Standard Export Data Format for Extension Storage of Standardized Structured Medical Information Exchange

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on behalf of the IHE Cardiology Team and SEAMAT Committee

Background: In the era of big data, the utilization and analysis of large amounts of clinical data are imperative. The standardized structured medical information exchange version 2 (SS-MIX2) is a standard data storage format used in Japan to share clinical data from various vendor-derived hospital information systems. This storage format is divided into 2 categories: standardized and extension storage. Although the standardized storage includes clinical data such as basic patient data, prescriptions, and laboratory results, all other data are stored in the extension storage, because their formats are not standardized.

Methods and Results: In 2015, the Japanese Circulation Society developed the standard export data format (SEAMAT) for electrocardiography (ECG), ultrasound cardiography (UCG), and catheterization (CATH) data for the SS-MIX2 extension storage. Using physical examination and catheter report systems in accordance with the SEAMAT, specific cardiological data such as ECG, UCG, and CATH can be transferred to the SS-MIX2 extension storage, resulting in efficient secondary use of these data for research purposes.

Conclusions: SEAMAT can aid in the effective establishment of a nationwide clinical database, and reduce tedious manual data input by clinicians and clinical research coordinators. Moreover, a program that enables the conversion of comma-separated data from information systems into SEAMAT can provide a useful and economical tool for transferring huge clinical data to the SS-MIX2.

Key Words: Big data; Cardiological examination; Data transition; Standardization

In the era of big data, the utilization and analysis of large amounts of clinical data are important. Clinical research studies in cardiology require a wide range of data, including diagnoses, medications, laboratory tests, and data from multiple modalities, such as electrocardiography (ECG), ultrasound cardiography (UCG), and catheter examinations (CATH), including percutaneous coronary intervention. Although these data exist in a digital format, data transition from the hospital information system (HIS) to a data repository for clinical research is performed manually in the majority of hospitals, resulting in an excess burden for physicians and clinical research coordinators. Therefore, the automated transfer of these data from the HIS to databases is desirable, and requires the determination of standard formats for data connection between HISs and databases.

In Japan, the standardized structured medical information exchange (SS-MIX), which was authorized by the Ministry of Health, Labour and Welfare (MHLW) of the Japanese government in 2006, is commonly used as a standard data storage format to share and utilize clinical data from various vendor-derived HISs. SS-MIX was modified and released as SS-MIX2 in 2012. Several projects using SS-MIX2 have been launched to store and utilize patient clinical data in Japanese hospitals. The number of hospitals using SS-MIX2 was 1471 in March 2019.

The storage format is divided into 2 categories. The first is the standardized storage, including standard clinical data such as basic patient data, prescriptions, and laboratory results, such as ECG, UCG, and CATH, which are well structured. The second is the extension storage, because their formats are not standardized.
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(1) the 2 storages need to be set separately (the hardware components for the 2 storages need not be separated); and (2) unstandardized data must not be stored in standard storage. All data should apply Logical Observation Identifiers Names and Codes (LOINC)\(^1\), which has been established as an international standard for identifying clinical information in electronic reports. Healthcare organizations, software vendors, in vitro diagnostic testing companies, and registered users globally use LOINC to move medical data seamlessly between systems.

**Validation of Data Conversion**

All data from a physiological examination system can be converted to SS-MIX\(^2\) extension storage with the data transition function in accordance with SEAMAT. We validated the accuracy of data conversion of ECG, UCG, and CATH, at Tohoku University, where the physiological examination system (ECG management system EFS-8800; Fukuda Denshi, Japan), UCG report system (Yahgee; Fuji Film Medical IT Solutions, Japan), and catheter report system (Canon Medical Systems, Japan) with data conversion in accordance with SEAMAT were implemented. We compared 100 datasets respectively from ECG, UCG, and CATH with the original data by visual judgement.

**CSV Converter Programs**

A program was developed to convert comma-separated values (CSV) data into XML files in cooperation with Nexis Co., Ltd (Fukuoka, Japan). The development language was C#. This software is available for Microsoft Windows 10 with Microsoft.NET Framework 4.5.2 or later. CSV data files are available in accordance with RFC 4180. To validate this program, we converted CSV files containing data obtained from the physiological examination system.

**Methods**

**Integrating the Healthcare Enterprise (IHE)**

IHE\(^3\) is an international association that aims to improve the manner in which healthcare computer systems share information, and sets profiles for the coordinated use of established standards, such as the Digital Imaging and Communications in Medicine and Health Level Seven. One of the IHE activities, “connectathon,” provides connectivity testing across various vendor platforms, and validates the interoperability and compliance of participants with the IHE profile.\(^4\) In Japan, IHE-Japan (IHE-J) is also active in promoting IHE profiles in accordance with the Japanese health system, through collaboration between technicians from vendor companies and clinicians from several hospitals.\(^5\) In this study, several members among the cardiology working group of IHE-J collaborated on the drafts.

**Application of SS-MIX2 Extension Storage**

The guidelines for SS-MIX2 are available on the webpage of the SS-MIX consortium.\(^6\) In brief, the extension storage of SS-MIX2 should follow the same rule of consisting of a tree structure of folders, as well as the standardized storage, in which structured data (e.g., disease names, blood test results, and prescriptions) can be stored (Figure 1). The following rules are implemented to store data files in the extension storage: (1) root folders should be set separately; in a medical facility, if both standard storage and extension storage are created in a storage system, the root folders for the 2 storages need to be set separately (the hardware components for the 2 storages need not be separated); and (2) unstandardized data must not be stored in standard storage. All data should apply Logical Observation Identifiers Names and Codes (LOINC),\(^7\) which has been established as an international standard for identifying clinical information in electronic reports. Healthcare organizations, software vendors, in vitro diagnostic testing companies, and registered users globally use LOINC to move medical data seamlessly between systems.

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system to XML files in SS-MIX2 storage according to the SEAMAT at Tohoku University Hospital and Kyushu University Hospital.

**Ethics**

Any identifying information of the patients was removed prior to the analysis. The authors had access to all of the data and take complete responsibility for the integrity thereof. Ethical approval was granted by the Tohoku University Ethics Committee.

### Table 1. Standard Export Data Format (SEAMAT) List for Electrocardiogram (ECG)

| Item name                  | Display name       | Data type | Unit     | Item code | Option Code | Meaning | Code system | Code system OID |
|----------------------------|--------------------|-----------|----------|-----------|-------------|---------|-------------|-----------------|
| Heart rate                 | Heart rate         | PQ        | L/min    | 8867-4    | LOINC       |         |             |                 |
| PR interval                | PR interval        | PQ        | ms       | 8625-6    | LOINC       |         |             |                 |
| QRS duration               | QRS duration       | PQ        | ms       | 8633-0    | LOINC       |         |             |                 |
| QT interval                | QT interval        | PQ        | ms       | 8634-8    | LOINC       |         |             |                 |
| QT interval corrected      | QT interval corrected | PQ      | ms       | 8636-3    | LOINC       |         |             |                 |
| QTc interval by Fridericia | QTc interval by Fridericia | PQ    | ms       | 76634-5   | LOINC       |         |             |                 |
| QTc interval by Bazett     | QTc interval by Bazett | PQ      | ms       | 76635-2   | LOINC       |         |             |                 |
| QTc_INT                    | QTc_INT            | PQ        | ms       | 14        | MEASURED    |         |             |                 |
| P wave axis                | P wave axis        | PQ        | deg      | 8626-4    | LOINC       |         |             |                 |
| QRS axis                   | QRS axis           | PQ        | deg      | 8632-2    | LOINC       |         |             |                 |
| T wave axis                | T wave axis        | PQ        | deg      | 8638-9    | LOINC       |         |             |                 |
| S wave Amp L-V1            | S wave amplitude in lead V1 | PQ | mV     | 10040-4   | LOINC       |         |             |                 |
| R wave Amp L-V5            | R wave amplitude in lead V5 | PQ | mV     | 9995-2    | LOINC       |         |             |                 |
| R wave Amp L-V6            | R wave amplitude in lead V6 | PQ | mV     | 9996-0    | LOINC       |         |             |                 |
| R wave Amp L-V5 + S wave Amp L-V1 | R wave amplitude in lead V5 + S wave amplitude in lead V1 | PQ | mV | 76636-0 | LOINC |         |             |                 |
| R wave Amp L-V6 + S wave Amp L-V1 | R wave amplitude in lead V6 + S wave amplitude in lead V1 | PQ | mV | 76646-9 | LOINC |         |             |                 |
| Analysis results (Nihon Kohden) | Analysis results are recorded (e.g., sinus rhythm) | Character – | string | ECAPS     | ECAPS       |         |             | 1.2.392.200119.5.2.3.3.3.1 |
| Minnesota Code (Nihon Kohden 1987) | Contents are recorded (e.g., normal) | Character – | string | Minnesota Code (e.g., 1–0) | MINNESOTA1987_NK | 1.2.392.200119.5.2.3.3.2.1 |
| Minnesota Code (Nihon Kohden 2005) | Contents are recorded (e.g., normal) | Character – | string | Minnesota Code (e.g., 1–0) | MINNESOTA2005_NK | 1.2.392.200119.5.2.3.3.2.2 |
| Analysis/adjudication results (Fukuda Denshi) | Analysis/adjudication results are recorded (e.g., normal range) | Character – | string | Adjudication code | FKD GRADE | 1.2.392.200119.5.2.4.1.1.1 |
| Analysis/findings (Fukuda Denshi) | Analysis results/findings are recorded (e.g., normal range) | Character – | string | Findings code | FKD_INTER | 1.2.392.200119.5.2.4.1.1.2 |
| Minnesota Code (Fukuda Denshi) | Minnesota Code and abnormalities are recorded (e.g., 1–1–1A) | Character – | string | Minnesota Code | MINESOTA_CODE | 1.2.392.200119.5.2.4.1.1.3 |

LOINC, Logical Observation Identifiers Names and Codes; PQ, value type.
| Item name | Display name | Data type | Unit | Item code | Option Code | Meaning | Name OID |
|-----------|--------------|-----------|------|-----------|-------------|---------|----------|
| Heart rate | Heart rate | PQ | L/min | Apr-67 | LOINC 2.16.840.1.113883.6.1 |
| LVIDd(M) | LVIDd(M) | PQ | mm | 29437-1 | LOINC 2.16.840.1.113883.6.1 |
| LVIDd(2D) | LVIDd(2D) | PQ | mm | 18083-6 | LOINC 2.16.840.1.113883.6.1 |
| LVIDs(M) | LVIDs(M) | PQ | mm | 29439-7 | LOINC 2.16.840.1.113883.6.1 |
| LVIDs(2D) | LVIDs(2D) | PQ | mm | 18085-1 | LOINC 2.16.840.1.113883.6.1 |
| LV sphericity index_long/short_end diastole | LV sphericity index_long/short_end diastole | PQ | 1 | 93663-3 | LOINC 2.16.840.1.113883.6.1 |
| IVSTd(M) | IVSTd(M) | PQ | mm | 29431-4 | LOINC 2.16.840.1.113883.6.1 |
| IVSTd(2D) | IVSTd(2D) | PQ | mm | 29430-6 | LOINC 2.16.840.1.113883.6.1 |
| IVSTs(M) | IVSTs(M) | PQ | mm | 79970-0 | LOINC 2.16.840.1.113883.6.1 |
| IVSTs(2D) | IVSTs(2D) | PQ | mm | 79971-8 | LOINC 2.16.840.1.113883.6.1 |
| LVPWTd(M) | LVPWTd(M) | PQ | mm | 29437-1 | LOINC 2.16.840.1.113883.6.1 |
| LVPWTd(2D) | LVPWTd(2D) | PQ | mm | 29442-1 | LOINC 2.16.840.1.113883.6.1 |
| LVPWTs(M) | LVPWTs(M) | PQ | mm | 80034-4 | LOINC 2.16.840.1.113883.6.1 |
| LVPWTs(2D) | LVPWTs(2D) | PQ | mm | 80034-2 | LOINC 2.16.840.1.113883.6.1 |
| LV EDV_Teichholz(M) | LV EDV_Teichholz(M) | PQ | mL | 20238-2 | LOINC 2.16.840.1.113883.6.1 |
| LV EDV_Teichholz(2D) | LV EDV_Teichholz(2D) | PQ | mL | 76549-5 | LOINC 2.16.840.1.113883.6.1 |
| LV EDV_biplane_MOD | LV EDV_biplane_MOD | PQ | mL | 20237-4 | LOINC 2.16.840.1.113883.6.1 |
| LV EDV_A4C_single plane_MOD | LV EDV_A4C_single plane_MOD | PQ | mL | 79999-9 | LOINC 2.16.840.1.113883.6.1 |
| LV EDV_A2C_single plane_MOD | LV EDV_A2C_single plane_MOD | PQ | mL | 79998-1 | LOINC 2.16.840.1.113883.6.1 |
| LV EDV_biplane_area length | LV EDV_biplane_area length | PQ | mL | 93662-5 | LOINC 2.16.840.1.113883.6.1 |
| LV EDV_A4C_single plane_area length | LV EDV_A4C_single plane_area length | PQ | mL | 93661-7 | LOINC 2.16.840.1.113883.6.1 |
| LV EDV_A2C_single plane_area length | LV EDV_A2C_single plane_area length | PQ | mL | 93660-9 | LOINC 2.16.840.1.113883.6.1 |
| LV EDV(3D) | LV EDV(3D) | PQ | mL | 79995-7 | LOINC 2.16.840.1.113883.6.1 |
| LV ESV_Teichholz(M) | LV ESV_Teichholz(M) | PQ | mL | 24530-8 | LOINC 2.16.840.1.113883.6.1 |
| LV ESV_Teichholz(2D) | LV ESV_Teichholz(2D) | PQ | mL | 76554-5 | LOINC 2.16.840.1.113883.6.1 |
| LV ESV_biplane_MOD | LV ESV_biplane_MOD | PQ | mL | 76557-8 | LOINC 2.16.840.1.113883.6.1 |
| LV ESV_A4C_single plane_MOD | LV ESV_A4C_single plane_MOD | PQ | mL | 80004-5 | LOINC 2.16.840.1.113883.6.1 |
| LV ESV_A2C_single plane_MOD | LV ESV_A2C_single plane_MOD | PQ | mL | 80003-7 | LOINC 2.16.840.1.113883.6.1 |
| LV ESV_biplane_area length | LV ESV_biplane_area length | PQ | mL | 93659-1 | LOINC 2.16.840.1.113883.6.1 |
| LV ESV_A4C_single plane_area length | LV ESV_A4C_single plane_area length | PQ | mL | 93658-3 | LOINC 2.16.840.1.113883.6.1 |
| LV ESV_A2C_single plane_area length | LV ESV_A2C_single plane_area length | PQ | mL | 93657-5 | LOINC 2.16.840.1.113883.6.1 |
| LV ESV(3D) | LV ESV(3D) | PQ | mL | 80000-3 | LOINC 2.16.840.1.113883.6.1 |
| LV SV_Teichholz(M) | LV SV_Teichholz(M) | PQ | mL | 76560-2 | LOINC 2.16.840.1.113883.6.1 |
| LV SV_Teichholz(2D) | LV SV_Teichholz(2D) | PQ | mL | 76561-0 | LOINC 2.16.840.1.113883.6.1 |
| LV SV_biplane_MOD | LV SV_biplane_MOD | PQ | mL | 20330-7 | LOINC 2.16.840.1.113883.6.1 |
| LV SV_A4C_single plane_MOD | LV SV_A4C_single plane_MOD | PQ | mL | 93656-7 | LOINC 2.16.840.1.113883.6.1 |

