



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

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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.^{1–3} 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.^{4,6} 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 informa-

tion 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.⁷ 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.^{8–10} The number of hospitals using SS-MIX2 was 1471 in March 2019.¹¹

The storage format is divided into 2 categories. The first is the standardized storage, including standard clinical data in a standard form (HL7 v2.5), such as basic patient data, prescriptions, and laboratory data. The second is the extension storage, including the remaining data not stored in the standard storage. Therefore, important cardiac data, such as ECG, UCG, and CATH, are categorized in the extension storage because they are not well structured,

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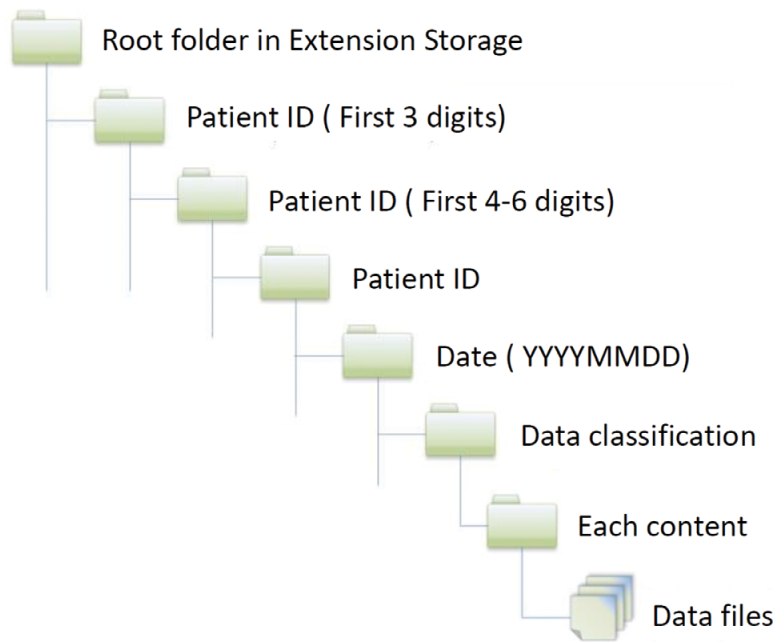


Figure 1. Rules for storing data files in standardized structured medical information exchange version 2 (SS-MIX2) extension storage.

coded, or standardized owing to no standard data format being determined. The aim of this study is to determine a standard data format for these examinations in cardiology.

Methods

Integrating the Healthcare Enterprise (IHE)

IHE¹² 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.¹³ 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.¹⁴ 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.⁵ 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),¹⁵ 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-MIX2 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 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 system	Code system OID
					Code	Meaning		
Heart rate	Heart rate	PQ	L/min	8867-4			LOINC	2.16.840.1.113883.6.1
PR interval	PR interval	PQ	ms	8625-6			LOINC	2.16.840.1.113883.6.1
QRS duration	QRS duration	PQ	ms	8633-0			LOINC	2.16.840.1.113883.6.1
QT interval	QT interval	PQ	ms	8634-8			LOINC	2.16.840.1.113883.6.1
QT interval corrected	QT interval corrected	PQ	ms	8636-3			LOINC	2.16.840.1.113883.6.1
QTc interval by Fridericia	QTc interval by Fridericia	PQ	ms	76634-5			LOINC	2.16.840.1.113883.6.1
QTc interval by Bazett	QTc interval by Bazett	PQ	ms	76635-2			LOINC	2.16.840.1.113883.6.1
QTC_INT	QTC_INT	PQ	ms	14			MEASURED	1.2.392.200119.5.2.3.3.3.1
P wave axis	P wave axis	PQ	deg	8626-4			LOINC	2.16.840.1.113883.6.1
QRS axis	QRS axis	PQ	deg	8632-2			LOINC	2.16.840.1.113883.6.1
T wave axis	T wave axis	PQ	deg	8638-9			LOINC	2.16.840.1.113883.6.1
S wave Amp L-V1	S wave amplitude in lead V1	PQ	mV	10040-4			LOINC	2.16.840.1.113883.6.1
R wave Amp L-V5	R wave amplitude in lead V5	PQ	mV	9995-2			LOINC	2.16.840.1.113883.6.1
R wave Amp L-V6	R wave amplitude in lead V6	PQ	mV	9996-0			LOINC	2.16.840.1.113883.6.1
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	2.16.840.1.113883.6.1
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	2.16.840.1.113883.6.1
Analysis results (Nihon Kohden)	Analysis results are recorded (e.g., sinus rhythm)	Character string	–	ECAPS code (e.g., 1100)			ECAPS	1.2.392.200119.5.2.3.3.1
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., 1–1–1;A)	Character string	–	Minnesota Code			MINNESOTA_CODE	1.2.392.200119.5.2.4.1.1.3

