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REVIEW

Hospitalized Patients, Treatments, and Quality of Care for Cardiovascular Diseases in Japan

— Outline of the Nationwide JROAD Investigation —

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Cardiovascular diseases (CVD) have imposed a substantial burden on population health and society. In Japan, the National Plan for the Promotion of Measures Against Cerebrovascular and Cardiovascular Disease, grounded in national legislation, seeks to improve the quality of care and standardize treatment for cerebrovascular disease and CVD. The plan emphasizes the need to develop standardized systems for collecting and disseminating medical information, as well as promoting data-driven research. The Japanese Registry Of All cardiac and vascular Diseases (JROAD) was launched by the Japanese Circulation Society to assess the clinical activities of institutions nationwide that have a dedicated cardiovascular inpatient service. Information from participating facilities is accumulated, and a database is constructed by linking Diagnosis Procedure Combination data, which includes patient characteristics and clinical data. Using this real-world data is expected to generate high-quality evidence, leading to a better understanding of CVD, improvements in the quality of care and clinical outcomes, and the implementation of effective health policies, including the appropriate allocation of medical resources and the reduction of medical costs. Ultimately, these efforts aim to extend the life span and healthy life expectancy. This design paper outlines the overall concept of the JROAD investigation in cardiovascular care. In addition, it summarizes representative CVD data, reviews the literature on the quality of care, and describes the prospects of the investigation.

Key Words: Cardiovascular disease; In-hospital mortality; Japanese Registry Of All cardiac and vascular Diseases (JROAD); Quality of care; Treatments

In developed countries, the morbidity and mortality rates for cardiovascular diseases are extremely high. In Japan, in 2021, heart disease was the second leading cause of death, and cerebrovascular disease was the fourth.[1] Combined, heart and cerebrovascular disease were the leading cause of death after cancer, accounting for over 310,000 deaths annually in Japan.[1] Of a total of 31.9583 trillion yen for medical expenses in the fiscal year 2019, cardiovascular diseases accounted for the largest share, at 6.1369 trillion yen (19.2%).[2] As such, cardiovascular diseases significantly impact the lives and health of the population and society as a whole. In October 2020, the Japanese National Plan for Promotion of Measures Against Cerebrovascular and Cardiovascular Disease, based on the *Cerebrovascular and Cardiovascular Disease Control Act*, was established.[3,4] This plan aims to improve the quality of medical care and standardize treatment, emphasizing the need to develop standardized systems for

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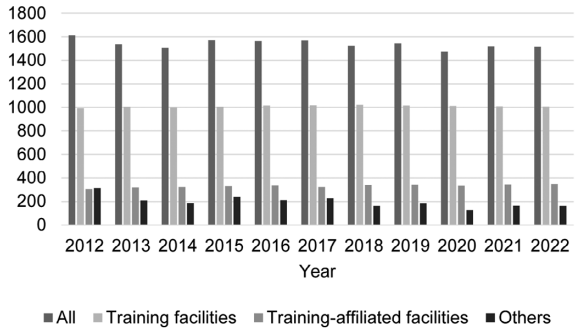

Figure 1. Institutions participating in the Japanese Registry Of All cardiac and vascular Diseases (JROAD). Participating institutions were classified as training, training-affiliated, and other facilities.

collecting and disseminating medical information, as well as promoting data-driven research.

The Japanese Registry Of All cardiac and vascular Diseases (JROAD) was launched in 2004 by the Japanese Circulation Society (JCS) to assess the clinical activities of institutions nationwide that have dedicated cardiovascular subspeciality inpatient services, and to provide adequate feedback to participating hospitals to improve their patient care.[5] Information from facilities participating in the JROAD investigation is accumulated, and a database was constructed by linking Diagnosis Procedure Combination (DPC) data, which includes patient characteristics and clinical data (e.g., medications and procedures) collected from DPC-participating hospitals. Using this real-world clinical data is expected to generate high-quality evidence, leading to a better understanding of cardiovascular diseases, improvements in the quality of care and clinical outcomes, and the implementation of effective health policies, including the appropriate allocation of medical resources and a reduction in medical costs.