(Table 2 continued the next page.)
| Item name                               | Display name                  | Data type | Unit | Item code   | Option Code system | Code | Meaning | Name | OID |
|-----------------------------------------|-------------------------------|-----------|------|-------------|-------------------|------|---------|------|-----|
| LV SV(3D)                               | LV SV(3D)                     | PQ        | mL   | 80035-9     | LOINC 2.16.840.1.113883.6.1 |
| LV CO_{Teichholz(M)}                    | LV CO_{Teichholz(M)}          | PQ        | L/min| 76568-5     | LOINC 2.16.840.1.113883.6.1 |
| LV CO_{biplane()}                       | LV CO_{biplane()}             | PQ        | L/min| 20209-3     | LOINC 2.16.840.1.113883.6.1 |
| LV CO_A2C_{single plane_area length}    | LV CO_A2C_{single plane_area length} | PQ       | mL   | 93655-9     | LOINC 2.16.840.1.113883.6.1 |
| LV CO_A2C_{single plane_area length}    | LV CO_A2C_{single plane_area length} | PQ       | mL   | 93654-2     | LOINC 2.16.840.1.113883.6.1 |
| LV CO_A4C_{single plane_area length}    | LV CO_A4C_{single plane_area length} | PQ       | mL   | 93653-4     | LOINC 2.16.840.1.113883.6.1 |
| LV CO_A2C_{single plane_area length}    | LV CO_A2C_{single plane_area length} | PQ       | mL   | 93652-6     | LOINC 2.16.840.1.113883.6.1 |
| LV CO_A2C_{single plane_area length}    | LV CO_A2C_{single plane_area length} | PQ       | mL   | 93651-8     | LOINC 2.16.840.1.113883.6.1 |
| LV CO_A2C_{single plane_area length}    | LV CO_A2C_{single plane_area length} | PQ       | mL   | 93650-0     | LOINC 2.16.840.1.113883.6.1 |
| LV CO_A2C_{single plane_area length}    | LV CO_A2C_{single plane_area length} | PQ       | mL   | 93649-2     | LOINC 2.16.840.1.113883.6.1 |
| LV CO_A2C_{single plane_area length}    | LV CO_A2C_{single plane_area length} | PQ       | mL   | 93648-4     | LOINC 2.16.840.1.113883.6.1 |
| LV CO_A2C_{single plane_area length}    | LV CO_A2C_{single plane_area length} | PQ       | mL   | 93647-6     | LOINC 2.16.840.1.113883.6.1 |
| LV CO_{Teichholz(2D)}                   | LV CO_{Teichholz(2D)}         | PQ        | L/min| 76569-3     | LOINC 2.16.840.1.113883.6.1 |
| LV CO_A4C_{single plane_area length}    | LV CO_A4C_{single plane_area length} | PQ       | mL   | 93646-8     | LOINC 2.16.840.1.113883.6.1 |
| LV CO_A4C_{single plane_area length}    | LV CO_A4C_{single plane_area length} | PQ       | mL   | 93645-0     | LOINC 2.16.840.1.113883.6.1 |
| LV CO_{Teichholz(M)}                    | LV CO_{Teichholz(M)}          | PQ        | L/min| 81390-7     | LOINC 2.16.840.1.113883.6.1 |
| LV EF_{Visual}                          | LV EF_{Visual}                | PQ        | %    | 8807-0      | LOINC 2.16.840.1.113883.6.1 |
| LV EF_{Teichholz(M)}                    | LV EF_{Teichholz(M)}          | PQ        | %    | 18049-7     | LOINC 2.16.840.1.113883.6.1 |
| LV EF_{biplane()}                       | LV EF_{biplane()}             | PQ        | %    | 77891-0     | LOINC 2.16.840.1.113883.6.1 |
| LV EF_A2C_{single plane_area length}    | LV EF_A2C_{single plane_area length} | PQ       | %    | 77892-8     | LOINC 2.16.840.1.113883.6.1 |
| LV EF_A2C_{single plane_area length}    | LV EF_A2C_{single plane_area length} | PQ       | %    | 77890-8     | LOINC 2.16.840.1.113883.6.1 |
| LV EF_A4C_{single plane_area length}    | LV EF_A4C_{single plane_area length} | PQ       | %    | 79999-3     | LOINC 2.16.840.1.113883.6.1 |
| LV EF_A2C_{single plane_area length}    | LV EF_A2C_{single plane_area length} | PQ       | %    | 79999-4     | LOINC 2.16.840.1.113883.6.1 |
| LV EF_A4C_{single plane_area length}    | LV EF_A4C_{single plane_area length} | PQ       | %    | 93664-8     | LOINC 2.16.840.1.113883.6.1 |
| LV EF_A4C_{single plane_area length}    | LV EF_A4C_{single plane_area length} | PQ       | %    | 93645-0     | LOINC 2.16.840.1.113883.6.1 |
| LV EF_A2C_{single plane_area length}    | LV EF_A2C_{single plane_area length} | PQ       | %    | 93644-3     | LOINC 2.16.840.1.113883.6.1 |
| LV EF(3D)                               | LV EF(3D)                     | PQ        | %    | 79990-8     | LOINC 2.16.840.1.113883.6.1 |
| FS(2D)                                  | FS(2D)                        | PQ        | %    | 29434-8     | LOINC 2.16.840.1.113883.6.1 |
| FS(M)                                   | FS(M)                         | PQ        | %    | 29435-5     | LOINC 2.16.840.1.113883.6.1 |
| LV mass_{ASE(M)}                        | LV mass_{ASE(M)}              | PQ        | g    | 18088-5     | LOINC 2.16.840.1.113883.6.1 |
| LV mass_{ASE(2D)}                       | LV mass_{ASE(2D)}             | PQ        | g    | 77894-4     | LOINC 2.16.840.1.113883.6.1 |
| LV mass_{Devereux}                      | LV mass_{Devereux}            | PQ        | g    | 77895-1     | LOINC 2.16.840.1.113883.6.1 |
| LV mass_area length                     | LV mass_area length           | PQ        | g    | 77896-9     | LOINC 2.16.840.1.113883.6.1 |
| LV MI_{ASE(M)}                          | LV MI_{ASE(M)}                | PQ        | g/m²| 77898-5     | LOINC 2.16.840.1.113883.6.1 |
| LV MI_{ASE(2D)}                         | LV MI_{ASE(2D)}               | PQ        | g/m²| 77899-3     | LOINC 2.16.840.1.113883.6.1 |
| LV MI_{Devereux}                        | LV MI_{Devereux}              | PQ        | g/m²| 81095-2     | LOINC 2.16.840.1.113883.6.1 |
| LV MI_area length                       | LV MI_area length             | PQ        | g/m²| 77900-9     | LOINC 2.16.840.1.113883.6.1 |

(Table 2 continued the next page.)
| Item name                      | Display name                      | Data type | Unit | Item code | Option | Code system |
|-------------------------------|-----------------------------------|-----------|------|-----------|---------|-------------|
| RVDd_basal_RVD1               | RVDd_basal_RVD1                  | PQ        | mm   | 80080-5   |         | LOINC 2.16.840.1.113883.6.1 |
| RVDd_mid_RVD2                | RVDd_mid_RVD2                   | PQ        | mm   | 80085-4   |         | LOINC 2.16.840.1.113883.6.1 |
| RVDd_longitudinal_RVD3       | RVDd_longitudinal_RVD3           | PQ        | mm   | 93643-5   |         | LOINC 2.16.840.1.113883.6.1 |
| RVOTD prox_PLAX              | RVOTD prox_PLAX                 | PQ        | mm   | 80088-8   |         | LOINC 2.16.840.1.113883.6.1 |
| RVOTD prox_SAX               | RVOTD prox_SAX                  | PQ        | mm   | 93642-7   |         | LOINC 2.16.840.1.113883.6.1 |
| RVOTD distal_SAX             | RVOTD distal_SAX                | PQ        | mm   | 80087-0   |         | LOINC 2.16.840.1.113883.6.1 |
| RV wall thickness            | RV wall thickness                | PQ        | mm   | 18153-7   |         | LOINC 2.16.840.1.113883.6.1 |
| TAPSE                        | TAPSE                            | PQ        | mm   | 77903-3   |         | LOINC 2.16.840.1.113883.6.1 |
| RV FAC                       | RV FAC                           | PQ        | %    | 78175-7   |         | LOINC 2.16.840.1.113883.6.1 |
| RV EF(3D)                    | RV EF(3D)                        | PQ        | %    | 81388-1   |         | LOINC 2.16.840.1.113883.6.1 |
| LADs_AP(M)                   | LADs_AP(M)                       | PQ        | mm   | 18024-0   |         | LOINC 2.16.840.1.113883.6.1 |
| LADs_AP(2D)                  | LADs_AP(2D)                      | PQ        | mm   | 29468-6   |         | LOINC 2.16.840.1.113883.6.1 |
| LA area_A4C                  | LA area_A4C                      | PQ        | mm²  | 79974-2   |         | LOINC 2.16.840.1.113883.6.1 |
| LA area_A2C                  | LA area_A2C                      | PQ        | mm²  | 79973-4   |         | LOINC 2.16.840.1.113883.6.1 |
| LA volume_biplane_MOD        | LA volume_biplane_MOD            | PQ        | mL   | 77904-1   |         | LOINC 2.16.840.1.113883.6.1 |
| LA volume_A4C_single_plane_MOD | LA volume_A4C_single_plane_MOD  | PQ        | mL   | 79986-6   |         | LOINC 2.16.840.1.113883.6.1 |
| LA volume_A2C_single_plane_MOD | LA volume_A2C_single_plane_MOD  | PQ        | mL   | 79985-8   |         | LOINC 2.16.840.1.113883.6.1 |
| LA volume_biplane_area_length | LA volume_biplane_area_length    | PQ        | mL   | 77905-8   |         | LOINC 2.16.840.1.113883.6.1 |
| LA volume_A4C_single_plane_area_length | LA volume_A4C_single_plane_area_length | PQ | mL | 93641-9 |         | LOINC 2.16.840.1.113883.6.1 |
| LA volume_A2C_single_plane_area_length | LA volume_A2C_single_plane_area_length | PQ | mL | 93640-1 |         | LOINC 2.16.840.1.113883.6.1 |
| LA VI_biplane_MOD           | LA VI_biplane_MOD                | PQ        | mL/m² | 77906-6 |         | LOINC 2.16.840.1.113883.6.1 |
| LA VI_A4C_single_plane_MOD  | LA VI_A4C_single_plane_MOD       | PQ        | mL/m² | 93639-3  |         | LOINC 2.16.840.1.113883.6.1 |
| LA VI_A2C_single_plane_MOD  | LA VI_A2C_single_plane_MOD       | PQ        | mL/m² | 93638-5  |         | LOINC 2.16.840.1.113883.6.1 |
| LA VI_biplane_area_length   | LA VI_biplane_area_length        | PQ        | mL/m² | 79982-5  |         | LOINC 2.16.840.1.113883.6.1 |
| LA VI_A4C_single_plane_area_length | LA VI_A4C_single_plane_area_length | PQ | mL/m² | 93637-7 |         | LOINC 2.16.840.1.113883.6.1 |
| LA VI_A2C_single_plane_area_length | LA VI_A2C_single_plane_area_length | PQ | mL/m² | 93636-9 |         | LOINC 2.16.840.1.113883.6.1 |
| RA major dimension_A4C      | RA major dimension_A4C           | PQ        | mm   | 80076-3   |         | LOINC 2.16.840.1.113883.6.1 |
| RA minor dimension_A4C      | RA minor dimension_A4C           | PQ        | mm   | 80077-1   |         | LOINC 2.16.840.1.113883.6.1 |
| RA area_A4C                 | RA area_A4C                      | PQ        | mm²  | 80075-5   |         | LOINC 2.16.840.1.113883.6.1 |
| RA volume_A4C               | RA volume_A4C                    | PQ        | mL   | 93635-1   |         | LOINC 2.16.840.1.113883.6.1 |
| IVCDExpiration              | IVCDExpiration                   | PQ        | mm   | 29459-5   |         | LOINC 2.16.840.1.113883.6.1 |
| IVCDInspiration             | IVCDInspiration                  | PQ        | mm   | 29429-8   |         | LOINC 2.16.840.1.113883.6.1 |
| IVC CI                      | IVC CI                           | PQ        | 1    | 18050-5   |         | LOINC 2.16.840.1.113883.6.1 |
| IVC collapse                | IVC collapse                     | CD        | –    | 93634-4   |         | LOINC 2.16.840.1.113883.6.1 |
| Estimated RAP               | Estimated RAP                    | PQ        | mmHg | 82337-7   |         | LOINC 2.16.840.1.113883.6.1 |
| Pericardial effusion        | Pericardial effusion             | CD        | –    | 93664-1   |         | LOINC 2.16.840.1.113883.6.1 |

(Continued on the next page.)
| Item name                  | Display name           | Data type | Unit | Item code | Option | Code system         | Name   | OID              |
|---------------------------|------------------------|-----------|------|-----------|--------|---------------------|--------|------------------|
| AoD(M)                    | AoD(M)                 | PQ        | mm   | 82338-5  |        | LOINC 2.16.840.1.113883.6.1 |
| AoD(2D)                   | AoD(2D)                | PQ        | mm   | 82339-3  |        | LOINC 2.16.840.1.113883.6.1 |
| AoD_annulus_end diastole  | AoD_annulus_end diastole | PQ       | mm   | 18016-6  |        | LOINC 2.16.840.1.113883.6.1 |
| AoD_Valsalva              | AoD_Valsalva           | PQ        | mm   | 78176-5  |        | LOINC 2.16.840.1.113883.6.1 |
| AoD_STJ                   | AoD_STJ                | PQ        | mm   | 79955-1  |        | LOINC 2.16.840.1.113883.6.1 |
| AoD_descending            | AoD_descending         | PQ        | mm   | 18012-5  |        | LOINC 2.16.840.1.113883.6.1 |
| LVOT vel_max              | LVOT vel_max           | PQ        | m/s  | 18164-4  |        | LOINC 2.16.840.1.113883.6.1 |
| LVOT VTI                  | LVOT VTI               | PQ        | m    | 18170-1  |        | LOINC 2.16.840.1.113883.6.1 |
| LVOT SV                   | LVOT SV                | PQ        | mL   | 20328-1  |        | LOINC 2.16.840.1.113883.6.1 |
| LVOT CO                   | LVOT CO                | PQ        | L/min| 20207-7  |        | LOINC 2.16.840.1.113883.6.1 |
| AoV vel_max               | AoV vel_max            | PQ        | m/s  | 11706-9  |        | LOINC 2.16.840.1.113883.6.1 |
| AoV peak_PG               | AoV peak_PG            | PQ        | mmHg | 18062-0  |        | LOINC 2.16.840.1.113883.6.1 |
| AoV mean_PG               | AoV mean_PG            | PQ        | mmHg | 18063-8  |        | LOINC 2.16.840.1.113883.6.1 |
| AoV VTI                   | AoV VTI                | PQ        | m    | 79965-0  |        | LOINC 2.16.840.1.113883.6.1 |
| LVOT/AoV_V ratio          | LVOT/AoV_V ratio       | PQ        | 1    | 93633-6  |        | LOINC 2.16.840.1.113883.6.1 |
| LVOT/AoV_VTI ratio        | LVOT/AoV_VTI ratio     | PQ        | 1    | 93632-8  |        | LOINC 2.16.840.1.113883.6.1 |
| LVOTD_mid systole         | LVOTD_mid systole      | PQ        | mm   | 18018-2  |        | LOINC 2.16.840.1.113883.6.1 |
| AVA(2D)                   | AVA(2D)                | PQ        | cm²  | 29487-6  |        | LOINC 2.16.840.1.113883.6.1 |
| AVA(Doppler)              | AVA(Doppler)           | PQ        | cm²  | 18090-1  |        | LOINC 2.16.840.1.113883.6.1 |
| AVAI(2D)                  | AVAI(2D)               | PQ        | cm²/m²| 81392-3  |        | LOINC 2.16.840.1.113883.6.1 |
| AVAI(Doppler)             | AVAI(Doppler)          | PQ        | cm²/m²| 79959-3  |        | LOINC 2.16.840.1.113883.6.1 |
| AS severity_semiquanti    | AS severity_semiquanti | CD        | –    | 77912-4  |        | LOINC 2.16.840.1.113883.6.1 |
| AR vel_PHT                | AR vel_PHT             | PQ        | ms   | 18105-7  |        | LOINC 2.16.840.1.113883.6.1 |
| AR vena contracta         | AR vena contracta      | PQ        | mm   | 77908-2  |        | LOINC 2.16.840.1.113883.6.1 |
| AR VTI                    | AR VTI                 | PQ        | m    | 93631-0  |        | LOINC 2.16.840.1.113883.6.1 |
| AR RVol_PISA              | AR RVol_PISA           | PQ        | mL   | 79951-0  |        | LOINC 2.16.840.1.113883.6.1 |
| AR RVol_volumetric        | AR RVol_volumetric     | PQ        | mL   | 79950-2  |        | LOINC 2.16.840.1.113883.6.1 |
| AR RF_PISA                | AR RF_PISA             | PQ        | %    | 93630-2  |        | LOINC 2.16.840.1.113883.6.1 |
| AR RF_volumetric          | AR RF_volumetric       | PQ        | %    | 79942-9  |        | LOINC 2.16.840.1.113883.6.1 |
| AR EROA_PISA              | AR EROA_PISA           | PQ        | mm²  | 77909-0  |        | LOINC 2.16.840.1.113883.6.1 |
| AR EROA_volumetric        | AR EROA_volumetric     | PQ        | mm²  | 77910-8  |        | LOINC 2.16.840.1.113883.6.1 |
| Ao holodiastolic flow reversal_descending | Ao holodiastolic flow reversal_descending | CD | – | 94148-4 | LA32-8 | LOINC 2.16.840.1.113883.6.1 |
| Ao holodiastolic flow reversal_abdominal | Ao holodiastolic flow reversal_abdominal | CD | – | 93629-4 | LA32-8 | LOINC 2.16.840.1.113883.6.1 |
| AR severity_semiquanti    | AR severity_semiquanti | CD        | –    | 18112-3  |        | LOINC 2.16.840.1.113883.6.1 |

