (COVID-19) cases increased exponentially and spread rapidly around the world, reaching pandemic status on March 11, 2020. The first declaration of a state of emergency in Japan was issued in Tokyo on April 7 and lasted until May 25, 2020, and was imposed to counter the spread of the first wave of coronavirus infections. The declaration was lifted, but the second and third waves came, and on January 7, 2021, the second state of emergency was declared, and the pandemic has continued since then. The COVID-19 pandemic and lockdowns have caused profound changes in emergency cardiovascular care around the world [1,2]. It has also been suggested that patients complaining of chest symptoms may be reluctant to go to the hospital for fear of COVID-19, leading to untreated or delayed treatment during the course of emergency cardiovascular disease (CVD) [3]. Analysis of acute coronary syndrome hospitalizations in different geographic areas where lockdown restrictions were used, including the United Kingdom [1], France [4], Greece [5], and California [6], showed a significant reduction during the COVID-19 pandemic. However, there are few studies on the number of hospitalizations [7,8] or percutaneous coronary intervention (PCI) [9–11] and in-hospital mortality for acute myocardial infarction (AMI) throughout 2020, and how this compares with pre-pandemic periods. Furthermore, no similar reports have examined other CVDs. To determine the impact of the COVID-19 pandemic on emergency CVD, we compared the number of

* Corresponding author at: Division of Cardiovascular Intensive Care, Nippon Medical School Hospital, 1-1-5 Sendagi, Bunkyo-ku, Tokyo 113-8603, Japan. Tel.: +81-3-3822-2131; fax: +81-3-5685-0987.
E-mail address: yamamoto56@nms.ac.jp (T. Yamamoto).

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cardiovascular care unit (CCU) admissions and in-hospital mortality for AMI and other emergency CVDs during the first year of the pandemic (from January to December 2020) with those before the pandemic (from January 2018 to December 2019), using quarterly data from the Tokyo CCU Network.

Methods

The Tokyo CCU Network.

In 1978, the Tokyo CCU Network was established with the goal of treating patients with emergency CVD as promptly as possible using ambulance units dispatched through the Tokyo Fire Department, with the support of the Tokyo Metropolitan Government [12]. All 73 hospitals (as of December 31, 2021) participating in the Tokyo CCU Network aim to perform emergency PCI within 1 h of arrival at the hospital. From the regional distribution of these 73 hospitals, it can be deduced that the Tokyo CCU Network probably includes 95 % of all patients who have had an AMI without cardiac arrest on hospital arrival within the greater Tokyo metropolitan area, serving a population of 14 million [12]. In addition, the Tokyo CCU Network has been conducting the Tokyo Acute Aortic Super-Network since 2011, with the aim of establishing a system to effectively and safely transfer patients with suspected or confirmed acute aortic dissection (AAD) or ruptured aortic aneurysm (RAA), and with the cooperation of cardiovascular surgery and tertiary emergency departments in the CCU Network hospitals [13].

The Tokyo CCU Network continually collects data regarding the numbers of AMI cases, age, sex, Killip classification, and in-hospital death, which are grouped into 3-month periods. Concurrently, the numbers and in-hospital mortality of the other emergency CVDs are recorded, including unstable angina pectoris (UAP), acute heart failure (AHF), AAD, RAA, acute pulmonary embolism (APE), emergency arrhythmia, takotsubo cardiomyopathy, and acute myocarditis [12,13].

Study subjects and data analysis.

The study subjects were emergency CVD patients admitted to the Tokyo CCU Network hospitals over the 3 years from 2018 to 2020. The study flowchart is shown in Fig. 1. The analysis was limited to the 63 hospitals (56 hospitals for acute aortic diseases) where all data for the relevant period were registered. We compared the number of CCU admissions and in-hospital mortality, per quarter and throughout the year, during 1 year of the pandemic (2020), and 2 years before the pandemic (2018 and 2019). The incidence rates of AMI and AHF were calculated as the ratio of the number of patients admitted to each hospital in 2020 divided by the average annual number of patients admitted in 2018 and 2019. Incidence rates for UAP, emergency arrhythmia, APE, AAD, and RAA were also calculated for each of the seven regional medical areas; takotsubo cardiomyopathy and myocarditis incidence rates were calculated for each of the four regional medical areas. In-hospital mortality during the pandemic was compared with that before the pandemic, and is presented as an odds ratio (OR) with 95 % confidence interval (CI). OR adjusted for age, sex, and Killip class were also calculated to compare in-hospital deaths from AMI during the pandemic with those before the pandemic. The requirement for informed consent was waived because all data were anonymized. This study was approved by the institutional review board of the Tokyo CCU Network Scientific Committee.

