Implementation of Percutaneous Coronary Intervention During the COVID-19 Pandemic in Japan
— Nationwide Survey Report of the Japanese Association of Cardiovascular Intervention and Therapeutics for Cardiovascular Disease —

Hideki Ishii, MD, PhD; Tetsuya Amano, MD, PhD; Kyohei Yamaji, MD, PhD; Shun Kohsaka, MD, PhD; Hiroyoshi Yokoi, MD, PhD; Yuji Ikari, MD, PhD

Background: With the rapid spread of COVID-19, hospitals providing percutaneous coronary intervention (PCI) were placed in unique and unfamiliar circumstances. This study evaluated variations in the treatment of coronary artery disease according to time course of the COVID-19 pandemic in Japan.

Methods and Results: The Japanese Association of Cardiovascular Intervention and Therapeutics performed serial surveys during the pandemic (in mid-April, late-April and mid-May 2020) with queries regarding the implementation of PCI. Hospitals were asked about their treatment strategies for elective PCI and emergency PCI for ST-elevation myocardial infarction (STEMI) and high-risk acute coronary syndrome (ACS) patients. Most hospitals opted to perform primary PCI in the usual manner at the beginning of the pandemic. As the pandemic progressed, hospitals in the 7 populated areas downgraded the performance of PCI for chronic coronary syndrome and high-risk ACS, but not for STEMI patients. After the state of emergency was lifted in most prefectures in mid-May, the rate of PCI gradually normalized. Screening tests, such as polymerase chain reaction and chest computed tomography, in ACS were frequently used.

Conclusions: The COVID-19 pandemic greatly affected PCI treatment in Japan. However, even in the most critical situations during the pandemic, most institutions continued to perform primary PCI normally for STEMI patients.

Key Words: COVID-19; Japan; Percutaneous coronary intervention; Survey
Chi-squared tests and differences were considered significant at 2-tailed \( P<0.05 \).

### Methods

The Japanese Association of Cardiovascular Intervention and Therapeutics (CVIT), the professional society for board certification of cardiovascular interventional procedures, conducted the survey. CVIT provided serial surveys during the pandemic (in mid-April, late-April and mid-May 2020) to 680 representative PCI centers from all 47 prefectures in Japan, which had an annual PCI case volume of at least 50 procedures. The survey included questions about how the situation was affecting the performance of hospitals and the care of patients with cardiovascular disease who needed interventional procedures such as PCI, as well as whether screening tests may be performed.

Each survey included 4 types of queries: (1) preferences regarding the performance of elective PCI; (2) preferences regarding the performance of primary PCI in ST-elevation myocardial infarction (STEMI) patients; (3) preferences regarding the performance of emergency PCI in high-risk non-ST-elevation ACS patients; and (4) the use of screening tests, such as polymerase chain reaction (PCR) and chest computed tomography (CT), to detect coronavirus-related pneumonia. STEMI and high-risk non-ST-elevation ACS categories have been described in detail elsewhere.\(^4,5\)

Metropolitan Tokyo and the Osaka, Kanagawa, Saitama, Chiba, Hyogo and Fukuoka prefectures, where a state of emergency was been first declared, were designated as the emergency areas.\(^2\)

All analyses were performed using SPSS v22 (IBM Corp., Armonk, NY, USA). Variables were compared using

### Results

Surveys were conducted 3 times: on April 15, April 30, and May 15, 2020. Answers were received from 367, 370, and 375 hospitals for each survey, respectively (Table). At the time of the first, second, and third surveys, 84.1%, 55.1%, and 68.2% of participating hospitals respectively reported performing elective PCI as usual (Figure 1). A sustained decrease in activity regarding elective PCI was seen between the first and second surveys (\( P<0.0001 \)), and this tendency was more pronounced in the emergency areas. However, the rate of elective PCI was normalized by the time of the third survey compared with the second survey.

Primary PCI for STEMI was performed as usual in 96.2%, 94.7%, and 96.9% of participating hospitals at the time of the first, second, and third surveys, respectively (Figure 2), although there was a significant difference between the emergency and non-emergency areas in the second survey (Figure 2). Compared with STEMI patients, hospitals throughout Japan were more hesitant to perform PCI for high-risk non-ST-elevation ACS patients; urgent or emergency PCI was performed as usual in 79.6%, 77.8%, and 79.6% of participating hospitals at the time of the first, second, and third surveys, respectively (Figure 3). This trend was more pronounced in emergency areas.