This design paper outlines the overall concept and role of the JROAD investigation in cardiovascular care. In addition, it summarizes representative cardiovascular disease data collected since the project's inception, reviews literature on the quality of care, and describes the prospects of the investigation.

Data Collection

The JROAD investigation has been conducted at facilities supporting regional medical care, regardless of size, among those with departments of cardiology, cardiovascular surgery, and pediatric cardiology. These facilities were selected by JCS board members from the 9 regions across Japan, as well as certified training and affiliated training facilities. Therefore, this investigation covers the majority of cardiovascular inpatients nationwide.

All institutions participating in the JROAD investigation provide data as part of an annual survey, including resources (e.g., hospitals, beds, and cardiologists) and burden (e.g., number of inpatients, examinations, and procedures; **Supplementary Table**). The investigation targets all patients hospitalized with cardiovascular diseases at the participating facilities between April 1, 2012 and March 31, 2022 (continuing as of July 31, 2024 at the time of writing). Hospitals implementing DPC, a payment system for acute care hospital, within the JROAD investigation collect DPC data, which includes details of diagnoses and medical procedures. The collected items include sex, age at admission, diagnosis at admission, comorbidities at admission, complications after admission along with their International Statistical Classification of Diseases and Related Health Problems (ICD) codes, the names and dates of procedures, medications and medical materials used, length of hospital stay, discharge outcomes, and cost information.[6,7]

Input and Storage

Each institution provides information to the JROAD office (within the National Cerebral and Cardiovascular Center) online through the dedicated web site for JROAD participating institutions. The registration is led by the JCS and is not legally mandated. Instead of site visits or external audits, queries are issued to the data input personnel for correction based on comments and logical checks if inconsistencies are found in the responses entered on the investigation forms, such as institution information, the number of inpatients, the number of examinations, and the number of treatments. The institutional information and DPC data are linked by the facility code. The raw data collected is stored under strict management at the National Cerebral and Cardiovascular Center.

Ethical Considerations

The JROAD investigation is approved by the Ethics Review Board of the JCS. Given the nature of the work, ethics approval was not required for the writing of this report. The database is anonymized, ensuring that no personal information is provided or handled, thus preventing any leakage of individual information. Consequently, obtaining individual consent is not required. Instead, each institute provides participants with an opt-out option.

Participating Institutions

Although there have been slight fluctuations in the number of institutes participating each year, in 2022 there were 1,516 institutions participating in JROAD. Of these, 1,010 were training facilities, 344 were affiliated training facilities, and 163 were other facilities (**Figure 1**). In 2022, there were 1,254 (82.8%) DPC-participating hospitals. In 2022, the overall response rate to JROAD investigation among nationwide institutions with a cardiovascular subspeciality inpatient service was 62.8%, with 100% (1,354/1,354) of training and affiliated training facilities and 15.3% (163/1,065) of other facilities participating. It is estimated that the data covers 91.2% of all cases of acute myocardial infarction (AMI), even after accounting for unreported cases, which reflects the high degree of data completeness. Due to the slight variations in the number of participating institutions each year, the aggregate data are presented without adjustments based on institution numbers.

Hospitalized Patients and Treatments for Cardiovascular Diseases

There has been a trend for an increase in the number of patients hospitalized for AMI over the past 11 years, rising from 69,219 in 2012 to 80,084 in 2022. Among these,