Statistical analyses.

The incidence rate in 2020 is compared with the average incidence rate observed in the same quarter of 2018 and 2019 and is presented as an incidence rate ratio (IRR) with 95 % CI. In-hospital mortality during the pandemic was compared with that before the pandemic and is presented as an OR with 95 % CI. Statistical significance was defined as a 95 % CI that excluded 1 (IRR/OR). Statistical analyses were performed with Microsoft Excel 2013 software.

Results

The number of admissions for AMI during the 2020 pandemic year was significantly lower than before the pandemic, with an IRR of 0.93 (95 % CI 0.88–0.98). In quarterly comparisons, the IRR from April to June was 0.86 (95 % CI 0.77–0.96), showing significantly fewer admissions during the first wave of the pandemic (Fig. 2A). The age-by-age comparison by sex showed a significant decrease in IRR for men under 65 years (IRR 0.88; 95 % CI 0.78–0.98) and over 75 years (IRR 0.87; 95 % CI 0.77–0.98) in the April–June period. There was no significant difference in IRR for any of the periods and ages for women. By severity of AMI according to the Killip classification, there was no difference for the year as a whole when compared with the pre-pandemic period, and only Killip 2 significantly decreased during the period from April to June (IRR 0.63;

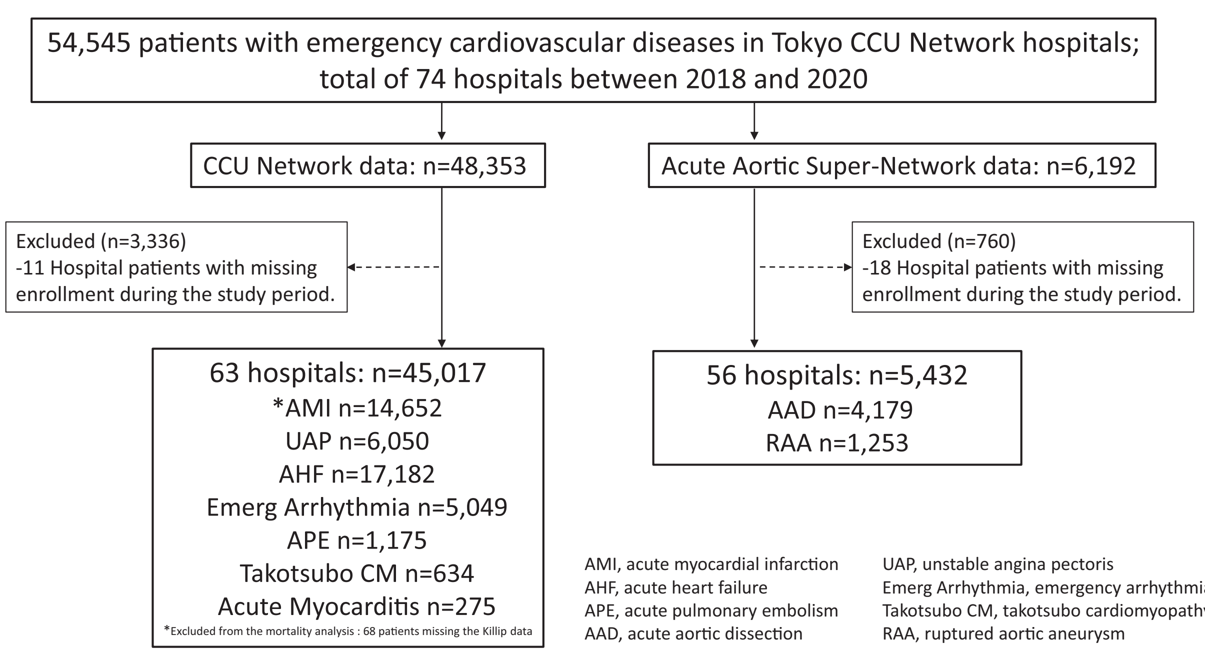

Fig. 1. Study flowchart.