(Table 2 continued the next page.)
| Item name         | Display name        | Data type | Unit   | Item code     | Option code system | Code | Meaning                | Name          | OID              |
|-------------------|---------------------|-----------|--------|---------------|---------------------|------|------------------------|---------------|------------------|
| LV E              | LV E                | PQ        | m/s    | 18037-2       | LOINC 2.16.840.1.113883.6.1 |
| LV A              | LV A                | PQ        | m/s    | 17978-8       | LOINC 2.16.840.1.113883.6.1 |
| LV E/A            | LV E/A              | PQ        | 1      | 18038-0       | LOINC 2.16.840.1.113883.6.1 |
| LV DeT            | LV DeT              | PQ        | ms     | 78191-4       | LOINC 2.16.840.1.113883.6.1 |
| A dur             | A dur               | PQ        | ms     | 59105-7       | LOINC 2.16.840.1.113883.6.1 |
| B-B' step         | B-B' step           | CD        | –      | 94147-6       | LA32-8 LA33-6 LA1-0 | LOINC 2.16.840.1.113883.6.1 |
| E VTI_tip         | E VTI_tip           | PQ        | m      | 82594-3       | LOINC 2.16.840.1.113883.6.1 |
| A VTI_tip         | A VTI_tip           | PQ        | m      | 82595-0       | LOINC 2.16.840.1.113883.6.1 |
| E+A VTI_annulus   | E+A VTI_annulus     | PQ        | m      | 80053-2       | LOINC 2.16.840.1.113883.6.1 |
| LV ejection time  | LV ejection time    | PQ        | ms     | 81391-5       | LOINC 2.16.840.1.113883.6.1 |
| LV total systolic time | LV total systolic time | PQ  | ms     | 82340-1       | LOINC 2.16.840.1.113883.6.1 |
| LV myocardial performance index | LV myocardial performance index | PQ  | 1      | 81393-1       | LOINC 2.16.840.1.113883.6.1 |
| Vp_E              | Vp_E                | PQ        | m/s    | 80072-2       | LOINC 2.16.840.1.113883.6.1 |
| E/Vp_E            | E/Vp_E              | PQ        | 1      | 81398-0       | LOINC 2.16.840.1.113883.6.1 |
| MV vel_max        | MV vel_max          | PQ        | m/s    | 11708-5       | LOINC 2.16.840.1.113883.6.1 |
| MV peak_PG        | MV peak_PG          | PQ        | mmHg   | 18057-0       | LOINC 2.16.840.1.113883.6.1 |
| MV mean_PG        | MV mean_PG          | PQ        | mmHg   | 18059-6       | LOINC 2.16.840.1.113883.6.1 |
| MV vel_PHT        | MV vel_PHT          | PQ        | ms     | 18001-8       | LOINC 2.16.840.1.113883.6.1 |
| MVA(2D)           | MVA(2D)             | PQ        | cm²    | 78179-9       | LOINC 2.16.840.1.113883.6.1 |
| MVA PHT           | MVA PHT             | PQ        | cm²    | 18097-6       | LOINC 2.16.840.1.113883.6.1 |
| MS severity_semi-quant        | MS severity_semi-quant | CD        | –      | 77916-5       | LA137-2 LA11832-5 LA6752-5 LA23856-0 LA8751-7 LA23857-8 LA6750-9 | LOINC 2.16.840.1.113883.6.1 |
| MR vel_max        | MR vel_max          | PQ        | m/s    | 20268-9       | LOINC 2.16.840.1.113883.6.1 |
| MR peak_PG        | MR peak_PG          | PQ        | mmHg   | 20250-7       | LOINC 2.16.840.1.113883.6.1 |
| MR Vel dur_1–3 m/s | MR Vel dur_1–3 m/s | PQ  | ms     | 81387-3       | LOINC 2.16.840.1.113883.6.1 |
| MR dP/dt          | MR dP/dt            | PQ        | mmHg   | 18035-6       | LOINC 2.16.840.1.113883.6.1 |
| MR vena contracta | MR vena contracta   | PQ        | mm     | 77913-2       | LOINC 2.16.840.1.113883.6.1 |
| MR VTI            | MR VTI              | PQ        | m      | 93628-6       | LOINC 2.16.840.1.113883.6.1 |
| MR RVol_PISA      | MR RVol_PISA        | PQ        | mL     | 29449-6       | LOINC 2.16.840.1.113883.6.1 |
| MR RVol_volumetric | MR RVol_volumetric  | PQ        | mL     | 81394-9       | LOINC 2.16.840.1.113883.6.1 |
| MR RF_PISA        | MR RF_PISA          | PQ        | %      | 80056-5       | LOINC 2.16.840.1.113883.6.1 |
| MR RF_volumetric  | MR RF_volumetric    | PQ        | %      | 81395-6       | LOINC 2.16.840.1.113883.6.1 |
| MR EROA_PISA      | MR EROA_PISA        | PQ        | mm²    | 29448-8       | LOINC 2.16.840.1.113883.6.1 |
| MR EROA_volumetric | MR EROA_volumetric  | PQ        | mm²    | 77914-0       | LOINC 2.16.840.1.113883.6.1 |
| MR severity_semi-quant         | MR severity_semi-quant | CD        | –      | 18113-1       | LA137-2 LA11832-5 LA6752-5 LA23856-0 LA8751-7 LA23857-8 LA6750-9 | LOINC 2.16.840.1.113883.6.1 |

(Table 2 continued the next page.)
| Item name | Display name | Data type | Unit | Item code | Option Code | Code Meaning | Name OID |
|-----------|--------------|-----------|------|-----------|-------------|--------------|----------|
| PV S vel  | PV S vel     | PQ        | m/s  | 29450-4   | LOINC 2.16.840.1.113883.6.1 |
| PV S1 vel | PV S1 vel    | PQ        | m/s  | 93627-8   | LOINC 2.16.840.1.113883.6.1 |
| PV S2 vel | PV S2 vel    | PQ        | m/s  | 93626-0   | LOINC 2.16.840.1.113883.6.1 |
| PV D vel  | PV D vel     | PQ        | m/s  | 29451-2   | LOINC 2.16.840.1.113883.6.1 |
| PV S/D   | PV S/D       | PQ        | 1    | 29452-0   | LOINC 2.16.840.1.113883.6.1 |
| PVA      | PVA          | PQ        | m/s  | 29453-8   | LOINC 2.16.840.1.113883.6.1 |
| PVA dur  | PVA dur      | PQ        | ms   | 78184-9   | LOINC 2.16.840.1.113883.6.1 |
| PulmV_annulus | PulmV_annulus | PQ  | mm  | 18022-4   | LOINC 2.16.840.1.113883.6.1 |
| PAD main | PAD main     | PQ        | m    | 18020-8   | LOINC 2.16.840.1.113883.6.1 |
| RVOT vel_max | RVOT vel_max | PQ  | m/s  | 18080-2   | LOINC 2.16.840.1.113883.6.1 |
| RVOT VTI | RVOT VTI     | PQ        | m    | 18171-9   | LOINC 2.16.840.1.113883.6.1 |
| RVOT SV  | RVOT SV      | PQ        | mL   | 81389-9   | LOINC 2.16.840.1.113883.6.1 |
| Qp/Qs    | Qp/Qs        | PQ        | 1    | 29462-9   | LOINC 2.16.840.1.113883.6.1 |
| PulmV vel_max | PulmV vel_max | PQ | m/s  | 11710-1   | LOINC 2.16.840.1.113883.6.1 |
| PulmV peak_PG | PulmV peak_PG | PQ | mmHg | 18058-8   | LOINC 2.16.840.1.113883.6.1 |
| PulmV mean_PG | PulmV mean_PG | PQ | mmHg | 18060-4   | LOINC 2.16.840.1.113883.6.1 |
| PR vel_early diastole | PR vel_early diastole | PQ | m/s  | 93625-2   | LOINC 2.16.840.1.113883.6.1 |
| PR vel_end diastole | PR vel_end diastole | PQ | m/s  | 78181-5   | LOINC 2.16.840.1.113883.6.1 |
| PR PG_early diastole | PR PG_early diastole | PQ | mmHg | 93624-5   | LOINC 2.16.840.1.113883.6.1 |
| PR PG_end diastole | PR PG_end diastole | PQ | mmHg | 78182-3   | LOINC 2.16.840.1.113883.6.1 |
| PR PHT | PR PHT       | PQ        | ms   | 93665-8   | LOINC 2.16.840.1.113883.6.1 |
| PA diastolic flow reversal | PA diastolic flow reversal | CD  | –     | 93623-7   | LOINC 2.16.840.1.113883.6.1 |
| PR severity_Semiquant | PR severity_Semiquant | CD  | –     | 18114-9   | LOINC 2.16.840.1.113883.6.1 |
| RV E     | RV E         | PQ        | m/s  | 18031-5   | LOINC 2.16.840.1.113883.6.1 |
| RV A     | RV A         | PQ        | m/s  | 18030-7   | LOINC 2.16.840.1.113883.6.1 |
| RV E/A   | RV E/A       | PQ        | 1    | 18039-8   | LOINC 2.16.840.1.113883.6.1 |
| RV DcT   | RV DcT       | PQ        | ms   | 18000-0   | LOINC 2.16.840.1.113883.6.1 |
| RV ejection time | RV ejection time | PQ  | ms   | 79929-6   | LOINC 2.16.840.1.113883.6.1 |
| RV total systolic time | RV total systolic time | PQ  | ms   | 93622-9   | LOINC 2.16.840.1.113883.6.1 |
| RV myocardial performance index | RV myocardial performance index | PQ  | 1    | 80086-2   | LOINC 2.16.840.1.113883.6.1 |
| TVD_annulus | TVD_annulus | PQ  | mm  | 80091-2   | LOINC 2.16.840.1.113883.6.1 |
| TV vel_max | TV vel_max   | PQ        | m/s  | 11712-7   | LOINC 2.16.840.1.113883.6.1 |
| TV peak_PG | TV peak_PG   | PQ        | mmHg | 18055-4   | LOINC 2.16.840.1.113883.6.1 |
| TV mean_PG | TV mean_PG   | PQ        | mmHg | 18056-2   | LOINC 2.16.840.1.113883.6.1 |
| TV vel_PHT | TV vel_PHT   | PQ        | ms   | 18032-3   | LOINC 2.16.840.1.113883.6.1 |
| TVA(2D)  | TVA(2D)      | PQ        | mm²  | 81091-1   | LOINC 2.16.840.1.113883.6.1 |
| TVA PHT  | TVA PHT      | PQ        | mm²  | 81092-9   | LOINC 2.16.840.1.113883.6.1 |
| TR vel_max | TR vel_max   | PQ        | m/s  | 18166-9   | LOINC 2.16.840.1.113883.6.1 |
| TR peak_PG | TR peak_PG   | PQ        | mmHg | 18065-3   | LOINC 2.16.840.1.113883.6.1 |
| Estimated RVSP | Estimated RVSP | PQ  | mmHg | 82341-9   | LOINC 2.16.840.1.113883.6.1 |
| Tricuspid valve Regurgitant orifice area | Tricuspid valve Regurgitant orifice area | PQ  | mm²  | 93621-1   | LOINC 2.16.840.1.113883.6.1 |

(Table 2 continued the next page.)
## Table 2 continued the next page.