The number of hospitals performing the COVID-19 screening tests increased as the pandemic progressed (Table). Throughout all 3 surveys, screening tests in both STEMI and high-risk non-ST elevation ACS patients were performed significantly more frequently in the emergency areas than in the other areas. Chest CT was more frequently

### Table. Answers to Survey Questions

<table>
<thead>
<tr>
<th>Area</th>
<th>First (n=367)</th>
<th>Second (n=379)</th>
<th>Third (n=393)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Em</td>
<td>Non-Em</td>
<td>Em</td>
</tr>
<tr>
<td>No. responses</td>
<td>170</td>
<td>197</td>
<td>173</td>
</tr>
<tr>
<td>Elective PCI (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performed as usual</td>
<td>74</td>
<td>93</td>
<td>46</td>
</tr>
<tr>
<td>Postponed</td>
<td>26</td>
<td>7</td>
<td>54</td>
</tr>
<tr>
<td>PCI in STEMI (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performed as usual</td>
<td>95</td>
<td>97</td>
<td>92</td>
</tr>
<tr>
<td>Any limitation</td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>PCI in high-risk ACS (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performed as usual</td>
<td>72</td>
<td>86</td>
<td>71</td>
</tr>
<tr>
<td>Any limitation</td>
<td>28</td>
<td>14</td>
<td>30</td>
</tr>
<tr>
<td>Screening for COVID-19 (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In STEMI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical examination only</td>
<td>75</td>
<td>86</td>
<td>57</td>
</tr>
<tr>
<td>PCR</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Chest CT</td>
<td>24</td>
<td>11</td>
<td>38</td>
</tr>
<tr>
<td>In high-risk ACS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical examination only</td>
<td>67</td>
<td>83</td>
<td>46</td>
</tr>
<tr>
<td>PCR</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Chest CT</td>
<td>30</td>
<td>14</td>
<td>47</td>
</tr>
</tbody>
</table>

The first, second, and third surveys were conducted on April 15, April 30, and May 15, 2020, respectively. ACS, acute coronary syndrome; CT, computed tomography; Em, emergency areas (metropolitan Tokyo and Osaka, Kanagawa, Saitama, Chiba, Hyogo and Fukuoka prefectures); non-Em, non-emergency areas (other prefectures); PCI, percutaneous coronary intervention; PCR, polymerase chain reaction; STEMI, ST-elevation myocardial infarction.
Figure 1. Performance of elective percutaneous coronary intervention. The first, second, and third surveys were conducted on April 15, April 30, and May 15, 2020, respectively. The emergency areas included metropolitan Tokyo and Osaka, Kanagawa, Saitama, Chiba, Hyogo, and Fukuoka prefectures.

Figure 2. Performance of emergency percutaneous coronary intervention in patients with ST-elevation acute myocardial infarction. The first, second, and third surveys were conducted on April 15, April 30, and May 15, 2020, respectively. The emergency areas included metropolitan Tokyo and Osaka, Kanagawa, Saitama, Chiba, Hyogo, and Fukuoka prefectures.
Whether there is a relationship among disasters or pandemics and the provision of emergency care for ACS is not clear. Data during pandemics are limited. However, one report suggested that the medical system worked well for patients with AMI and improved the chain of survival immediately after the Great East Japan Earthquake. 

Similarly, the findings of the present study suggest that most institutions continued to perform primary PCI as normal for STEMI patients even during the most critical current situations.

At present, we cannot determine how postponing PCI may affect the clinical outcomes of patients with coronary artery disease. Furthermore, we have no data on the precise incidence of ACS. As to the situations in disasters and pandemics, both physical and psychological stresses may affect the sympathetic nervous system, resulting in the onset of ACS. An increase in long-term mortality after a huge earthquake has been reported.

Conversely, the incidence of ACS during the COVID-19 pandemic was decreased compared with inter- and intrayear control periods.

One report has speculated that inflammatory respiratory disease may induce coronary plaque rupture, resulting in the onset of ACS through a cytokine storm. In addition, the pandemic may have an effect on door-to-balloon time, which greatly affects prognosis in STEMI patients. To prove such phenomena and speculations, it is necessary to collect clinical and registry data on short- to long-term follow-up during and after the COVID-19 pandemic.

Of note, the present study also highlights that the frequency of screening tests for COVID-19 increased as time passed. In particular, chest CT was frequently performed in the participating hospitals. The best method of screening

---

**Discussion**

In many countries, a collapse of the medical care system has been a feature of the current COVID-19 pandemic. There may be regional differences in medical systems among various countries, as well as nationwide. Indeed, mortality due to COVID-19 seemed lower in Japan than in other countries. Against this background, we performed serial surveys and showed a gradual changes in PCI practice during the early phase of the COVID-19 pandemic.