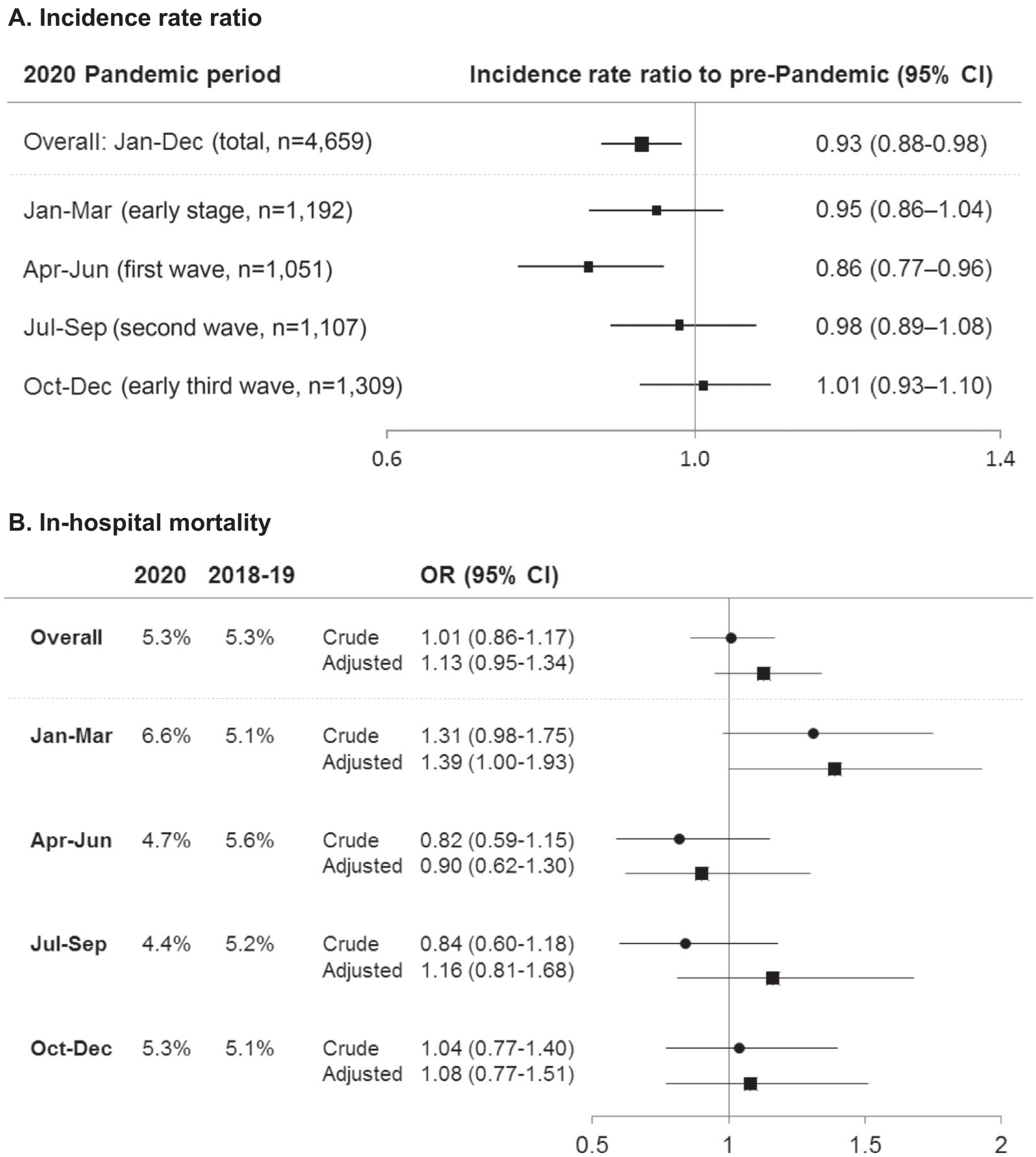

Fig. 2. Quarterly comparison of incidence rate ratios (A) and in-hospital mortality (B) for acute myocardial infarction, during the coronavirus disease 2019 pandemic (2020) to 2 years in the pre-pandemic period (2018–2019). Adjusted factors included age, sex, and Killip classification.
OR, odds ratio; CI, confidence interval.

95 % CI 0.41–0.85)). The in-hospital mortality rate for AMI was not significantly different, at 5.3 % in both 2020 and 2018–2019. There were no significant differences after adjustment for age, sex, and Killip classification (Fig. 2B).

A comparison of IRR for other CVD before and during the pandemic is shown in Fig. 3. UAP decreased significantly in all quarters during the pandemic [overall IRR 0.78 (95 % CI; 0.72–0.83)], and AHF also showed a significant 16 % decrease over the year [IRR 0.84 (95 % CI; 0.76–0.91)], with the only significant decrease occurring in the April to June pandemic period [IRR 0.82 (95 % CI; 0.65–0.997)]. Emergency arrhythmia decreased significantly in the July–September pandemic period [IRR 0.78 (95 % CI; 0.63–0.93)], but did not significantly differ for the full year. APE decreased significantly in the April–June pandemic period [IRR 0.78 (95%CI; 0.61–0.95)], but did not significantly differ for the full year. Takotsubo cardiomyopathy and acute myocarditis both decreased significantly