| Item name                          | Display name                          | Data type | Unit | Item code | Option           | Code system | Code | Meaning                | OID             |
|-----------------------------------|---------------------------------------|-----------|------|-----------|-------------------|-------------|------|-------------------------|-----------------|
| Hepatic vein systolic flow reversal | Hepatic vein systolic flow reversal   | CD        | –    | 93619-5   | LA32-8            | LOINC       | 2.16.840.1.113883.6.1 |
| TR vena contracta                 | TR vena contracta                     | PQ        | mm   | 77917-3   | LA32-8            | LOINC       | 2.16.840.1.113883.6.1 |
| TR VTI                           | TR VTI                                | PQ        | m    | 93620-3   | LA33-6            | LOINC       | 2.16.840.1.113883.6.1 |
| TR PISA radius                    | TR PISA radius                        | PQ        | mm   | 79932-0   | LA1-0             | LOINC       | 2.16.840.1.113883.6.1 |
| TR RVol_PISA                      | TR RVol_PISA                          | PQ        | mL   | 93618-7   | LA137-2           | LOINC       | 2.16.840.1.113883.6.1 |
| TR EROA_PISA                      | TR EROA_PISA                          | PQ        | mm²  | 81093-7   | LA6751-7          | LOINC       | 2.16.840.1.113883.6.1 |
| TR severity_semiquant            | TR severity_semiquant                 | CD        | –    | 18115-6   | None              | LOINC       | 2.16.840.1.113883.6.1 |
| s’_septal                         | s’_septal                             | PQ        | m/s  | 78187-2   | LA11832-5         | LOINC       | 2.16.840.1.113883.6.1 |
| s’_lateral                        | s’_lateral                            | PQ        | m/s  | 78188-0   | LA6752-5          | LOINC       | 2.16.840.1.113883.6.1 |
| s’_mean                           | s’_mean                               | PQ        | m/s  | 81383-2   | LA23856-0         | LOINC       | 2.16.840.1.113883.6.1 |
| e’_septal                         | e’_septal                             | PQ        | m/s  | 78185-6   | LA6751-7          | LOINC       | 2.16.840.1.113883.6.1 |
| e’_lateral                        | e’_lateral                            | PQ        | m/s  | 78186-4   | LA23857-8         | LOINC       | 2.16.840.1.113883.6.1 |
| e’_mean                           | e’_mean                               | PQ        | m/s  | 81384-0   | Moderate          | LOINC       | 2.16.840.1.113883.6.1 |
| a’_septal                         | a’_septal                             | PQ        | m/s  | 81396-4   | Moderate-to-severe| LOINC       | 2.16.840.1.113883.6.1 |
| a’_lateral                        | a’_lateral                            | PQ        | m/s  | 81397-2   | Severe            | LOINC       | 2.16.840.1.113883.6.1 |
| a’_mean                           | a’_mean                               | PQ        | m/s  | 81385-7   | None              | LOINC       | 2.16.840.1.113883.6.1 |
| E/e’_septal                       | E/e’_septal                           | PQ        | 1    | 78189-8   | Detected          | LOINC       | 2.16.840.1.113883.6.1 |
| E/e’_lateral                      | E/e’_lateral                          | PQ        | 1    | 78190-6   | Unclear           | LOINC       | 2.16.840.1.113883.6.1 |
| RV s’                             | RV s’                                 | PQ        | m/s  | 79926-2   | LA11832-5         | LOINC       | 2.16.840.1.113883.6.1 |
| RV e’                             | RV e’                                 | PQ        | m/s  | 79924-7   | LA6751-7          | LOINC       | 2.16.840.1.113883.6.1 |
| Peak strain_longitudinal(2D)      | Peak strain_longitudinal(2D)          | PQ        | %    | 81399-8   | None              | LOINC       | 2.16.840.1.113883.6.1 |
| Peak strain_circumferential(2D)   | Peak strain_circumferential(2D)       | PQ        | %    | 81401-2   | LA11832-5         | LOINC       | 2.16.840.1.113883.6.1 |
| Peak strain_radial(2D)            | Peak strain_radial(2D)                | PQ        | %    | 81400-4   | LA6752-5          | LOINC       | 2.16.840.1.113883.6.1 |
| Peak strain_longitudinal(3D)      | Peak strain_longitudinal(3D)          | PQ        | %    | 93617-9   | LA23856-0         | LOINC       | 2.16.840.1.113883.6.1 |
| Peak strain_circumferential(3D)   | Peak strain_circumferential(3D)       | PQ        | %    | 93616-1   | LA6751-7          | LOINC       | 2.16.840.1.113883.6.1 |
| Peak strain_area(3D)              | Peak strain_area(3D)                  | PQ        | %    | 93615-3   | LA23857-8         | LOINC       | 2.16.840.1.113883.6.1 |
| Peak SR_S_longitudinal(2D)        | Peak SR_S_longitudinal(2D)            | PQ        | %    | 81403-8   | None              | LOINC       | 2.16.840.1.113883.6.1 |
| Peak SR_S_circumferential(2D)     | Peak SR_S_circumferential(2D)         | PQ        | %    | 81405-3   | LA6751-7          | LOINC       | 2.16.840.1.113883.6.1 |
| Peak SR_S_radial(2D)              | Peak SR_S_radial(2D)                  | PQ        | %    | 81404-6   | LA23856-0         | LOINC       | 2.16.840.1.113883.6.1 |
| Peak SR_S_longitudinal(3D)        | Peak SR_S_longitudinal(3D)            | PQ        | %    | 93614-6   | LA6751-7          | LOINC       | 2.16.840.1.113883.6.1 |
| Peak SR_S_circumferential(3D)     | Peak SR_S_circumferential(3D)         | PQ        | %    | 93613-8   | LA23857-8         | LOINC       | 2.16.840.1.113883.6.1 |
| Peak SR_S_area(3D)                | Peak SR_S_area(3D)                    | PQ        | %    | 82596-8   | LA6751-7          | LOINC       | 2.16.840.1.113883.6.1 |
| Peak SR_E_longitudinal(2D)        | Peak SR_E_longitudinal(2D)            | PQ        | %    | 81407-9   | LA11832-5         | LOINC       | 2.16.840.1.113883.6.1 |
| Peak SR_E_circumferential(2D)     | Peak SR_E_circumferential(2D)         | PQ        | %    | 81409-5   | LA6751-7          | LOINC       | 2.16.840.1.113883.6.1 |
| Peak SR_E_radial(2D)              | Peak SR_E_radial(2D)                  | PQ        | %    | 81408-7   | LA23856-0         | LOINC       | 2.16.840.1.113883.6.1 |
| Item name                        | Display name                        | Data type | Unit | Item code | Option Code | Meaning | Name | OID        |
|---------------------------------|-------------------------------------|-----------|------|-----------|-------------|---------|------|------------|
| Peak SR_E_ longitudinal(3D)     | Peak SR_E_ longitudinal(3D)         | PQ %      |      | 93612-0   |             |         |      |            |
| Peak SR_E_ circumferential(3D)  | Peak SR_E_ circumferential(3D)      | PQ %      |      | 93611-2   |             |         |      |            |
| Peak SR_E_ area(3D)             | Peak SR_E_ area(3D)                 | PQ %      |      | 81410-3   |             |         |      |            |
| Peak SR_A_ longitudinal(2D)     | Peak SR_A_ longitudinal(2D)         | PQ %      |      | 81411-1   |             |         |      |            |
| Peak SR_A_ circumferential(2D)  | Peak SR_A_ circumferential(2D)      | PQ %      |      | 81413-7   |             |         |      |            |
| Peak SR_A_ radial(2D)           | Peak SR_A_ radial(2D)               | PQ %      |      | 81412-9   |             |         |      |            |
| Peak SR_A_ longitudinal(3D)     | Peak SR_A_ longitudinal(3D)         | PQ %      |      | 93610-4   |             |         |      |            |
| Peak SR_A_ circumferential(3D)  | Peak SR_A_ circumferential(3D)      | PQ %      |      | 93609-6   |             |         |      |            |
| Peak SR_A_ area(3D)             | Peak SR_A_ area(3D)                 | PQ %      |      | 93608-8   |             |         |      |            |
| Peak apical rotation           | Peak apical rotation               | PQ deg    |      | 81415-2   |             |         |      |            |
| Peak basal rotation             | Peak basal rotation                | PQ deg    |      | 81416-0   |             |         |      |            |
| Peak torsion                    | Peak torsion                       | PQ deg    |      | 81417-8   |             |         |      |            |
| Peak twist rate                 | Peak twist rate                    | PQ %      |      | 81418-6   |             |         |      |            |
| Peak untwist rate               | Peak untwist rate                  | PQ %      |      | 81419-4   |             |         |      |            |
| WMS basal anterior              | WMS basal anterior                 | CD –      |      | 18121-4   | LA24346-1  | Normal or hyperkinetic | LOINC 2.16.840.1.113883.6.1 |
|                                |                                     |           |      |           | L9283-8    | Hypokinetic                      |          |
|                                |                                     |           |      |           | UCG-A001   | Severe hypokinetic               |          |
|                                |                                     |           |      |           | L9284-6    | Akinetic                         |          |
|                                |                                     |           |      |           | L9285-3    | Dyskinetic                        |          |
| WMS basal anteroseptal         | WMS basal anteroseptal             | CD –      |      | 18122-2   | LA24346-1  | Normal or hyperkinetic          | LOINC 2.16.840.1.113883.6.1 |
|                                |                                     |           |      |           | L9283-8    | Hypokinetic                      |          |
|                                |                                     |           |      |           | UCG-A001   | Severe hypokinetic               |          |
|                                |                                     |           |      |           | L9284-6    | Akinetic                         |          |
|                                |                                     |           |      |           | L9285-3    | Dyskinetic                        |          |
| WMS basal inferoseptal         | WMS basal inferoseptal             | CD –      |      | 78192-2   | LA24346-1  | Normal or hyperkinetic          | LOINC 2.16.840.1.113883.6.1 |
|                                |                                     |           |      |           | L9283-8    | Hypokinetic                      |          |
|                                |                                     |           |      |           | UCG-A001   | Severe hypokinetic               |          |
|                                |                                     |           |      |           | L9284-6    | Akinetic                         |          |
|                                |                                     |           |      |           | L9285-3    | Dyskinetic                        |          |
| WMS basal inferior             | WMS basal inferior                 | CD –      |      | 18123-0   | LA24346-1  | Normal or hyperkinetic          | LOINC 2.16.840.1.113883.6.1 |
|                                |                                     |           |      |           | L9283-8    | Hypokinetic                      |          |
|                                |                                     |           |      |           | UCG-A001   | Severe hypokinetic               |          |
|                                |                                     |           |      |           | L9284-6    | Akinetic                         |          |
|                                |                                     |           |      |           | L9285-3    | Dyskinetic                        |          |
| WMS basal inferolateral        | WMS basal inferolateral            | CD –      |      | 78193-0   | LA24346-1  | Normal or hyperkinetic          | LOINC 2.16.840.1.113883.6.1 |
|                                |                                     |           |      |           | L9283-8    | Hypokinetic                      |          |
|                                |                                     |           |      |           | UCG-A001   | Severe hypokinetic               |          |
|                                |                                     |           |      |           | L9284-6    | Akinetic                         |          |
|                                |                                     |           |      |           | L9285-3    | Dyskinetic                        |          |

(Table 2 continued the next page.)
| Item name          | Display name          | Data type | Unit | Item code | Option                     | Code system |
|-------------------|-----------------------|-----------|------|-----------|----------------------------|-------------|
| WMS_basal         | WMS_basal anterolateral | CD        | –    | 78194-8  | LA24346-1 Normal or hyperkinetic | LOINC 2.16.840.1.113883.6.1 |
|                   |                       |           |      |           | LA9283-8 Hypokinetic        |              |
|                   |                       |           |      |           | UCG-A001 Severe hypokinetic |              |
|                   |                       |           |      |           | LA9284-6 Akinetic           |              |
|                   |                       |           |      |           | LA9285-3 Dyskinetic         |              |
| WMS_mid anterior  | WMS_mid anterior      | CD        | –    | 18129-7  | LA24346-1 Normal or hyperkinetic | LOINC 2.16.840.1.113883.6.1 |
|                   |                       |           |      |           | LA9283-8 Hypokinetic        |              |
|                   |                       |           |      |           | UCG-A001 Severe hypokinetic |              |
|                   |                       |           |      |           | LA9284-6 Akinetic           |              |
|                   |                       |           |      |           | LA9285-3 Dyskinetic         |              |
| WMS_mid anteroseptal | WMS_mid anteroseptal    | CD        | –    | 18130-5  | LA24346-1 Normal or hyperkinetic | LOINC 2.16.840.1.113883.6.1 |
|                   |                       |           |      |           | LA9283-8 Hypokinetic        |              |
|                   |                       |           |      |           | UCG-A001 Severe hypokinetic |              |
|                   |                       |           |      |           | LA9284-6 Akinetic           |              |
|                   |                       |           |      |           | LA9285-3 Dyskinetic         |              |
| WMS_mid inferoseptal | WMS_mid inferoseptal    | CD        | –    | 18195-5  | LA24346-1 Normal or hyperkinetic | LOINC 2.16.840.1.113883.6.1 |
|                   |                       |           |      |           | LA9283-8 Hypokinetic        |              |
|                   |                       |           |      |           | UCG-A001 Severe hypokinetic |              |
|                   |                       |           |      |           | LA9284-6 Akinetic           |              |
|                   |                       |           |      |           | LA9285-3 Dyskinetic         |              |
| WMS_mid inferior  | WMS_mid inferior      | CD        | –    | 18131-3  | LA24346-1 Normal or hyperkinetic | LOINC 2.16.840.1.113883.6.1 |
|                   |                       |           |      |           | LA9283-8 Hypokinetic        |              |
|                   |                       |           |      |           | UCG-A001 Severe hypokinetic |              |
|                   |                       |           |      |           | LA9284-6 Akinetic           |              |
|                   |                       |           |      |           | LA9285-3 Dyskinetic         |              |
| WMS_mid inferolateral | WMS_mid inferolateral    | CD        | –    | 18196-3  | LA24346-1 Normal or hyperkinetic | LOINC 2.16.840.1.113883.6.1 |
|                   |                       |           |      |           | LA9283-8 Hypokinetic        |              |
|                   |                       |           |      |           | UCG-A001 Severe hypokinetic |              |
|                   |                       |           |      |           | LA9284-6 Akinetic           |              |
|                   |                       |           |      |           | LA9285-3 Dyskinetic         |              |
| WMS_mid anterolateral | WMS_mid anterolateral    | CD        | –    | 18197-1  | LA24346-1 Normal or hyperkinetic | LOINC 2.16.840.1.113883.6.1 |
|                   |                       |           |      |           | LA9283-8 Hypokinetic        |              |
|                   |                       |           |      |           | UCG-A001 Severe hypokinetic |              |
|                   |                       |           |      |           | LA9284-6 Akinetic           |              |
|                   |                       |           |      |           | LA9285-3 Dyskinetic         |              |
| WMS_apical anterior | WMS_apical anterior    | CD        | –    | 18119-8  | LA24346-1 Normal or hyperkinetic | LOINC 2.16.840.1.113883.6.1 |
|                   |                       |           |      |           | LA9283-8 Hypokinetic        |              |
|                   |                       |           |      |           | UCG-A001 Severe hypokinetic |              |
|                   |                       |           |      |           | LA9284-6 Akinetic           |              |
|                   |                       |           |      |           | LA9285-3 Dyskinetic         |              |

(Table 2 continued the next page.)
| Item name       | Display name       | Data type | Unit | Item code | Option Code | Meaning           | Code system          |
|-----------------|--------------------|-----------|------|-----------|--------------|--------------------|----------------------|
| WMS_apical septal | WMS_apical septal | CD        | –    | 18120-6   | LA24346-1    | Normal or hyperkinetic | LOINC 2.16.840.1.113883.6.1 |
|                 |                    |           |      |           | LA9283-8     | Hypokinetic        |                      |
|                 |                    |           |      |           | UCG-A001     | Severe hypokinetic  |                      |
|                 |                    |           |      |           | LA9284-6     | Akinetic           |                      |
|                 |                    |           |      |           | LA9285-3     | Dyskinetic         |                      |
| WMS_apical inferior | WMS_apical inferior | CD | –    | 18127-1   | LA24346-1    | Normal or hyperkinetic | LOINC 2.16.840.1.113883.6.1 |
|                 |                    |           |      |           | LA9283-8     | Hypokinetic        |                      |
|                 |                    |           |      |           | UCG-A001     | Severe hypokinetic  |                      |
|                 |                    |           |      |           | LA9284-6     | Akinetic           |                      |
|                 |                    |           |      |           | LA9285-3     | Dyskinetic         |                      |
| WMS_apical lateral | WMS_apical lateral | CD | –    | 18128-9   | LA24346-1    | Normal or hyperkinetic | LOINC 2.16.840.1.113883.6.1 |
|                 |                    |           |      |           | LA9283-8     | Hypokinetic        |                      |
|                 |                    |           |      |           | UCG-A001     | Severe hypokinetic  |                      |
|                 |                    |           |      |           | LA9284-6     | Akinetic           |                      |
|                 |                    |           |      |           | LA9285-3     | Dyskinetic         |                      |
| WMS_apex        | WMS_apex          | CD        | –    | 78198-9   | LA24346-1    | Normal or hyperkinetic | LOINC 2.16.840.1.113883.6.1 |
|                 |                    |           |      |           | LA9283-8     | Hypokinetic        |                      |
|                 |                    |           |      |           | UCG-A001     | Severe hypokinetic  |                      |
|                 |                    |           |      |           | LA9284-6     | Akinetic           |                      |
|                 |                    |           |      |           | LA9285-3     | Dyskinetic         |                      |

CD, code type; LOINC, logical observation identifiers names and codes; PQ, value type.
Table 3. Standard Export Data Format (SEAMAT) List for Catheterization (CATH); (1) List of Examinations; (2) Information of Examinations; (3) Coronary Angiography; and (4) Percutaneous Coronary Intervention

| (1) List of Examinations | Item name | Display name | Item code | Code system | Code system OID |
|--------------------------|-----------|--------------|-----------|-------------|-----------------|
| 1 | Cardiac catheterization study | Cardiac catheterization study | 18745-0 | LOINC | 2.16.840.1.113883.6.1 |

1. List of examinations

| Item name | Display name | Item code | Code system | Code system OID |
|-----------|--------------|-----------|-------------|-----------------|
| 1-1 | Patient information | Patient information | 52460-3 | LOINC | 2.16.840.1.113883.6.1 |
| 1-2 | Comorbid condition | Comorbid condition panel | 78923-0 | LOINC | 2.16.840.1.113883.6.1 |
| 1-3 | CAD risk factor | Coronary artery disease risk factor panel | 78940-4 | LOINC | 2.16.840.1.113883.6.1 |
| 1-4 | History of CVD | Cardiovascular disease history panel | 78941-2 | LOINC | 2.16.840.1.113883.6.1 |
| 1-5 | History of CVD surgery | History of surgical procedures of cardiovascular system | 80286-8 | LOINC | 2.16.840.1.113883.6.1 |
| 1-6 | Preoperative information | Catheterization and angiography preoperative information panel | 80528-3 | LOINC | 2.16.840.1.113883.6.1 |
| 1-7 | Information of examination | Catheterization and angiography procedure details panel | 80190-2 | LOINC | 2.16.840.1.113883.6.1 |
| 1-8 | Contents of examination | Catheterization and angiography procedures performed panel | 78949-5 | LOINC | 2.16.840.1.113883.6.1 |
| 1-9 | Assist devices | Assisted circulation procedures performed panel | 78933-9 | LOINC | 2.16.840.1.113883.6.1 |