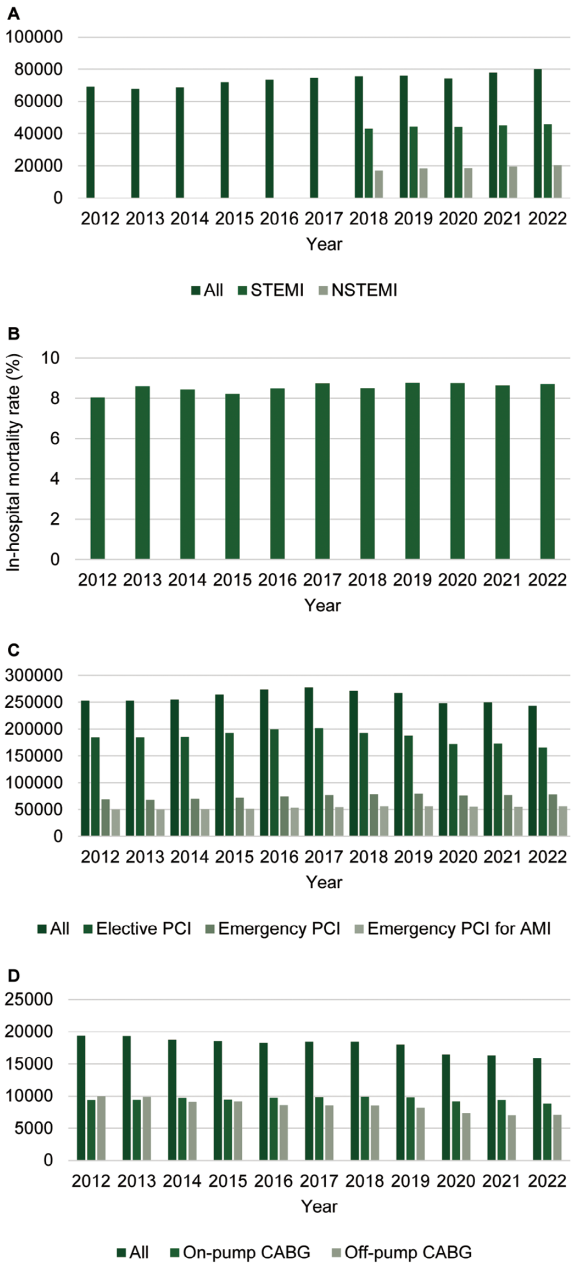

Figure 2. Ischemic heart disease data from the Japanese Registry Of All cardiac and vascular Diseases (JROAD). (**A**) Number of patients hospitalized with acute myocardial infarction (AMI). STEMI, ST-elevation myocardial infarction; NSTEMI, non-ST-elevation myocardial infarction. (**B**) In-hospital mortality rate for AMI. (**C**) Number of patients undergoing percutaneous coronary intervention (PCI) procedures for ischemic heart disease. (**D**) Number of patients undergoing coronary artery bypass grafting (CABG) for ischemic heart disease.

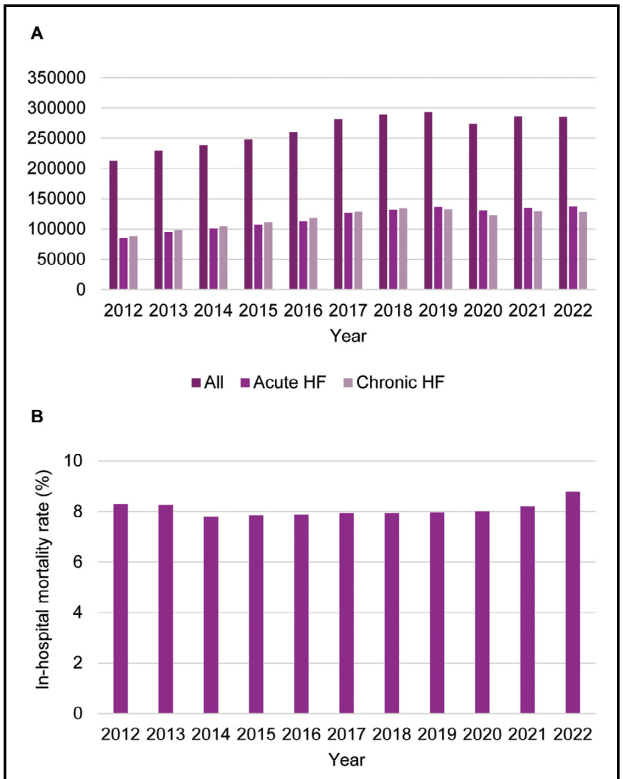

Figure 3. Heart failure data from the Japanese Registry Of All cardiac and vascular Diseases (JROAD). (**A**) Number of patients hospitalized with heart failure (HF). (**B**) In-hospital mortality rate for HF.