during the April–June pandemic period but did not significantly change during the whole year (Fig. 3). Analysis of in-hospital mortality showed no difference during the pandemic compared with before the pandemic for UAP [OR 1.65 (95 % CI; 0.93–2.94)], AHF [OR 1.08 (95 % CI; 0.95–1.23)], emergency arrhythmia [OR 0.90 (95 % CI; 0.63–1.29)], APE [OR 0.82 (95 % CI; 0.42–1.57)], takotsubo cardiomyopathy [OR 1.82 (95 % CI; 0.79–4.17)], or acute myocarditis [OR 1.21 (95 % CI; 0.57–2.57)].

Admissions for AAD decreased significantly from July to September during the pandemic period [IRR 0.75 (95%CI; 0.52–0.98)], as did the annual number [IRR 0.88 (95 % CI; 0.78–0.98)] (Fig. 3). Analysis based on the Stanford Classification showed that the proportion of type A AAD was 54 % before and 56 % during the pandemic, with no statistical difference; the number of admissions due to type B AAD showed the same trend as for AAD overall, with a significant decrease in the July–September period and for the entire year. In contrast, admissions due to type A AAD were the same before and during the pandemic for the entire year (Online Fig. S1). The number of admissions for RAAs similarly decreased significantly from July to September of the pandemic period [IRR 0.45 (95 % CI; 0.19–0.71)], as did the annual number [IRR 0.75 (95 % CI; 0.62–0.88)] (Fig. 3). In-hospital mortality of AAD was significantly