2. Coronary angiography

| Item name | Display name | Item code | Code system | Code system OID |
|-----------|--------------|-----------|-------------|-----------------|
| 2-1 | Devices | Catheterization and angiography device panel | 78942-0 | LOINC | 2.16.840.1.113883.6.1 |
| 2-2 | Coronary angiography panel | Coronary angiography panel | 78895-0 | LOINC | 2.16.840.1.113883.6.1 |
| 2-3 | LV wall motion | Left ventricle segmental wall motion panel by angiogram | 78950-3 | LOINC | 2.16.840.1.113883.6.1 |
| 2-4 | Blood pressure | Blood pressure panel | 35094-2 | LOINC | 2.16.840.1.113883.6.1 |
| 2-5 | Spasm stress test | Spasm stress test panel | 80191-0 | LOINC | 2.16.840.1.113883.6.1 |

3. Percutaneous coronary intervention

| Item name | Display name | Item code | Code system | Code system OID |
|-----------|--------------|-----------|-------------|-----------------|
| 3-1 | Cardiac procedure complications | Cardiac procedure complications panel | 78943-8 | LOINC | 2.16.840.1.113883.6.1 |
| 3-2 | Procedure | Percutaneous coronary intervention panel | 78914-9 | LOINC | 2.16.840.1.113883.6.1 |

(2) Information of Examinations

1. Information of examination

1-1. Inspection information

| Item name | Display name | Data type | Unit | Item code | Option | Code | Meaning | Name | OID |
|-----------|--------------|-----------|------|-----------|--------|------|---------|------|-----|
| Age | Age | PQ | a | 30525-0 | – | – | – | LOINC 2.16.840.1.113883.6.1 |

1-2. History

| Item name | Display name | Data type | Unit | Item code | Option | Code | Meaning | Name | OID |
|-----------|--------------|-----------|------|-----------|--------|------|---------|------|-----|
| Renal failure | Renal failure | CD | – | 45678-0 | LA32-8 | No | – | LOINC 2.16.840.1.113883.6.1 |
| Dialysis | Dialysis | CD | – | 45842-2 | LA32-8 | No | – | LOINC 2.16.840.1.113883.6.1 |
| COPD | COPD | CD | – | 45670-7 | LA32-8 | No | – | LOINC 2.16.840.1.113883.6.1 |
| Peripheral vascular disease | Peripheral vascular disease | CD | – | 58264-3 | LA32-8 | No | – | LOINC 2.16.840.1.113883.6.1 |
| Hyperuricemia | Hyperuricemia | CD | – | 78924-8 | LA32-8 | No | – | LOINC 2.16.840.1.113883.6.1 |

(Table 3 continued the next page.)
### 1-3. Coronary risk factors

| Item name                        | Display name                                      | Data type | Unit | Item code | Option                      | Code system          |
|----------------------------------|---------------------------------------------------|-----------|------|-----------|-----------------------------|----------------------|
| Diabetes                         | Diabetes                                          | CD        | –    | 66678-4  | LA32-8  No                  | LOINC 2.16.840.1.113883.6.1 |
|                                  |                                                   |           |      |           | LA33-6  Yes                  |                      |
| Hypertension                     | Hypertension                                      | CD        | –    | 45643-4  | LA32-8  No                  | LOINC 2.16.840.1.113883.6.1 |
|                                  |                                                   |           |      |           | LA33-6  Yes                  |                      |
|                                  |                                                   |           |      |           | LA1-0  Unknown               |                      |
| Hyperlipidemia                   | History of hyperlipidemia                         | CD        | –    | 88655-6  | LA32-8  No                  | LOINC 2.16.840.1.113883.6.1 |
|                                  |                                                   |           |      |           | LA33-6  Yes                  |                      |
|                                  |                                                   |           |      |           | LA1-0  Unknown               |                      |
| Family history                   | Family history of premature coronary artery disease| CD        | –    | 80985-5  | LA32-8  No                  | LOINC 2.16.840.1.113883.6.1 |
|                                  |                                                   |           |      |           | LA33-6  Yes                  |                      |
|                                  |                                                   |           |      |           | LA1-0  Unknown               |                      |
| Current smoker                   | Smoking                                           | CD        | –    | 64234-8  | LA32-8  No                  | LOINC 2.16.840.1.113883.6.1 |
|                                  |                                                   |           |      |           | LA33-6  Yes                  |                      |
|                                  |                                                   |           |      |           | LA4489-6 Unknown             |                      |
| Brinkman index                   | Brinkman index                                    | PQ score  | 78948-7 | –         | –                            | LOINC 2.16.840.1.113883.6.1 |

### 1-4. History of cardiovascular disease

| Item name                        | Display name                                      | Data type | Unit | Item code | Option                      | Code system          |
|----------------------------------|---------------------------------------------------|-----------|------|-----------|-----------------------------|----------------------|
| Stroke                           | History of cerebrovascular accident               | CD        | –    | 78925-5  | LA32-8  No                  | LOINC 2.16.840.1.113883.6.1 |
|                                  |                                                   |           |      |           | LA33-6  Yes                  |                      |
|                                  |                                                   |           |      |           | LA4489-6 Unknown             |                      |
| Myocardial infarction            | Myocardial infarction                             | CD        | –    | 66624-8  | LA32-8  No                  | LOINC 2.16.840.1.113883.6.1 |
|                                  |                                                   |           |      |           | LA33-6  Yes                  |                      |
|                                  |                                                   |           |      |           | LA16789-2 Yes, more than 1   |                      |
| Congestive heart failure         | Heart failure                                     | CD        | –    | 45641-8  | LA32-8  No                  | LOINC 2.16.840.1.113883.6.1 |
|                                  |                                                   |           |      |           | LA33-6  Yes                  |                      |
|                                  |                                                   |           |      |           | LA1-0  Unknown               |                      |

### 1-5. Past revascularization

| Item name                        | Display name                                      | Data type | Unit | Item code | Option                      | Code system          |
|----------------------------------|---------------------------------------------------|-----------|------|-----------|-----------------------------|----------------------|
| PCI                              | History of percutaneous coronary intervention     | CD        | –    | 88656-4  | LA32-8  No                  | LOINC 2.16.840.1.113883.6.1 |
|                                  |                                                   |           |      |           | LA33-6  Yes                  |                      |
|                                  |                                                   |           |      |           | LA1-0  Unknown               |                      |
| CABG                             | History of coronary artery bypass graft surgery   | CD        | –    | 88654-9  | LA32-8  No                  | LOINC 2.16.840.1.113883.6.1 |
|                                  |                                                   |           |      |           | LA33-6  Yes                  |                      |
|                                  |                                                   |           |      |           | LA1-0  Unknown               |                      |

### 1-6. Preoperative information

| Item name                        | Display name                                      | Data type | Unit | Item code | Option                      | Code system          |
|----------------------------------|---------------------------------------------------|-----------|------|-----------|-----------------------------|----------------------|
| Cardiac arrest within 24 h prior to procedure | Cardiac arrest within 24 h | CD        | –    | 80986-3  | LA32-8  No                  | LOINC 2.16.840.1.113883.6.1 |
|                                  |                                                   |           |      |           | LA33-6  Yes                  |                      |
|                                  |                                                   |           |      |           | LA1-0  Unknown               |                      |
| Cardiogenic shock within 24 h prior to procedure | Cardiogenic shock within 24 h | CD        | –    | 80987-1  | LA32-8  No                  | LOINC 2.16.840.1.113883.6.1 |
|                                  |                                                   |           |      |           | LA33-6  Yes                  |                      |
|                                  |                                                   |           |      |           | LA1-0  Unknown               |                      |
| Acute heart failure 24 h prior to procedure | Acute heart failure within 24 h prior to procedure | CD        | –    | 88653-1  | LA32-8  No                  | LOINC 2.16.840.1.113883.6.1 |
|                                  |                                                   |           |      |           | LA33-6  Yes                  |                      |
|                                  |                                                   |           |      |           | LA1-0  Unknown               |                      |

(Table 3 continued the next page.)
### Preoperative examination

| Item name | Display name | Data type | Unit | Item code | Option | Code | Meaning | Code system | OID |
|-----------|--------------|-----------|------|-----------|--------|------|---------|-------------|------|
| Preoperative examination | Preoperative examination (image/stress testing) | CD | – | 85064-4 | | LA137-2 | No | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | | LA16043-4 | Chest XP | |
| | | | | | | LA26714-8 | CAG | |
| | | | | | | LA24330-5 | UCG | |
| | | | | | | LA24331-3 | ECG | |
| | | | | | | LA26713-0 | Spasm provocation | |
| | | | | | | LA28649-4 | Stress UCG | |
| | | | | | | LA28650-2 | Stress ECG | |
| | | | | | | LA28651-0 | Stress MRI | |
| | | | | | | LA28652-8 | FFR | |
| | | | | | | LA28648-6 | Coronary CT | |
| | | | | | | LA46-8 | Others | |

### Platelet aggregation inhibitor

| Item name | Display name | Data type | Unit | Item code | Option | Code | Meaning | Code system | OID |
|-----------|--------------|-----------|------|-----------|--------|------|---------|-------------|------|
| Platelet aggregation inhibitor | Antiplatelet medications | CD | – | 85063-6 | | LA137-2 | None | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | | LA26702-3 | ASA | |
| | | | | | | LA26704-9 | Clopidogrel | |
| | | | | | | LA26703-1 | Dipyridamole | |
| | | | | | | LA26705-6 | Ticagrelor | |
| | | | | | | LA26706-4 | Cilostazol | |
| | | | | | | LA28653-6 | Prasugrel | |
| | | | | | | LA46-8 | Others | |

### Anticoagulant medications

| Item name | Display name | Data type | Unit | Item code | Option | Code | Meaning | Code system | OID |
|-----------|--------------|-----------|------|-----------|--------|------|---------|-------------|------|
| Anticoagulant medications | Anticoagulant medications | CD | – | 85062-8 | | LA137-2 | None | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | | LA26712-2 | Apixaban | |
| | | | | | | LA26711-4 | Bivalirudin | |
| | | | | | | LA26709-8 | Dalteparin | |
| | | | | | | LA26708-0 | Enoxaparin | |
| | | | | | | LA26707-2 | Tiromisin | |
| | | | | | | LA28654-4 | Warfarin | |
| | | | | | | LA28655-1 | Dabigatran | |
| | | | | | | LA28657-7 | Edoxaban | |
| | | | | | | LA28656-9 | Rivaroxaban | |
| | | | | | | LA46-8 | Others | |

### Hemoglobin

| Item name | Display name | Data type | Unit | Item code | Option | Code | Meaning | Code system | OID |
|-----------|--------------|-----------|------|-----------|--------|------|---------|-------------|------|
| Hemoglobin | Hemoglobin | PQ | g/d | 718-7 | – | – | – | LOINC | 2.16.840.1.113883.6.1 |

### Creatine

| Item name | Display name | Data type | Unit | Item code | Option | Code | Meaning | Code system | OID |
|-----------|--------------|-----------|------|-----------|--------|------|---------|-------------|------|
| Creatine | Creatine | PQ | mg/dL | 2160-0 | – | – | – | LOINC | 2.16.840.1.113883.6.1 |

### 1-7. Basic information of cardiac catheterization study

| Item name | Display name | Data type | Unit | Item code | Option | Code | Meaning | Code system | OID |
|-----------|--------------|-----------|------|-----------|--------|------|---------|-------------|------|
| Hospital admission ischemic heart disease diagnosis | Hospital admission ischemic heart disease diagnosis | CD | – | 78976-8 | | LA24432-9 | Stable angina | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | | LA24433-7 | Unstable angina | |
| | | | | | | LA24434-5 | NSTEMI | |
| | | | | | | LA24436-0 | STEMI | |
| | | | | | | LA24435-2 | Silent myocardial ischemia | |
| | | | | | | LA20365-5 | History of myocardial infarction | |
| | | | | | | LA17719-8 | Ventricular tachycardia | |
| | | | | | | LA24542-5 | Acute heart failure | |
| | | | | | | LA20080-0 | Cyanotic congenital heart disease | |
| | | | | | | LA22210-1 | Vascular aneurysms | |
| | | | | | | LA7432-3 | Endocarditis | |
| | | | | | | LA25773-5 | Myocarditis | |
| | | | | | | LA28658-5 | Staged PCI | |

(Table 3 continued the next page.)
| Item name                              | Display name                         | Data type | Unit | Item code   | Option               | Code system     |
|---------------------------------------|--------------------------------------|-----------|------|-------------|----------------------|-----------------|
| Stent thrombosis                      | Stent thrombosis                     | CD        | –    | 80989-9     |                      | LOINC 2.16.840.1.113883.6.1 |
| Date of procedure                     | Date of procedure                    | TS        | –    | 80989-7     |                      | LOINC 2.16.840.1.113883.6.1 |
| Procedure sequence                    | Procedure sequence                   | CD        | –    | 80245-4     |                      | LOINC 2.16.840.1.113883.6.1 |
| Procedure urgency                     | Procedure urgency                    | CD        | –    | 78927-1     |                      | LOINC 2.16.840.1.113883.6.1 |
| Attending physician name              | Attending physician name             | PN        | –    | 52526-1     |                      | LOINC 2.16.840.1.113883.6.1 |
| Cardiologist name provider            | Cardiologist name provider           | PN        | –    | 78977-6     |                      | LOINC 2.16.840.1.113883.6.1 |
| Teaching physician name               | Teaching physician name              | PN        | –    | 78928-9     |                      | LOINC 2.16.840.1.113883.6.1 |
| Procedure duration                    | Procedure duration                   | PQ        | min  | 89875-9     |                      | LOINC 2.16.840.1.113883.6.1 |
| Anesthesia duration                   | Anesthesia duration                  | PQ        | min  | 89874-2     |                      | LOINC 2.16.840.1.113883.6.1 |
| Fluoroscopy duration                  | Fluoroscopy duration                 | PQ        | min  | 80990-5     |                      | LOINC 2.16.840.1.113883.6.1 |
| Fluoroscopy dose                      | Fluoroscopy dose                     | PO        | mGy  | 80991-3     |                      | LOINC 2.16.840.1.113883.6.1 |
| Illness or injury onset date and time | Illness or injury onset date and time| TS        | –    | 11368-8     |                      | LOINC 2.16.840.1.113883.6.1 |
| Hospital admission date               | Hospital admission date              | TS        | –    | 8656-1      |                      | LOINC 2.16.840.1.113883.6.1 |
| Operation date and time               | Operation date and time              | TS        | –    | 80992-1     |                      | LOINC 2.16.840.1.113883.6.1 |
| Date and time of first balloon inflation heart catheterization | Date and time of first balloon inflation heart catheterization | TS | – | 80993-9 | | LOINC 2.16.840.1.113883.6.1 |
| Door-to-balloon time heart            | Door-to-balloon time                 | PQ        | min  | 85061-0     |                      | LOINC 2.16.840.1.113883.6.1 |
| Amount of contrast medium             | Amount of contrast medium            | PQ        | ml   | 80242-1     |                      | LOINC 2.16.840.1.113883.6.1 |

1-8. Contents of procedure in cardiac catheterization study

| Item name                              | Display name                         | Data type | Unit | Item code   | Option               | Code system     |
|---------------------------------------|--------------------------------------|-----------|------|-------------|----------------------|-----------------|
| Coronary angiography                  | CAG                                  | CD        | –    | 80994-7     |                      | LOINC 2.16.840.1.113883.6.1 |
| Left ventriculography                 | LVG                                  | CD        | –    | 80995-4     |                      | LOINC 2.16.840.1.113883.6.1 |
| Peripheral angiography                | Peripheral angiography               | CD        | –    | 80995-4     |                      | LOINC 2.16.840.1.113883.6.1 |
| Right heart catheterization           | Right heart catheterization          | CD        | –    | 78930-5     |                      | LOINC 2.16.840.1.113883.6.1 |
| Spasm load test performed             | Spasm load test                      | CD        | –    | 78931-3     |                      | LOINC 2.16.840.1.113883.6.1 |
| Blood sampling                        | Blood sampling                       | CD        | –    | 80726-3     |                      | LOINC 2.16.840.1.113883.6.1 |
| Intravascular ultrasound performed    | IVUS                                 | CD        | –    | 80996-2     |                      | LOINC 2.16.840.1.113883.6.1 |
| Optical coherence tomography performed| OCT                                  | CD        | –    | 78932-1     |                      | LOINC 2.16.840.1.113883.6.1 |

(Table 3 continued the next page.)
| Item name                          | Display name          | Data type | Unit | Item code | Option                  | Code system | Name       | OID       |
|-----------------------------------|-----------------------|-----------|------|-----------|-------------------------|-------------|------------|-----------|
| Fractional flow reserve performed| FFR                   | CD        | –    | 80997-0  | 1-9. Assisted circulation|             |            |           |
| Access site                       | Access site           | CD        | –    | 80243-9  | 1-9. Assisted circulation|             |            |           |
| Type of right coronary artery catheter | RCA_catheter       | ST        | –    | 80224-9  | 2-1. Catheter used in cardiac angiography|             |            |           |
| Type of left coronary artery catheter | LCA_catheter       | ST        | –    | 80225-6  | 2-1. Catheter used in cardiac angiography|             |            |           |
| Type of pigtail catheter          | PIG_catheter         | ST        | –    | 80226-4  | 2-1. Catheter used in cardiac angiography|             |            |           |

CD, code; IABP, intra-aortic balloon pump; IIPD, intra-cardiac indwelling pump device; LVAD, left ventricular assistive device; NSTEMI, non-ST-segment elevation myocardial infarction; PCPS, percutaneous cardiopulmonary support; PN, person name; PQ, value; STEMI, ST-segment elevation myocardial infarction; TS, point in time.