45,850 had ST-elevation myocardial infarction (STEMI) and 20,476 had non-STEMI cases, with the remaining cases being undefined (**Figure 2A**). The in-hospital mortality rate for AMI patients in 2022 was 8.7%, with the mean in-hospital mortality rate over the past 11 years being 8.5% (**Figure 2B**). The number of percutaneous coronary interventions (PCIs) for ischemic heart disease peaked in 2017, and then showed a decreasing trend, with a total of 243,516 PCIs performed in 2022, of which 165,567 were elective and 77,949 were emergency procedures. Among the emergency procedures, 56,856 were for AMI (**Figure 2C**). The number of AMI patients who did not undergo emergency PCI increased from 19,259 in 2012 to 23,228 in 2022. In 2013, 19,067 patients underwent coronary artery bypass grafting, but this number has decreased in recent years, with a total of 15,893 patients undergoing the procedure in 2022, including 8,824 on-pump and 7,069 off-pump procedures (**Figure 2D**).

The number of patients hospitalized for heart failure (HF) showed an increasing trend until 2019, plateauing thereafter, with 284,815 patients hospitalized for HF in 2022 (137,327 acute cases and 127,826 chronic cases; **Figure 3A**). The in-hospital mortality rate for HF patients in 2022 was 8.7%, with a mean in-hospital mortality rate for HF of 8.0% over the past 11 years (**Figure 3B**).

Since the start of data collection on acute aortic dissection in 2015, the number of patients with acute aortic dissection has increased, reaching 25,996 in 2022 (**Figure 4A**). The in-hospital mortality rate for patients with acute aortic dissection was 11.8% in 2022, with a mean rate of 12.0% over the past 8 years (**Figure 4B**). The number of treatments has increased annually, with 8,759 surgeries (7,013 emergency surgeries) and 7,872 thoracic aortic stent grafts in 2022 (**Figure 4C**).

In the treatment of valvular disease, the number of transcatheter aortic valve replacement (TAVR) procedures

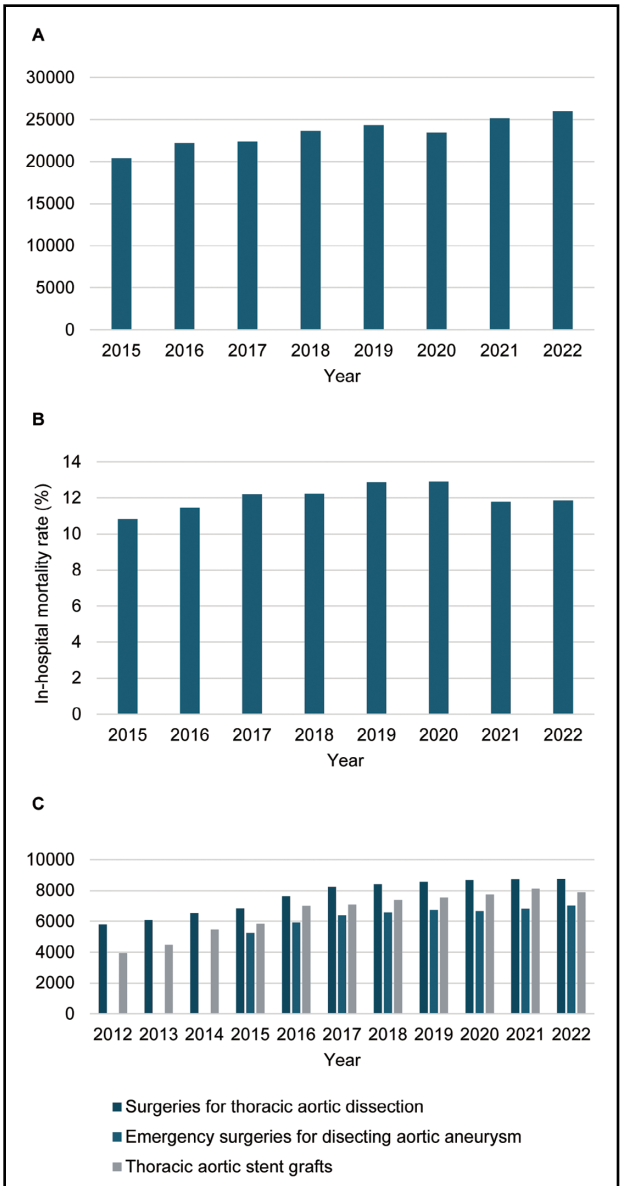

Figure 4. Aortic disease data from the Japanese Registry Of All cardiac and vascular Diseases (JROAD). (**A**) Number of patients hospitalized with acute dissection of aortic aneurysm. (**B**) In-hospital mortality rate for acute dissection of aortic aneurysm. (**C**) Different procedures performed for the treatment of aortic disease.