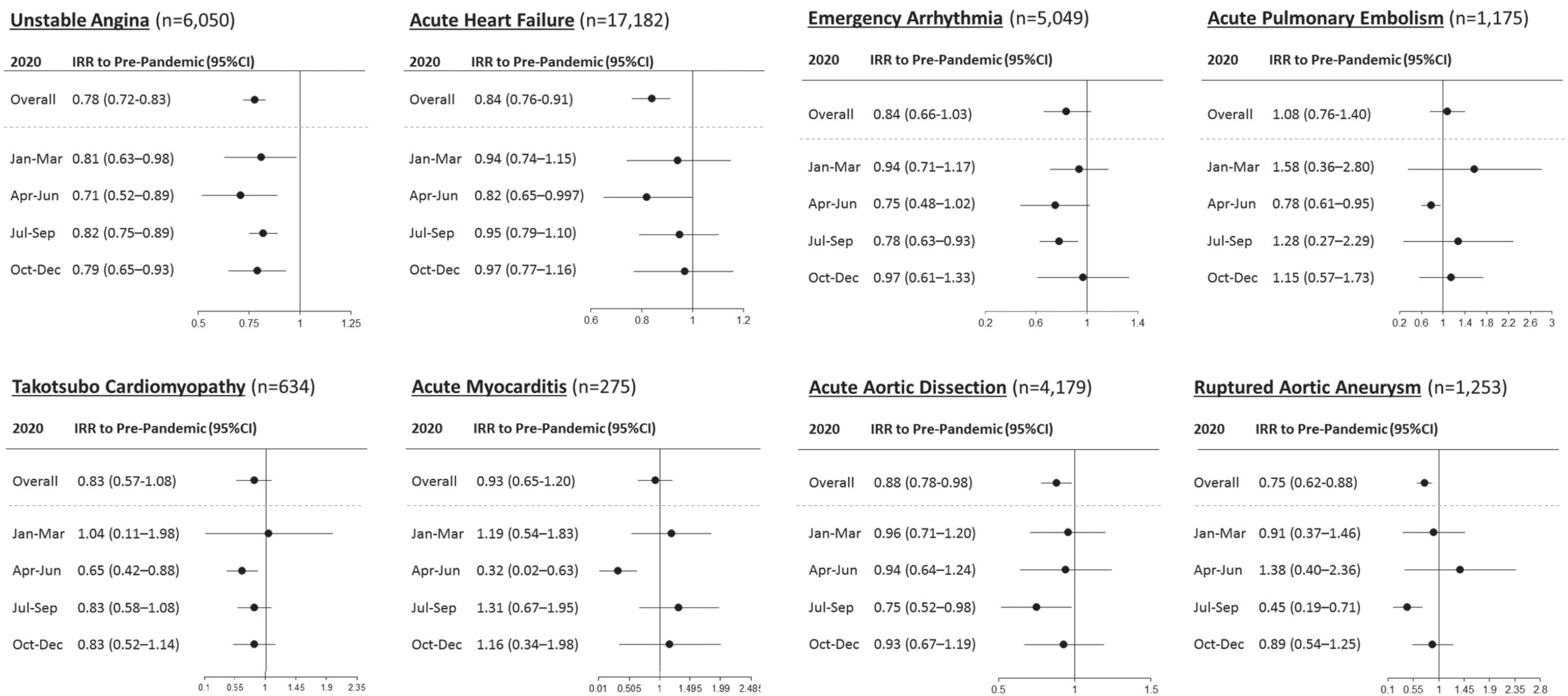

Fig. 3. Quarterly comparison of incidence rate ratios for emergency cardiovascular diseases, during the coronavirus disease 2019 pandemic (2020) to 2 years in the pre-pandemic period (2018–2019). IRR, incidence rate ratio; CI, confidence interval.