(3) Coronary Angiography

2. CAG report

2-1. Catheter used in cardiac angiography

| Item name                          | Display name          | Data type | Unit | Item code | Option                  | Code system | Name       | OID       |
|-----------------------------------|-----------------------|-----------|------|-----------|-------------------------|-------------|------------|-----------|

(Table 3 continued the next page.)
| Item name | Display name | Data type | Unit | Item code | Option | Meaning | Code system | Name | OID |
|-----------|--------------|-----------|------|-----------|--------|---------|-------------|------|-----|
| Number of diseased coronary segments on cardiac angiogram | Number of diseased vessels | CD | – | 78896-8 | LA137-2 | None | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | LA24356-0 | 1 vessel without left main coronary artery | |
| | | | | | LA24358-6 | 2 vessels without left main coronary artery | |
| | | | | | LA24360-2 | 3 vessels without left main coronary artery | |
| | | | | | LA24354-5 | Left main coronary artery alone | |
| | | | | | LA24355-2 | 1 vessel and left main coronary artery | |
| | | | | | LA24357-8 | 2 vessels and left main coronary artery | |
| | | | | | LA24359-4 | 3 vessels and left main coronary artery | |
| Percent stenosis of proximal right coronary artery by cardiac angiogram | Seg_1 stenosis | CD | % | 78897-6 | LA15243-1 | 0% | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | LA24352-9 | 1–24% | |
| | | | | | LA24431-1 | 25–49% | |
| | | | | | LA15328-0 | 50–69% | |
| | | | | | LA15329-8 | 70–89% | |
| | | | | | LA24351-1 | 90–99% | |
| | | | | | LA15253-0 | 100% | |
| Percent stenosis of mid right coronary artery by cardiac angiogram | Seg_2 stenosis | CD | % | 78898-4 | LA15243-1 | 0% | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | LA24352-9 | 1–24% | |
| | | | | | LA24431-1 | 25–49% | |
| | | | | | LA15328-0 | 50–69% | |
| | | | | | LA15329-8 | 70–89% | |
| | | | | | LA24351-1 | 90–99% | |
| | | | | | LA15253-0 | 100% | |
| Percent stenosis of distal right coronary artery by cardiac angiogram | Seg_3 stenosis | CD | % | 78899-2 | LA15243-1 | 0% | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | LA24352-9 | 1–24% | |
| | | | | | LA24431-1 | 25–49% | |
| | | | | | LA15328-0 | 50–69% | |
| | | | | | LA15329-8 | 70–89% | |
| | | | | | LA24351-1 | 90–99% | |
| | | | | | LA15253-0 | 100% | |
| Percent stenosis of AV nodal artery by cardiac angiogram | Seg_4 AV stenosis | CD | % | 78900-8 | LA15243-1 | 0% | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | LA24352-9 | 1–24% | |
| | | | | | LA24431-1 | 25–49% | |
| | | | | | LA15328-0 | 50–69% | |
| | | | | | LA15329-8 | 70–89% | |
| | | | | | LA24351-1 | 90–99% | |
| | | | | | LA15253-0 | 100% | |
| Percent stenosis of posterior descending branch from right coronary artery by cardiac angiogram | Seg_4 PD stenosis | CD | % | 78901-6 | LA15243-1 | 0% | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | LA24352-9 | 1–24% | |
| | | | | | LA24431-1 | 25–49% | |
| | | | | | LA15328-0 | 50–69% | |
| | | | | | LA15329-8 | 70–89% | |
| | | | | | LA24351-1 | 90–99% | |
| | | | | | LA15253-0 | 100% | |

(Table 3 continued the next page.)
| Item name | Display name | Data type | Unit | Item code | Option | Code system | Code | Meaning | Name | OID |
|-----------|--------------|-----------|------|-----------|--------|-------------|------|---------|------|-----|
| Percent stenosis of left main coronary artery by cardiac angiogram | Seg_5 stenosis | CD | % | 78902-4 | LA15243-1 | 0% | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | LA24352-9 | 1–24% | | | |
| | | | | | LA24431-1 | 25–49% | | | |
| | | | | | LA15328-0 | 50–69% | | | |
| | | | | | LA15329-8 | 70–89% | | | |
| | | | | | LA24351-1 | 90–99% | | | |
| | | | | | LA15253-0 | 100% | | | |
| Percent stenosis of proximal left anterior descending artery by cardiac angiogram | Seg_6 stenosis | CD | % | 78903-2 | LA15243-1 | 0% | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | LA24352-9 | 1–24% | | | |
| | | | | | LA24431-1 | 25–49% | | | |
| | | | | | LA15328-0 | 50–69% | | | |
| | | | | | LA15329-8 | 70–89% | | | |
| | | | | | LA24351-1 | 90–99% | | | |
| | | | | | LA15253-0 | 100% | | | |
| Percent stenosis of mid left anterior descending artery by cardiac angiogram | Seg_7 stenosis | CD | % | 78904-0 | LA15243-1 | 0% | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | LA24352-9 | 1–24% | | | |
| | | | | | LA24431-1 | 25–49% | | | |
| | | | | | LA15328-0 | 50–69% | | | |
| | | | | | LA15329-8 | 70–89% | | | |
| | | | | | LA24351-1 | 90–99% | | | |
| | | | | | LA15253-0 | 100% | | | |
| Percent stenosis of distal left anterior descending artery by cardiac angiogram | Seg_8 stenosis | CD | % | 78905-7 | LA15243-1 | 0% | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | LA24352-9 | 1–24% | | | |
| | | | | | LA24431-1 | 25–49% | | | |
| | | | | | LA15328-0 | 50–69% | | | |
| | | | | | LA15329-8 | 70–89% | | | |
| | | | | | LA24351-1 | 90–99% | | | |
| | | | | | LA15253-0 | 100% | | | |
| Percent stenosis of first diagonal artery by cardiac angiogram | Seg_9 stenosis | CD | % | 78906-5 | LA15243-1 | 0% | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | LA24352-9 | 1–24% | | | |
| | | | | | LA24431-1 | 25–49% | | | |
| | | | | | LA15328-0 | 50–69% | | | |
| | | | | | LA15329-8 | 70–89% | | | |
| | | | | | LA24351-1 | 90–99% | | | |
| | | | | | LA15253-0 | 100% | | | |
| Percent stenosis of second diagonal artery by cardiac angiogram | Seg_10 stenosis | CD | % | 78907-3 | LA15243-1 | 0% | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | LA24352-9 | 1–24% | | | |
| | | | | | LA24431-1 | 25–49% | | | |
| | | | | | LA15328-0 | 50–69% | | | |
| | | | | | LA15329-8 | 70–89% | | | |
| | | | | | LA24351-1 | 90–99% | | | |
| | | | | | LA15253-0 | 100% | | | |
| Percent stenosis of proximal left circumflex artery by cardiac angiogram | Seg_11 stenosis | CD | % | 78908-1 | LA15243-1 | 0% | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | LA24352-9 | 1–24% | | | |
| | | | | | LA24431-1 | 25–49% | | | |
| | | | | | LA15328-0 | 50–69% | | | |
| | | | | | LA15329-8 | 70–89% | | | |
| | | | | | LA24351-1 | 90–99% | | | |
| | | | | | LA15253-0 | 100% | | | |
| Percent stenosis of obtuse marginal artery by cardiac angiogram | Seg_12 stenosis | CD | % | 78909-9 | LA15243-1 | 0% | LOINC | 2.16.840.1.113883.6.1 |
| | | | | | LA24352-9 | 1–24% | | | |
| | | | | | LA24431-1 | 25–49% | | | |
| | | | | | LA15328-0 | 50–69% | | | |
| | | | | | LA15329-8 | 70–89% | | | |
| | | | | | LA24351-1 | 90–99% | | | |
| | | | | | LA15253-0 | 100% | | | |

(Table 3 continued the next page.)
| Item name                                                                 | Display name   | Data type | Unit | Item code | Code      | Meaning                      | Code system            |
|--------------------------------------------------------------------------|----------------|-----------|------|-----------|-----------|------------------------------|------------------------|
| Percent stenosis of mid and distal left circumflex artery by cardiac angiogram | Seg_13 stenosis | CD        | %    | 78910-7   | LA15243-1 | 0%                           | LOINC 2.16.840.1.113883.6.1 |
|                                                                           |                |           |      |           | LA24352-9 | 1–24%                        |
|                                                                           |                |           |      |           | LA24431-1 | 25–49%                       |
|                                                                           |                |           |      |           | LA15328-0 | 50–69%                       |
|                                                                           |                |           |      |           | LA15329-8 | 70–89%                       |
|                                                                           |                |           |      |           | LA24351-1 | 90–99%                       |
|                                                                           |                |           |      |           | LA15253-0 | 100%                         |
| Percent stenosis of posterolateral branch from left circumflex artery by cardiac angiogram | Seg_14 stenosis | CD        | %    | 78911-5   | LA15243-1 | 0%                           | LOINC 2.16.840.1.113883.6.1 |
|                                                                           |                |           |      |           | LA24352-9 | 1–24%                        |
|                                                                           |                |           |      |           | LA24431-1 | 25–49%                       |
|                                                                           |                |           |      |           | LA15328-0 | 50–69%                       |
|                                                                           |                |           |      |           | LA15329-8 | 70–89%                       |
|                                                                           |                |           |      |           | LA24351-1 | 90–99%                       |
|                                                                           |                |           |      |           | LA15253-0 | 100%                         |
| Percent stenosis of posterior descending branch from left circumflex artery by cardiac angiogram | Seg_15 stenosis | CD        | %    | 78912-3   | LA15243-1 | 0%                           | LOINC 2.16.840.1.113883.6.1 |
|                                                                           |                |           |      |           | LA24352-9 | 1–24%                        |
|                                                                           |                |           |      |           | LA24431-1 | 25–49%                       |
|                                                                           |                |           |      |           | LA15328-0 | 50–69%                       |
|                                                                           |                |           |      |           | LA15329-8 | 70–89%                       |
|                                                                           |                |           |      |           | LA24351-1 | 90–99%                       |
|                                                                           |                |           |      |           | LA15253-0 | 100%                         |

2-3. Left ventricle angiography

| Item name                                                                 | Display name   | Data type | Unit | Item code | Code      | Meaning                      | Code system            |
|--------------------------------------------------------------------------|----------------|-----------|------|-----------|-----------|------------------------------|------------------------|
| LV basal anterior segmental wall motion by cardiac angiogram              | LVG_segment1   | CD        | –    | 78951-1   | LA24346-1 | Normal or hyperkinetic       | LOINC 2.16.840.1.113883.6.1 |
|                                                                           |                |           |      |           | LA9283-8  | Hypokinetic                  |
|                                                                           |                |           |      |           | LA9282-0  | Mildly hypokinetic           |
|                                                                           |                |           |      |           | LA28647-8 | Severely hypokinetic         |
|                                                                           |                |           |      |           | LA9284-6  | Akinetic                     |
|                                                                           |                |           |      |           | LA9285-3  | Dyskinetic                   |
|                                                                           |                |           |      |           | LA11137-9 | Unable to determine           |
| LV lateral anterior segmental wall motion by cardiac angiogram            | LVG_segment2   | CD        | –    | 78952-9   | LA24346-1 | Normal or hyperkinetic       | LOINC 2.16.840.1.113883.6.1 |
|                                                                           |                |           |      |           | LA9283-8  | Hypokinetic                  |
|                                                                           |                |           |      |           | LA9282-0  | Mildly hypokinetic           |
|                                                                           |                |           |      |           | LA28647-8 | Severely hypokinetic         |
|                                                                           |                |           |      |           | LA9284-6  | Akinetic                     |
|                                                                           |                |           |      |           | LA9285-3  | Dyskinetic                   |
|                                                                           |                |           |      |           | LA11137-9 | Unable to determine           |
| LV apex segmental wall motion by cardiac angiogram                        | LVG_segment3   | CD        | –    | 78953-7   | LA24346-1 | Normal or hyperkinetic       | LOINC 2.16.840.1.113883.6.1 |
|                                                                           |                |           |      |           | LA9283-8  | Hypokinetic                  |
|                                                                           |                |           |      |           | LA9282-0  | Mildly hypokinetic           |
|                                                                           |                |           |      |           | LA28647-8 | Severely hypokinetic         |
|                                                                           |                |           |      |           | LA9284-6  | Akinetic                     |
|                                                                           |                |           |      |           | LA9285-3  | Dyskinetic                   |
|                                                                           |                |           |      |           | LA11137-9 | Unable to determine           |