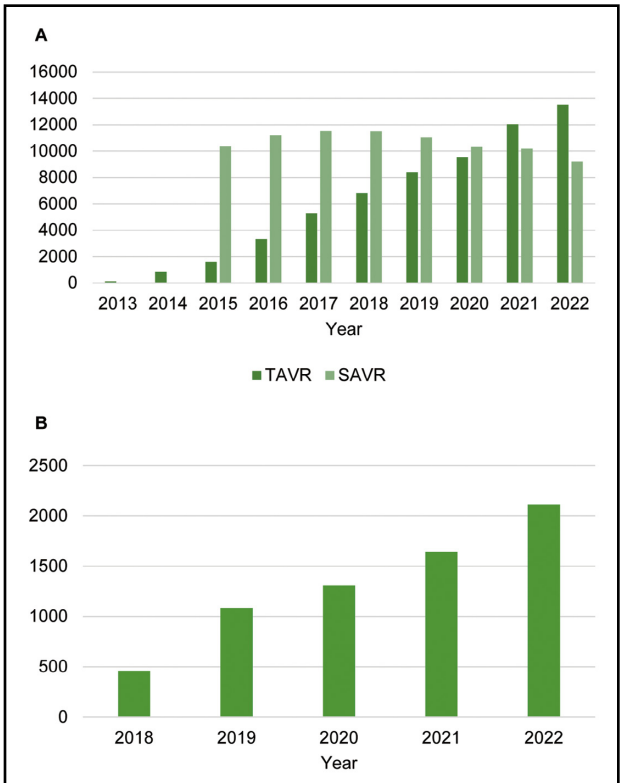

Figure 5. Valvular heart disease data from the Japanese Registry Of All cardiac and vascular Diseases (JROAD). (**A**) Procedures performed for the treatment of aortic stenosis. The numbers of surgical aortic valve replacement (SAVR) procedures in 2023 and 2024 are not shown separately because they were included in the total count of all surgical valve replacements. TAVR, transcatheter aortic valve replacement. (**B**) Number of mitral valve repairs (MitraClip).

for aortic valves has increased significantly each year. In 2021, the number of TAVR procedures surpassed surgical aortic valve replacement (SAVR), with 13,533 TAVR and 9,207 SAVR procedures in 2022 (**Figure 5A**). The number of mitral valve repairs (MitraClip) has increased, reaching 2,110 in 2022 (**Figure 5B**).

Studies Evaluating Quality of Care for Cardiovascular Diseases

Linking JROAD data with DPC data has expanded its usability, providing a more detailed reflection of actual clinical practice and enabling high-quality research on the quality of cardiovascular care. As of March 31, 2023, there were 24 papers that had scientifically examined the quality of cardiovascular care using these data (**Table**). The target diseases are broad and include HF, AMI, thoracic aortic aneurysm, abdominal aortic aneurysm, cardiogenic shock, and adult congenital heart disease.

Factors affecting the quality of cardiovascular care can be classified at region, institution, physician, and patient levels. Region-related factors include country and population density.[8–11] Many of the reports focus on institution-related factors, examining hospitalizations,[12,13] cardiologists[14–17] or surgeons,[18] healthcare resources,[19] prescriptions,[20] echocardiography,[21] surgeries,[18] mechanical circulatory support,[22] educational facilities,[23] integrated hospital practice factors,[24] and hospital performance measures.[25] There are also studies at the physician level, investigating factors such as the age and experience of cardiologists.[26] At the patient level, there are studies examining the effects of age,[27] sex differences,[28,29] and comorbidities, such as Kawasaki disease[30] and schizophrenia,[31] on the quality of cardiovascular care.