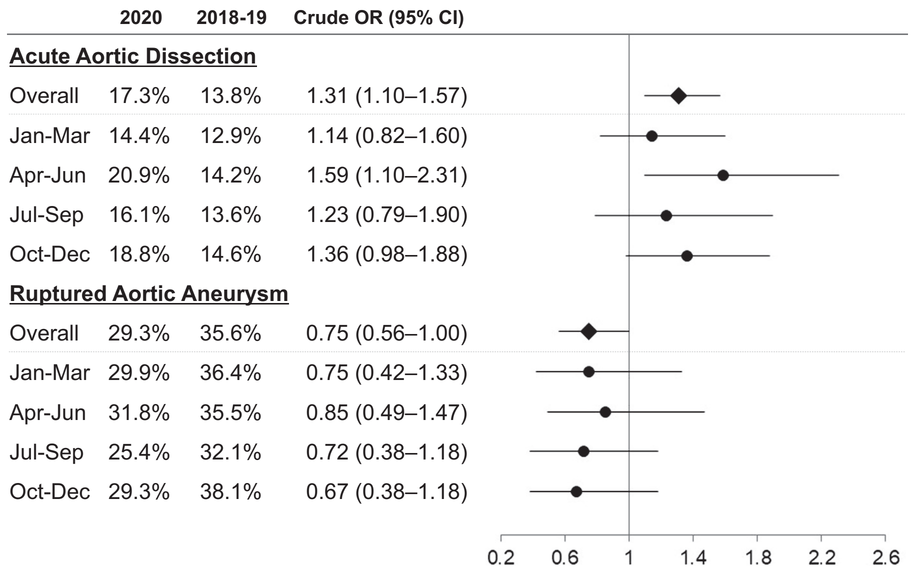

Fig. 4. Quarterly comparison of in-hospital mortality for acute aortic dissection and ruptured aortic aneurysm during the coronavirus disease 2019 pandemic (2020) to 2 years in the pre-pandemic period (2018–2019).
OR, odds ratio; CI, confidence interval.

elevated with an OR 1.31 (95 % CI 1.10–1.57), in contrast, that of RAA tended to decrease, with an OR 0.75 (0.56–1.00) (Fig. 4). In-hospital mortality of AAD by Stanford classification significantly increased for both type A and type B (Online Fig. S2).

Discussion

In the first year of the COVID-19 pandemic, the number of CCU admissions for all emergency CVDs decreased significantly from the pre-pandemic level, throughout the year or in some quarters. The numbers of acute aortic diseases and emergency arrhythmia significantly decreased from July to September, while those of other emergency CVDs significantly declined in the April–June period, which includes the first wave period in Japan. In-hospital mortality was unchanged, except for AAD, which increased.

The extent and timing of the COVID-19 epidemic differed between countries, but the impact of the first wave was almost universally extremely strong. Acute coronary syndrome hospitalizations in different countries showed a significant reduction during the COVID-19 pandemic [1,4–6]. In Tokyo, emergency admissions for most CVDs declined because of the initial impact of the pandemic, but subsequently returned to a similar level to that seen before the pandemic. The emergency declarations issued in Japan, unlike lockdowns in other countries, did not contain draconian restrictions. However, the number of CCU admissions probably decreased as a result of the emergency declaration issued for April and May. Possible reasons for the decline in admissions include a decrease in the Tokyo Metropolitan population due to changes in human flow [14], and public hesitancy to call ambulances because of concerns about possible nosocomial SARS-COV-2 infection [15]. Another possibility is that activity limitation may have had favorable effects on some cardiovascular risk factors. The effects of lockdown (emergency declaration in Japan) on cardiovascular risk factors have been reported, including unfavorable changes in metabolic factors [16,17] as well as favorable changes such as lower-than-usual blood pressure [18,19] and heart rate [20]. Tobacco and alcohol intake during the pandemic also varies by sociodemographic group and mental health status [21]. Therefore, the effects of the emergency declaration on incidence of CVD are still unclear. Interestingly, acute aortic diseases and emergency arrhythmia were unaffected by the first wave of COVID-19 in Japan and then decreased in the second wave. The reason for this is unclear, but it is possibly due to delayed positive effects on cardiovascular risk factors that occurred during the first wave, especially at the time of the emergency declaration. Since acute aortic disease is known to have pre-existing lesions, i.e. the formation of tunica media lesions during dissection [22] and an increase in aneurysm diameter prior to rupture, it is possible that good blood pressure control during the first wave from April to June may have been protective and reduced the occurrence of subsequent events. The number of admissions for APE and myocarditis decreased significantly during the April–June period, while the rest of the year showed an increasing trend, although this was not statistically significant, a different pattern to that shown by other emergency CVDs.

For emergency CVDs other than AAD, in-hospital mortality rates did not increase during the pandemic year compared with the pre-pandemic periods. Studies in other countries have reported significantly higher in-hospital mortality for AMI during lockdown when compared with before lockdown [23]. The CCU Network system is well established [12], and this may be why the emergency declaration did not lead to a significant increase in the mortality rate in Tokyo. The reasons for the increase in in-hospital mortality in AAD and the decreasing trend in RAA during the pandemic are unknown, but may be influenced by changes in the in-hospital healthcare system to manage not only aortic emergencies but also critically ill COVID-19 patients, as an important role of the center hospital.