The survey responses indicate that the COVID-19 pandemic has greatly affected how institutions perform, as well as the care of patients who need PCI, particularly in areas where a state of emergency was first declared. The tendency to change practices in hospitals has become more pronounced throughout Japan as COVID-19 outbreaks have prompted institutions to suspend elective PCIs. In mid-April 2020, CVIT released a statement to support the management of coronary artery disease during the COVID-19 pandemic. The American College of Cardiology (ACC) Interventional Council and the Society for Cardiovascular Angiography and Interventions (SCAI) also made joint statements to support the management of catheterization laboratories. Such statements would have strongly influenced decisions regarding the performance of PCI during the early phase of the pandemic. However, after the coronavirus state of emergency was lifted in 39 of 47 prefectures in Japan on May 14, 2020, the rate of PCIs tended to recover as was in a steady state world. A similar tendency was found for PCI in high-risk non-ST-elevation ACS patients.

Figure 3. Performance of emergency percutaneous coronary intervention in patients with high-risk non-ST-elevation acute coronary syndrome. The first, second, and third surveys were conducted on April 15, April 30, and May 15, 2020, respectively. The emergency areas included metropolitan Tokyo and Osaka, Kanagawa, Saitama, Chiba, Hyogo, and Fukuoka prefectures.
for COVID-19 is currently unknown. Shortening the time to confirm or rule out COVID-19 is important in patients with STEMI. Simultaneously, it is necessary to protect frontline medical staff and to avoid in-hospital infections. In Japan, a limitation to this is the limited number of institutions where PCR tests are available for detecting coronavirus. In contrast, Japan has significantly more CT machines available per capita than other countries. The interim clinical guidance from the Centers for Disease Control and Prevention (CDC) states that CT alone is not recommended for the diagnosis of COVID-19. However, because of the limited number of PCR tests, CT may be a testing tool to detect COVID-19-associated pneumonia in Japan. Acquisitions of CT images involve significantly greater exposure to radiation, as well as a longer time before PCI can be performed, but chest CT easily detects pneumonia. Further investigations are needed to find more importance of screening tests.

The present study has some limitations. First, because the surveys were voluntary, we could not collect data from all hospitals in Japan that perform PCI. However, it is of note that more than half of all hospitals volunteered to participate in the surveys and they covered all 47 prefectures. Second, we were only able to collect data on the performance of institutions, and not important data such as the incidence of ACS and door-to-balloon time in STEMI patients. Moreover, the survey did not ask what specific measures were taken in centers that decided to perform PCI with limitation for high-risk ACS or STEMI. That is, we do not have data on infection control, how patients were triaged according to the severity of known COVID-19 infection or the severity of coronary artery disease, or the different strategies of revascularization therapy compared with usual practice. Third, patients experiencing ACS may fear becoming infected after going to hospital, resulting in a lower number of consultations. Fourth, therapeutic procedures and protective equipment may change as the phase of the pandemic worsens. Therefore, continuous evaluations should be conducted. Finally, the generalizability of the study finding may be limited to Japan because of the differences in healthcare systems between Japan and other countries, such as the accessibility of facilities for urgent PCI in patients with ACS. Furthermore, there are significant differences between Asian and Western countries in terms of the number of patients with COVID-19 infections and their mortality rates, which may lead to differences in the strategies used by cardiac catheterization laboratories.

In conclusion, COVID-19 greatly affected institutions’ treatment of coronary artery disease in Japan. However, most of the institutions performed primary PCI for STEMI as usual. Moreover, the rate of non-urgent PCI gradually normalized after the state of emergency was lifted in 39 prefectures in mid-May 2020. The results of the present study should be referred to, considering the very real fears of potential new outbreaks that may spiral out of control in the future.

Acknowledgments
The authors thank all the participating hospitals for their efforts in completing the surveys and the staff of the Japanese Association of CVIT for providing administrative support.

Sources of Funding
This work was supported by the Japanese Association of CVIT and Grants-in-Aid from the 24th General Assembly of the Japanese Association of Medical Sciences.

Disclosures
H.I. has received lecture fees from Astellas Pharma, AstraZeneca, Bayer Pharmaceutical, Chugai Pharma, Daiichi-Sankyo, and MSD. T.A. has received lecture fees from Astellas Pharma, AstraZeneca, Bayer, Daiichi Sankyo, and Bristol-Myers Squibb. K.Y. has received investigator-initiated grant funding from Abbott. S.K. has received investigator-initiated grant funding from Bayer and Daiichi Sankyo, and lecture fees from Bristol-Myers Squibb. H.Y. has received lecture fees from Abbott Vascular Japan, Amgen, Astellas BioPharma, Astellas Pharma, Bayer Pharmaceutical, Boston Scientific, Daiichi Sankyo, HeartFlow Japan, Kyowa Pharmaceutical, Sanoﬁ, Takada Pharmaceutical, and Terumo. Y.I. has received research grants from Boston Scientiﬁc and Bayer. T.A., Y.I., and H.I are members of Circulation Journal Editorial Team. The other authors report no potential conﬂicts of interest.

IRB Information
This study was granted an exemption from requiring ethics approval by the Committee of the Japanese Association of CVIT.

References