Further Research Areas and Prospects

In this paper we have summarized aggregated data on major cardiovascular diseases. However, it is also possible to clarify the characteristics of patients with rare diseases,

Table. List of JROAD Studies Evaluating the Quality of Cardiovascular Care

Category	Factor	Disease	Study
Region	Country	HF	Sundaram et al. (2022)[8]
		AMI	Nakao et al. (2023)[9]
	Population density	HF	Konishi et al. (2020)[10]
		AMI	Matsuzawa et al. (2020)[11]
Institution	Hospitalizations	AMI and HF	Yasuda et al. (2016)[12]
	Hospitalizations per cardiologist	HF	Nishi et al. (2023)[13]
	Cardiologists	Any CVD	Yoneyama et al. (2019)[14]
		AMI	Kanaoka et al. (2018)[15]
			Matoba et al. (2021)[16]
	Cardiologists per bed	HF	Kanaoka et al. (2019)[17]
	Healthcare resources	AMI	Ishii et al. (2022)[19]
	Hospital practice factor	HF	Kaku et al. (2020)[24]
	Hospital performance measures	HF	Nakao et al. (2021)[25]
	Prescriptions	AMI	Nakao et al. (2019)[20]
	Echocardiography	HF	Kusunose et al. (2021)[21]
	Surgeries, surgeons, and cardiologists	TAA/AAA	Yamaguchi et al. (2019)[18]
	MCS cases per year	Cardiogenic shock	Araki et al. (2023)[22]
	Educational facility	ACHD	Mizuno et al. (2020)[23]
Physician	Cardiologist age and experience	Any CVD	Watanabe et al. (2019)[26]
Patient	Age	AMI	Uemura et al. (2019)[27]
	Sex	TAA/AAA	Yamaguchi et al. (2020)[28]
		AMI	Shikuma et al. (2024)[29]
	Kawasaki disease	AMI	Anzai et al. (2022)[30]
	Schizophrenia	HF	Nishi et al. (2023)[31]

AAA, abdominal aortic aneurysm; ACHD, adult congenital heart disease; AMI, acute myocardial infarction; CVD, cardiovascular disease; HF, heart failure; JROAD, Japanese Registry Of All cardiac and vascular Diseases; MCS, mechanical circulatory support; TAA, thoracic aortic aneurysm.

congenital or hereditary diseases, and diseases that do not achieve sufficient treatment effects with current therapies. Annual reports have been published and are available on the JROAD website (https://www.j-circ.or.jp/jittai_chosa/about/report/). In addition, clinical performance at each facility is evaluated using benchmark quality indicators, and feedback is provided. Since 2022, regional governments have used this registry data to develop plans for promoting cardiovascular disease countermeasures within health initiatives. By collecting data related to HF from some facilities participating in the JROAD investigation, a nationwide investigation on HF (JROAD-HF) has also been conducted. The evidence established by the JROAD investigation can be reflected in various guidelines, thereby raising the standard of cardiovascular care in Japan and promoting the spread of individualized patient treatment.

In addition, the safety and effectiveness of new drugs and novel treatment techniques can be evaluated, which is expected to lead to the identification of unmet needs and the development of innovative medicines and medical devices. Industry–academia collaborative projects have already started. Currently, the introduction of laboratory test items and the standardization of image data are also progressing, which will enable the accurate evaluation of new technologies, as well as the effectiveness and safety of new drugs.

This investigation consists of an overview of the institution, examinations, and treatment status, reflecting the actual conditions of cardiovascular care in Japan. The overview of the institution shows the level of supply of cardiovascular care, whereas examinations and treatment status indicate the demand for cardiovascular care, allowing for an analysis from both the supply and demand perspectives. As a result of research based on this database research, it is expected that effective health policies (e.g., appropriate allocation of medical resources and cost-savings on medical expenses) will be implemented.

Conclusions

The JROAD investigation can contribute to a better understanding of cardiovascular diseases, improvements in the quality of cardiovascular care and clinical outcomes, and the implementation of effective health policies. Investigating the supply–demand balance will lead to an appropriate allocation of medical resources and a reduction in medical costs. Ultimately, these efforts are expected to extend both the life span and healthy life expectancy of people.

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Disclosures

K.N., Y.K.B., and Y.F. are members of *Circulation Journal*'s Editorial Team. The remaining authors have no conflicts of interest to declare.

Data Availability

The deidentified participant data will not be shared.

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Supplementary Files

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