This study has several limitations. First, we used hospitalization numbers as a substitute for the incidence of AMI. Prehospital deaths are not included. Second, there was no information regarding patient characteristics, transportation time, and treatment in-hospital including door-to-balloon time, which may affect patient prognosis. Several reports indicate a significant prolongation of door-to-balloon time during the pandemic [8,10,23,24]. Data from one hospital in the Tokyo CCU Network also showed significantly longer transport time and door-to-balloon time than before the pandemic, and a significantly increased proportion of cases being admitted 24 h after onset of AMI. Despite these circumstances, there was no significant difference in in-hospital mortality [8]. Third, data on the contribution of each member hospital to COVID-19 care are not available. Furthermore, the exact relationship between the prevalence of COVID-19 and the number of CCU admissions and in-hospital mortality is unknown.

Conclusions

The COVID-19 pandemic significantly reduced the number of CCU admissions for all emergency CVDs throughout the year or in some quarters. In-hospital mortality was unchanged from the pre-pandemic period, except for AAD, which increased.

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Disclosures

The authors declare that there is no conflict of interest.

Appendix A. Appendix

Participating hospitals for the Tokyo CCU Network (as of January 1, 2020):

Ayase Heart Hospital; Bokutoh Metropolitan General Hospital; Center Hospital of the National Center for Global Health and Medicine; Disaster Medical Center; Edogawa Hospital; Fuchu Keijinkai Hospital; Hakujikai Memorial Hospital; Higashiyamato Hospital; Ikegami General Hospital; IMS Katsushika Heart Center; Itabashi Chuo Medical Center; Japanese Red Cross Medical Center; JCHO Tokyo Shinjuku Medical Center; JCHO Tokyo Takanawa Hospital; JCHO Tokyo Yamate Medical Center; Jikei University Daisan Hospital; Jikei University Katsushika Medical Center; Juntendo University Hospital; Kanto Central Hospital; Kanto Medical Center NTT EC; Kawakita General Hospital; Keio University Hospital; Kohsei General Hospital; Kosei Hospital; Kyorin University Hospital; Machida Municipal Hospital; Meirikai Chuo General Hospital; Mishuku Hospital; Mitsui Memorial Hospital; Musashino Red Cross Hospital; National Hospital Organization Tokyo Medical Center; Nerima-Hikarigaoka Hospital; Nihon University Hospital; Nihon University Itabashi Hospital; Nippon Medical School Hospital; Nippon Medical School Tama-Nagayama Hospital; Nishiarai Heart Center Hospital; Nishitokyo Central General Hospital; Ogikubo Hospital; Ome Municipal General Hospital; Omori Red Cross Hospital; Saiseikai Central Hospital; Sakakibara Heart Institute; Showa General Hospital; Showa University Hospital; Showa University Koto Toyosu Hospital; St.Luke's International Hospital; Tachikawa Hospital; Tama Nambu Chiiki Hospital; Tama-Hokubu Medical Center; Teikyo University Hospital; The Cardiovascular Institute; The Fraternity Memorial Hospital; The Jikei University Hospital; The Juntendo University Nerima Hospital; The University of Tokyo Hospital; Tobu Chiiki Hospital; Toho University Omori Medical Center; Toho University Ohashi Medical Center; Tokai University Hachioji-Hospital; Tokyo Hospital; Tokyo Kamata Hospital; Tokyo Medical and Dental University Medical Hospital; Tokyo Medical University Hachioji Medical Center; Tokyo Medical University Hospital; Tokyo Metropolitan Geriatric Medical Center; Tokyo Metropolitan Hiroo Hospital; Tokyo Metropolitan Police Hospital; Tokyo Metropolitan Tama Medical Center; Tokyo Nishi Tokushukai Hospital; Tokyo Women's Medical University Hospital; Tokyo-kita Medical Center; Toranomon Hospital; Toshima Hospital.

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