(Table 3 continued the next page.)
| Item name                                                                 | Display name | Data type | Unit | Item code | Option Code system | Code | Meaning                                | Name | OID                          |
|--------------------------------------------------------------------------|--------------|-----------|------|-----------|--------------------|------|----------------------------------------|------|------------------------------|
| LV inferior segmental wall motion by cardiac angiogram                    | LVG_seg4     | CD        | –    | 78954-5   | LOINC 2.16.840.1.113883.6.1 | LA24346-1 | Normal or hyperkinetic              |      | 2.16.840.1.113883.6.1 |
|                                                                          |              |           |      |           |                    | LA9283-8 | Hypokinetic                            |      |                             |
|                                                                          |              |           |      |           |                    | LA9282-0 | Mildly hypokinetic                    |      |                             |
|                                                                          |              |           |      |           |                    | LA28647-8 | Severely hypokinetic                  |      |                             |
|                                                                          |              |           |      |           |                    | LA9284-6 | Akinetic                               |      |                             |
|                                                                          |              |           |      |           |                    | LA9285-3 | Dyskinetic                            |      |                             |
|                                                                          |              |           |      |           |                    | LA11137-9 | Unable to determine                   |      |                             |
| LV basal posterior segmental wall motion by cardiac angiogram             | LVG_seg5     | CD        | –    | 78955-2   | LOINC 2.16.840.1.113883.6.1 | LA24346-1 | Normal or hyperkinetic              |      | 2.16.840.1.113883.6.1 |
|                                                                          |              |           |      |           |                    | LA9283-8 | Hypokinetic                            |      |                             |
|                                                                          |              |           |      |           |                    | LA9282-0 | Mildly hypokinetic                    |      |                             |
|                                                                          |              |           |      |           |                    | LA28647-8 | Severely hypokinetic                  |      |                             |
|                                                                          |              |           |      |           |                    | LA9284-6 | Akinetic                               |      |                             |
|                                                                          |              |           |      |           |                    | LA9285-3 | Dyskinetic                            |      |                             |
|                                                                          |              |           |      |           |                    | LA11137-9 | Unable to determine                   |      |                             |
| Ventricular septal segmental wall motion by cardiac angiogram            | LVG_seg6     | CD        | –    | 78956-0   | LOINC 2.16.840.1.113883.6.1 | LA24346-1 | Normal or hyperkinetic              |      | 2.16.840.1.113883.6.1 |
|                                                                          |              |           |      |           |                    | LA9283-8 | Hypokinetic                            |      |                             |
|                                                                          |              |           |      |           |                    | LA9282-0 | Mildly hypokinetic                    |      |                             |
|                                                                          |              |           |      |           |                    | LA28647-8 | Severely hypokinetic                  |      |                             |
|                                                                          |              |           |      |           |                    | LA9284-6 | Akinetic                               |      |                             |
|                                                                          |              |           |      |           |                    | LA9285-3 | Dyskinetic                            |      |                             |
|                                                                          |              |           |      |           |                    | LA11137-9 | Unable to determine                   |      |                             |
| LV lateral posterior segmental wall motion by cardiac angiogram           | LVG_seg7     | CD        | –    | 78957-8   | LOINC 2.16.840.1.113883.6.1 | LA24346-1 | Normal or hyperkinetic              |      | 2.16.840.1.113883.6.1 |
|                                                                          |              |           |      |           |                    | LA9283-8 | Hypokinetic                            |      |                             |
|                                                                          |              |           |      |           |                    | LA9282-0 | Mildly hypokinetic                    |      |                             |
|                                                                          |              |           |      |           |                    | LA28647-8 | Severely hypokinetic                  |      |                             |
|                                                                          |              |           |      |           |                    | LA9284-6 | Akinetic                               |      |                             |
|                                                                          |              |           |      |           |                    | LA9285-3 | Dyskinetic                            |      |                             |
|                                                                          |              |           |      |           |                    | LA11137-9 | Unable to determine                   |      |                             |
| LV ejection fraction by cardiac angiogram                                | LVG_EF       | PQ        | %    | 8808-8    | LOINC 2.16.840.1.113883.6.1 | LA24346-1 | Normal or hyperkinetic              |      | 2.16.840.1.113883.6.1 |
| LV end-diastolic volume by Imaging                                       | LVG_EDV      | PQ        | mL   | 8821-1    | LOINC 2.16.840.1.113883.6.1 | LA24346-1 | Normal or hyperkinetic              |      | 2.16.840.1.113883.6.1 |
| LV end-systolic volume by imaging                                        | LVG_ESV      | PQ        | mL   | 8823-7    | LOINC 2.16.840.1.113883.6.1 | LA24346-1 | Normal or hyperkinetic              |      | 2.16.840.1.113883.6.1 |
| LV stroke volume by angiography single plane                             | LVG_SV       | PQ        | mL   | 8767-6    | LOINC 2.16.840.1.113883.6.1 | LA24346-1 | Normal or hyperkinetic              |      | 2.16.840.1.113883.6.1 |

Regurgitation degree aortic valve angiography

| AR | CD | 81431-9 |
|----|----|---------|

LA137-2 None
LA11841-6 1+
LA11842-4 2+
LA11843-2 3+
LA28404-4 I
LA28405-1 II
LA28406-9 III
LA28407-7 IV

(Table 3 continued the next page.)
| Item name                                      | Display name             | Data type | Unit | Item code   | Option       | Code system       |
|-----------------------------------------------|--------------------------|-----------|------|-------------|---------------|------------------|
| Regurgitation degree                         | MR                       | CD        | –    | 81432-7     | LA137-2       | LOINC 2.16.840.1.113883.6.1 |
| mitral valve angiography                      |                          |           |      |             | 1+            |                   |
|                                               |                          |           |      |             | LA11841-6     |                   |
|                                               |                          |           |      |             | 2+            |                   |
|                                               |                          |           |      |             | LA11842-4     |                   |
|                                               |                          |           |      |             | 3+            |                   |
|                                               |                          |           |      |             | LA28404-4     |                   |
|                                               |                          |           |      |             | I             |                   |
|                                               |                          |           |      |             | LA28405-1     |                   |
|                                               |                          |           |      |             | II            |                   |
|                                               |                          |           |      |             | LA28406-9     |                   |
|                                               |                          |           |      |             | III           |                   |
|                                               |                          |           |      |             | LA28407-7     |                   |
|                                               |                          |           |      |             | IV            |                   |
| Orifice [area] aortic valve cardiac catheterization | AVA                     | PQ        | cm²  | 80230-6     | –             | LOINC 2.16.840.1.113883.6.1 |
| Orifice [area] mitral valve cardiac catheterization | MVA                     | PQ        | cm²  | 80231-4     | –             | LOINC 2.16.840.1.113883.6.1 |

| Item name                                      | Display name             | Data type | Unit | Item code   | Option       | Code system       |
|-----------------------------------------------|--------------------------|-----------|------|-------------|---------------|------------------|
| 2-4. Blood pressure method                    |                          |           |      |             |               |                  |
| A wave amplitude of pulmonary artery wedge    | PCW_A                    | PQ        | mmHg | 80232-2     | –             | LOINC 2.16.840.1.113883.6.1 |
| cardiac catheterization                       |                          |           |      |             |               |                  |
| V wave amplitude of pulmonary artery wedge    | PCW_V                    | PQ        | mmHg | 80233-0     | –             | LOINC 2.16.840.1.113883.6.1 |
| cardiac catheterization                       |                          |           |      |             |               |                  |
| Pulmonary artery wedge mean blood pressure    | PCW_mean                 | PQ        | mmHg | 8587-8      | –             | LOINC 2.16.840.1.113883.6.1 |
| Left pulmonary artery systolic blood pressure| Left_PA_sys              | PQ        | mmHg | 8441-8      | –             | LOINC 2.16.840.1.113883.6.1 |
| Right pulmonary artery systolic blood pressure| Right_PA_sys             | PQ        | mmHg | 8442-6      | –             | LOINC 2.16.840.1.113883.6.1 |
| Left pulmonary artery diastolic blood pressure| Left_PA_dias             | PQ        | mmHg | 8386-5      | –             | LOINC 2.16.840.1.113883.6.1 |
| Right pulmonary artery diastolic blood pressure| Right_PA_dias            | PQ        | mmHg | 8387-3      | –             | LOINC 2.16.840.1.113883.6.1 |
| Left pulmonary artery mean blood pressure     | Left_PA_mean             | PQ        | mmHg | 8415-2      | –             | LOINC 2.16.840.1.113883.6.1 |
| Right pulmonary artery mean blood pressure    | Right_PA_mean            | PQ        | mmHg | 8416-0      | –             | LOINC 2.16.840.1.113883.6.1 |
| Pulmonary artery systolic blood pressure      | Main_PA_sys              | PQ        | mmHg | 8440-0      | –             | LOINC 2.16.840.1.113883.6.1 |
| Pulmonary artery diastolic blood pressure     | Main_PA_dias             | PQ        | mmHg | 8385-7      | –             | LOINC 2.16.840.1.113883.6.1 |
| Pulmonary artery mean blood pressure          | Main_PA_mean             | PQ        | mmHg | 8414-5      | –             | LOINC 2.16.840.1.113883.6.1 |
| Right ventricular intrachamber diastolic      | RV_dias                  | PQ        | mmHg | 8377-4      | –             | LOINC 2.16.840.1.113883.6.1 |
| pressure                                      |                          |           |      |             |               |                  |
| Right ventricular intrachamber systolic       | RV_sys                   | PQ        | mmHg | 8432-7      | –             | LOINC 2.16.840.1.113883.6.1 |
| pressure                                      |                          |           |      |             |               |                  |
| Right ventricular end diastolic blood pressure| RV_EDP                   | PQ        | mmHg | 8392-3      | –             | LOINC 2.16.840.1.113883.6.1 |
| A wave amplitude of right atrium cardiac      | RA_A                     | PQ        | mmHg | 80234-8     | –             | LOINC 2.16.840.1.113883.6.1 |
| catheterization                              |                          |           |      |             |               |                  |

(Table 3 continued the next page.)
| Item name                                                        | Display name          | Data type | Unit      | Item code   | Option Code system | Code | Meaning | Name | OID           |
|-----------------------------------------------------------------|-----------------------|-----------|-----------|-------------|--------------------|------|---------|------|--------------|
| V wave amplitude of right atrium cardiac catheterization        | RA_V                  | PQ        | mmHg      | 80235-5     | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| Right atrial intrachamber mean pressure                         | RA_mean               | PQ        | mmHg      | 8400-4      | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| A wave amplitude of left atrium cardiac catheterization        | LA_A                  | PQ        | mmHg      | 80236-3     | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| V wave amplitude of left atrium cardiac catheterization        | LA_V                  | PQ        | mmHg      | 80237-1     | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| Left atrial intrachamber mean pressure                          | LA_mean               | PQ        | mmHg      | 8399-8      | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| LV intrachamber systolic pressure                               | LV_sys                | PQ        | mmHg      | 8430-1      | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| LV intrachamber diastolic pressure                              | LV_dias               | PQ        | mmHg      | 8375-8      | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| LV end diastolic blood pressure                                 | LV_EDP                | PQ        | mmHg      | 8391-5      | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| Intrachamber systolic pressure left ventricle – post procedure  | Post LV_sys           | PQ        | mmHg      | 82661-0     | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| Intrachamber diastolic pressure left ventricle – post procedure | Post LV_dias          | PQ        | mmHg      | 82662-8     | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| End diastolic blood pressure left ventricle – post procedure    | Post LV_EDP           | PQ        | mmHg      | 82663-6     | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| Ao_dias                                                         | Ao_dias               | PQ        | mmHg      | 8367-5      | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| Proximal ascending thoracic aorta systolic blood pressure       | Ao_sys                | PQ        | mmHg      | 8422-8      | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| Proximal ascending thoracic aorta mean blood pressure           | Ao_mean               | PQ        | mmHg      | 8397-2      | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| LV cardiac output CO thermo                                     | CO_thermo             | PQ        | L/min     | 8741-1      | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| LV cardiac output by Fick method                                | CO_Fick               | PQ        | L/min     | 8736-1      | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| LV stroke volume by indicator dilution                          | SV_thermo             | PQ        | mL        | 8771-8      | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| LV stroke volume by Fick method                                 | SV_Fick               | PQ        | mL        | 8770-0      | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |

| Item name                                                        | Display name          | Data type | Unit      | Item code   | Option Code system | Code | Meaning | Name | OID           |
|-----------------------------------------------------------------|-----------------------|-----------|-----------|-------------|--------------------|------|---------|------|--------------|
| Drug given for spasm stress test                                | Used drug             | CD        | –         | 80238-9     | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| Spasm induced                                                   | Spasm induced         | CD        | –         | 81433-5     | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |
| Symptom induced                                                 | Symptom induced       | CD        | –         | 81434-3     | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |

| Item name                                                        | Display name          | Data type | Unit      | Item code   | Option Code system | Code | Meaning | Name | OID           |
|-----------------------------------------------------------------|-----------------------|-----------|-----------|-------------|--------------------|------|---------|------|--------------|
| Cardiac procedure complication [presence]                       | Cardiac procedure complication | CD        | –         | 78936-2     | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |

CD, code; LV, left ventricular; PQ, value; ST, character string.

(4) Percutaneous Coronary Intervention

| Item name                                                        | Display name          | Data type | Unit      | Item code   | Option Code system | Code | Meaning | Name | OID           |
|-----------------------------------------------------------------|-----------------------|-----------|-----------|-------------|--------------------|------|---------|------|--------------|
| Cardiac procedure complication                                   | Cardiac procedure complication | CD        | –         | 78936-2     | –                  | –    | –       | –    | LOINC 2.16.840.1.113883.6.1 |

(Table 3 continued the next page.)
| Item name                                      | Display name                                      | Data type | Unit | Item code | Option            | Code system |
|-----------------------------------------------|---------------------------------------------------|-----------|------|-----------|-------------------|-------------|
| Cardiac procedure complication type          | Cardiac procedure complication type               | CD        | –    | 78937-0   |                   |             |
| Cardiac procedure complication narrative     | Other cardiac procedure complications             | ST        | –    | 78938-8   |                   |             |
| Death in the hospital                        | Death in the hospital                             | CD        | –    | CATH-19003-0 | Yes/No            | LOCAL      |
| Date of death                                | Date of death                                     | TS        | –    | 81954-0   |                   | LOINC      |
| Cause of death                               | Cause of death                                    | CD        | –    | 79378-6   | Cardiac death related with operation | LOINC |
| Cause of death                               | Cause of death                                    | CD        | –    | 79378-6   | Cardiac death related without operation | LOINC |
| Cause of death                               | Cause of death                                    | CD        | –    | 79378-6   | Non cardiac death | LOINC |
| Segment(s) affected by lesion coronary artery segment | Lesion segment ACC/AHA | CD        | –    | 80999-6   | RCA1, RCA2, RCA3, RCA4PD, RCA4AV, LMT5, LAD6, LAD7, LAD8, LAD9, LAD10, LCX11, LCX12, LCX13, LCX14, LCX15, SVG (LAD), SVG (LCX), SVG (RCA), AG (LAD), AG (LCX), AG (RCA), Others | LOINC |
| Item name                                                                 | Display name | Data type | Unit | Item code | Option                        | Code  | Meaning       | Name         | Code system     |
|---------------------------------------------------------------------------|--------------|-----------|------|-----------|-------------------------------|-------|---------------|--------------|----------------|
| Percutaneous coronary intervention performed                              | Operation    | CD –      |      | 80727-1   | LA32-8 No                     |       |               | LOINC       | 2.16.840.1.113883.6.1 |
|                                                                           |              |           |      |           | LA33-6 Yes                    |       |               |              |                |
|                                                                           |              |           |      |           | LA4489-6 Unknown              |       |               |              |                |
| Procedure successful                                                      | Procedure    | CD –      |      | 67544-7   | LA32-8 Failure                |       |               | LOINC       | 2.16.840.1.113883.6.1 |
|                                                                           | successful   |           |      |           | LA33-6 Success                |       |               |              |                |
| Percent stenosis of coronary artery segment – pre procedure              | Stenosis pre | CD %      |      | 80728-9   | LA15243-1 0%                  |       |               | LOINC       | 2.16.840.1.113883.6.1 |
|                                                                           |              |           |      |           | LA24352-9 1–24%               |       |               |              |                |
|                                                                           |              |           |      |           | LA24431-1 25–49%              |       |               |              |                |
|                                                                           |              |           |      |           | LA15328-0 50–69%              |       |               |              |                |
|                                                                           |              |           |      |           | LA15329-8 70–89%              |       |               |              |                |
|                                                                           |              |           |      |           | LA24351-1 90–99%              |       |               |              |                |
|                                                                           |              |           |      |           | LA15253-0 100%                |       |               |              |                |
| Percent stenosis of coronary artery segment – post procedure             | Stenosis post| CD %      |      | 80239-7   | LA15243-1 0%                  |       |               | LOINC       | 2.16.840.1.113883.6.1 |
|                                                                           |              |           |      |           | LA24352-9 1–24%               |       |               |              |                |
|                                                                           |              |           |      |           | LA24431-1 25–49%              |       |               |              |                |
|                                                                           |              |           |      |           | LA15328-0 50–69%              |       |               |              |                |
|                                                                           |              |           |      |           | LA15329-8 70–89%              |       |               |              |                |
|                                                                           |              |           |      |           | LA24351-1 90–99%              |       |               |              |                |
|                                                                           |              |           |      |           | LA15253-0 100%                |       |               |              |                |
| TIMI grade coronary artery segment – pre procedure                       | TIMI grade   | CD –      |      | 81000-2   | LA26047-3 TIMI 0              |       |               | LOINC       | 2.16.840.1.113883.6.1 |
|                                                                           | pre          |           |      |           | LA26048-1 TIMI 1              |       |               |              |                |
|                                                                           |              |           |      |           | LA26049-9 TIMI 2              |       |               |              |                |
|                                                                           |              |           |      |           | LA26050-7 TIMI 3              |       |               |              |                |
| TIMI grade coronary artery segment – post procedure                      | TIMI grade   | CD –      |      | 81001-0   | LA26047-3 TIMI 0              |       |               | LOINC       | 2.16.840.1.113883.6.1 |
|                                                                           | post         |           |      |           | LA26048-1 TIMI 1              |       |               |              |                |
|                                                                           |              |           |      |           | LA26049-9 TIMI 2              |       |               |              |                |
|                                                                           |              |           |      |           | LA26050-7 TIMI 3              |       |               |              |                |
| New or recurrent stenosis coronary artery segment                         | De novo or   | CD –      |      | 80729-7   | LA24479-0 De novo stenosis    |       |               | LOINC       | 2.16.840.1.113883.6.1 |
|                                                                           | restenosis   |           |      |           | LA24480-8 Restenosis          |       |               |              |                |
| Stenosis classification coronary artery segment ACC/AHA                   | Stenosis     | CD –      |      | 80730-5   | LA24481-6 Type A              |       |               | LOINC       | 2.16.840.1.113883.6.1 |
|                                                                           | classification|           |      |           | LA24482-4 Type B1             |       |               |              |                |
|                                                                           | ACC/AHA      |           |      |           | LA24483-2 Type B2             |       |               |              |                |
|                                                                           |              |           |      |           | LA24484-0 Type C              |       |               |              |                |
| Devices used during cardiac catheterization                               | Device types | CD –      |      | 81002-8   | LA26041-6 Balloon             |       |               | LOINC       | 2.16.840.1.113883.6.1 |
|                                                                           |              |           |      |           | LA26042-4 Drug dissolution balloon | |       |              |                |
|                                                                           |              |           |      |           | LA26043-2 Metal stent         |       |               |              |                |
|                                                                           |              |           |      |           | LA26044-0 Drug elution stent  |       |               |              |                |
|                                                                           |              |           |      |           | LA26045-7 Rotational ablator  |       |               |              |                |
|                                                                           |              |           |      |           | LA28659-3 Thrombus aspiration device | |       |              |                |
|                                                                           |              |           |      |           | LA28661-9 DCA device          |       |               |              |                |
|                                                                           |              |           |      |           | LA28660-1 Distal protection device | |       |              |                |
|                                                                           |              |           |      |           | CATH-A013 Diamondback 360     |       |               |              |                |
|                                                                           |              |           |      |           | LA46-8 Others                 |       |               |              |                |

CD, code; DCA, directional coronary atherectomy; ST, character string; TS, point in time.
| Item name                  | Display name                                      | Data type | Unit | Item code | Option Code | Code system OID                      |
|---------------------------|---------------------------------------------------|-----------|------|-----------|-------------|--------------------------------------|
| TES LV SPECT              | Time to end-systole left ventricle SPECT          | PQ        | ms   | 82621-4   |             | 2.16.840.1.113883.6.1               |
| PFR W stress LV SPECT     | Peak filling rate left ventricle SPECT – w stress | PQ        | L/s  | 82622-2   |             | 2.16.840.1.113883.6.1               |
| PFR at rest LV SPECT      | Peak filling rate left ventricle SPECT – at rest  | PQ        | L/s  | 82623-0   |             | 2.16.840.1.113883.6.1               |
| 1/3 MFR at rest LV SPECT  | One-third mean filling rate left ventricle SPECT – at rest | PQ    | L/s  | 82624-8 |             | 2.16.840.1.113883.6.1               |
| TPFFR at rest LV SPECT    | Time to peak filling rate left ventricle SPECT – at rest | PQ  | ms   | 82625-5 |             | 2.16.840.1.113883.6.1               |
| TPFFR/RR at rest LV SPECT | Time to peak filling rate/RR interval left ventricle SPECT – at rest | PQ | L    | 82653-7 |             | 2.16.840.1.113883.6.1               |
| SSS.17 myocardium SPECT   | Summed stress score for 17 segment model myocardium | PQ      | score | 82642-0 |             | 2.16.840.1.113883.6.1               |
| SRS.17 myocardium SPECT   | Summed rest score for 17 segment model myocardium | PQ      | score | 82643-8 |             | 2.16.840.1.113883.6.1               |
| SDS.17 myocardium SPECT   | Summed difference score for 17 segment model myocardium | PQ   | score | 82644-6 |             | 2.16.840.1.113883.6.1               |
| SSS.20 myocardium SPECT   | Summed stress score for 20 segment model myocardium | PQ    | score | 82645-3 |             | 2.16.840.1.113883.6.1               |
| SRS.20 myocardium SPECT   | Summed rest score for 20 segment model myocardium | PQ    | score | 82646-1 |             | 2.16.840.1.113883.6.1               |
| SDS.20 myocardium SPECT   | Summed difference score for 20 segment model myocardium | PQ | score | 82647-9 |             | 2.16.840.1.113883.6.1               |
| SSS myocardium SPECT      | Summed stress score myocardium SPECT              | PQ      | %    | 82648-7   |             | 2.16.840.1.113883.6.1               |
| SRS myocardium SPECT      | Summed rest score myocardium SPECT                | PQ      | %    | 82649-5   |             | 2.16.840.1.113883.6.1               |
| SDS myocardium SPECT      | Summed difference score myocardium SPECT          | PQ      | %    | 82650-3   |             | 2.16.840.1.113883.6.1               |
| Washout myocardium SPECT  | Washout rate [ratio] myocardium SPECT             | PQ      | %    | 82651-1   |             | 2.16.840.1.113883.6.1               |
| TID LV SPECT              | Transient ischemic dilation left ventricle SPECT  | PQ      | 1    | 82652-9   |             | 2.16.840.1.113883.6.1               |
| Max phase w stress angle LV SPECT | Maximum phase [angle] left ventricle SPECT – w stress | PQ | deg | 82626-3 |             | 2.16.840.1.113883.6.1               |
| Mean phase w stress angle LV SPECT | Mean phase [angle] left ventricle SPECT – w stress | PQ | deg | 82627-1 |             | 2.16.840.1.113883.6.1               |
| Ph.sd w stress angle LV SPECT | Phase.standard deviation [angle] left ventricle SPECT – w stress | PQ | deg | 82628-9 |             | 2.16.840.1.113883.6.1               |
| Phase bandwidth w stress LV SPECT | Phase bandwidth left ventricle SPECT – w stress | PQ | deg | 82629-7 |             | 2.16.840.1.113883.6.1               |
| Phase entropy w stress score LV SPECT | Phase entropy [score] left ventricle SPECT – w stress | PQ | score | 82630-5 |             | 2.16.840.1.113883.6.1               |
| MDTES w stress LV SPECT   | Maximum difference in time to end-systole left ventricle SPECT – w stress | PQ | % | 82631-3 |             | 2.16.840.1.113883.6.1               |
| DTES-LS w stress LV SPECT | Difference in time to end-systole between lateral and septal wall left ventricle SPECT – w stress | PQ | % | 82632-1 |             | 2.16.840.1.113883.6.1               |
| SDTES w stress LV SPECT   | Standard deviation of time to end-systole left ventricle SPECT – w stress | PQ | % | 82633-9 |             | 2.16.840.1.113883.6.1               |

(Table 4 continued the next page.)
Physiological examination systems that comply with the SEAMAT guidelines can transfer data from the system to SS-MIX2 extension storage. Furthermore, to accelerate the prevalence of data availability, we developed a program to convert data from CSV files into SS-MIX2 extension storage according to the SEAMAT. This program was validated at Tohoku University Hospital and Kyushu University Hospital. In Tohoku University Hospital, a total of 424,130 units of electrocardiogram data obtained from examinations conducted between 23 June 2000 and 14 June 2018 were successfully converted from CSV to XML files according to the SEAMAT. After the Minnesota process of SEAMAT remain transparent among vendors, informaticians, and cardiologists. As the next step, it was necessary to obtain consensus among more cardiologists with various subspecialties in order to satisfy their requirements. We asked several associations to join the committee of SEAMAT for maintenance and updating. As of December 2019, the JCS, Japanese Heart Rhythm Society, Japanese Association of Cardiovascular Intervention and Therapeutics, Japanese Heart Failure Society, Japanese Society of Nuclear Cardiology, Japanese Association of Cardiac Rehabilitation, Japanese Society of Echocardiography, and Japan Association for Medical Informatics have been collaborating on updating the SEAMAT. Moreover, other examinations, including the Holter ECG test, stress ECG, pulse wave velocity, and ankle-brachial pressure index, are under consideration. Through this committee, the maintenance and updating processes of SEAMAT remain transparent among vendors, informaticians, and cardiologists.

Results

Cardiologist opinions should be prioritized in determining the standard item names of the data from various examinations in cardiology. The committee of the Japanese Circulation Society (JCS), which is the largest association among cardiologists in Japan, permitted the development of a standardized format in 2014. Within 1 year, IHE-J along with several voluntary cardiologists decided the standard item names and units in cardiological examinations, such as ECG, UCG, and CATH, in accordance with the generality and significance of these examinations for clinical activity. The format was aimed at transferring clinical data to the SS-MIX2 extension storage, because SS-MIX2 storage has become common in numerous hospitals for collecting data from different facilities in Japan. The technical problems encountered in developing the standard format were solved by technicians from different vendor companies in IHE-J cardiology. In 2015, the format for the SS-MIX2 extension storage was named SEAMAT, and it was approved by the JCS. The SEAMAT describes the standard names and units of examinations, such as the heart rate in beats per minute (“HR, bpm”) and the interval between R and R in seconds (“RR, s”) in ECG (Table 1), as well as the diastolic diameter of the left ventricle in millimeters (“LVDd, mm”) and ejection fraction in percentage (“EF, %”) in UCG (Table 2). Similarly, catheterization examinations (Table 3) and nuclear cardiology (Table 4) have standard item names and units for SEAMAT. All SEAMAT item names use LOINC, according to the guidelines for SS-MIX2 extension storage. The format of catheter intervention is partially compatible with the Japan Percutaneous Coronary Intervention registry form. Thereafter, the information of SEAMAT was announced on the JCS webpages. Sequentially, several companies producing physical examination and catheter examination reporting systems have released merchandized products, which enable data conversion following the SEAMAT. Using these systems, ECG and UCG data can be automatically transferred to SS-MIX2 storage, thereby enabling availability for secondary use (Figure 2).

As the next step, it was necessary to obtain consensus among more cardiologists with various subspecialties in order to satisfy their requirements. We asked several associations to join the committee of SEAMAT for maintenance and updating. As of December 2019, the JCS, Japanese Heart Rhythm Society, Japanese Association of Cardiovascular Intervention and Therapeutics, Japanese Heart Failure Society, Japanese Society of Nuclear Cardiology, Japanese Association of Cardiac Rehabilitation, Japanese Society of Echocardiography, and Japan Association for Medical Informatics have been collaborating on updating the SEAMAT. Moreover, other examinations, including the Holter ECG test, stress ECG, pulse wave velocity, and ankle-brachial pressure index, are under consideration. Through this committee, the maintenance and updating processes of SEAMAT remain transparent among vendors, informaticians, and cardiologists.

| Item name Display name | Data type | Unit | Item code | Option Code | Display name Code system | Code system OID |
|------------------------|-----------|------|-----------|-------------|--------------------------|----------------|
| Max phase at rest angle LV SPECT | Maximum phase [angle] left ventricle SPECT – at rest | PQ | deg | 82634-7 | LOINC | 2.16.840.1.113883.6.1 |
| Mean phase at rest angle LV SPECT | Mean phase [angle] left ventricle SPECT – at rest | PQ | deg | 82635-4 | LOINC | 2.16.840.1.113883.6.1 |
| Phase at rest angle LV SPECT | Phase standard deviation [angle] left ventricle SPECT – at rest | PQ | deg | 82636-2 | LOINC | 2.16.840.1.113883.6.1 |
| Phase bandwidth at rest LV SPECT | Phase bandwidth left ventricle SPECT – at rest | PQ | deg | 82637-0 | LOINC | 2.16.840.1.113883.6.1 |
| Phase entropy at rest score LV SPECT | Phase entropy [score] left ventricle SPECT – at rest | PQ | score | 82638-8 | LOINC | 2.16.840.1.113883.6.1 |
| MDTS at rest LV SPECT | Maximum difference in time to end-systole left ventricle SPECT – at rest | PQ | % | 82639-6 | LOINC | 2.16.840.1.113883.6.1 |
| DTES-LS at rest LV SPECT | Difference in time to end-systole between lateral and septal wall left ventricle SPECT – at rest | PQ | % | 82640-4 | LOINC | 2.16.840.1.113883.6.1 |
| SDTS at rest LV SPECT | Standard deviation of time to end-systole left ventricle SPECT – at rest | PQ | % | 82641-2 | LOINC | 2.16.840.1.113883.6.1 |

PQ, value.
Hospital, a total of 288,090 units of electrocardiogram data obtained between 4 January 2008 and 28 December 2017 were changed according to the SEAMAT after CSV files were reformatted as RFC4180 and any extra textual data in fixed value format were omitted. A total of 79,992 units of UCG data from examinations conducted between 4 January 2008 and 29 December 2017 were finally transformed according to the SEAMAT after textual data were modified as value data. Using this software, many facilities can use past data and convert them into SS-MIX2, without additional costs for system vendors.

**Discussion**

In this study, we have introduced a standard format that facilitates the collection of data, particularly relating to cardiology, from different hospitals with various vendors. Several significant achievements can be summarized. First, the standard data format was determined by cooperation with cardiologist associations, including the JCS and other societies. This format is based on the opinions of cardiologists from various cardiology associations in Japan. To establish standardization, it is crucial to reach agreement with clinicians from the perspective of real clinical usage. Moreover, collaboration between medical informaticians and cardiologists aided the successful development of a standard format for data transfer in cardiology. This format enables data transfers from physiological examination systems to Japanese standard storages for secondary use. This stepwise accomplishment may lead to the establishment of a nationwide clinical cardiology database and registry. Second, we succeeded to enable available products with the function of transferring data in accordance with SEAMAT from several vendors. This is practical for making data available to clinicians for secondary use without the unnecessary burden of manually transferring the data. Third, a program that we developed is freely available to all cardiologists who wish to convert CSV data into the SEAMAT instead of purchasing a new system that can transfer SEAMAT data or paying a substantial amount of money to convert past data into the SEAMAT. Although the use of SS-MIX2 has expanded throughout Japan, clinicians still require extensions of structured storage formats to use clinical data, regardless of the differences among vendors or modalities. Using the SS-MIX2 standard storage, we combined cardiological data with basic patient data, laboratory data, and medication lists. We believe that our software can clear the hurdles in the implementation of SEAMAT.

Several limitations should be mentioned. First, this format is based on SS-MIX2, which is only available in Japan. However, if the data can be collected once, these datasets can be converted from SEAMAT into another format that is suitable for international use. The items of SEAMAT are connected to LOINC codes, which are commonly used as standard codes internationally, particularly in the USA. Second, this study has only presented a scheme for the data transfer process during the development of a standard for the cardiological data and format of SEAMAT. However, we have already certified a proof of concept in a previous study, which showed SEAMAT has been implemented at Tohoku University Hospital, Kyusyu University Hospital, Tokyo University Hospital, and Jichi Medical University Hospital. Furthermore, several other university hospitals are preparing to implement SEAMAT. Large volumes of cardiological data with SEAMAT can be
collected in the near future. The subsequent research will address new findings in a real-world data study.

In conclusion, we have reported on the development of a format for cardiological data such as ECG, UCG, and CATH. This resulted from collaboration among cardiologists, medical informaticians, and vendors to make better use of real-world data from HIS. The application of SEAMAT may reduce the burden of achieving clinical studies, and may be useful for providing efficient and optimized treatment for each patient.

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IRB Information
The Tohoku University Ethics Committee (2015-1-493) approved this study.

Disclosure
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