LOINC, Logical Observation Identifiers Names and Codes; PQ, value type.

Table 2. Standard Export Data Format (SEAMAT) List for Ultrasound Cardiography (UCG)								
Item name	Display name	Data type	Unit	Item code	Option		Code system	
					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	29443-9			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	80033-4			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_A2C_ single plane_MOD	LV SV_A2C_single plane_MOD	PQ	mL	93655-9			LOINC	2.16.840.1.113883.6.1
LV SV_biplane_ area length	LV SV_biplane_area length	PQ	mL	93654-2			LOINC	2.16.840.1.113883.6.1
LV SV_A4C_ single plane_area length	LV SV_A4C_single plane_area length	PQ	mL	93653-4			LOINC	2.16.840.1.113883.6.1
LV SV_A2C_ single plane_area length	LV SV_A2C_single plane_area length	PQ	mL	93652-6			LOINC	2.16.840.1.113883.6.1
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_ Teichholz(2D)	LV CO_Teichholz(2D)	PQ	L/min	76569-3			LOINC	2.16.840.1.113883.6.1
LV CO_biplane_ MOD	LV CO_biplane_MOD	PQ	L/min	20209-3			LOINC	2.16.840.1.113883.6.1
LV CO_A4C_ single plane_MOD	LV CO_A4C_single plane_MOD	PQ	L/min	93651-8			LOINC	2.16.840.1.113883.6.1
LV CO_A2C_ single plane_MOD	LV CO_A2C_single plane_MOD	PQ	L/min	93650-0			LOINC	2.16.840.1.113883.6.1
LV CO_biplane_ area length	LV CO_biplane_area length	PQ	L/min	93649-2			LOINC	2.16.840.1.113883.6.1
LV CO_A4C_ single plane_area length	LV CO_A4C_single plane_area length	PQ	L/min	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	L/min	93647-6			LOINC	2.16.840.1.113883.6.1
LV CO(3D)	LV CO(3D)	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_ Teichholz(2D)	LV EF_Teichholz(2D)	PQ	%	77891-0			LOINC	2.16.840.1.113883.6.1
LV EF_biplane_ MOD	LV EF_biplane_MOD	PQ	%	77892-8			LOINC	2.16.840.1.113883.6.1
LV EF_A4C_ single plane_MOD	LV EF_A4C_single plane_MOD	PQ	%	79993-2			LOINC	2.16.840.1.113883.6.1
LV EF_A2C_ single plane_MOD	LV EF_A2C_single plane_MOD	PQ	%	79992-4			LOINC	2.16.840.1.113883.6.1
LV EF_biplane_ area length	LV EF_biplane_area length	PQ	%	93646-8			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/m ²	77898-5			LOINC	2.16.840.1.113883.6.1
LV MI_ASE(2D)	LV MI_ASE(2D)	PQ	g/m ²	77899-3			LOINC	2.16.840.1.113883.6.1
LV MI_Devereux	LV MI_Devereux	PQ	g/m ²	81095-2			LOINC	2.16.840.1.113883.6.1
LV MI_area length	LV MI_area length	PQ	g/m ²	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	
					Code	Meaning	Name	OID
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	mm ²	79974-2			LOINC	2.16.840.1.113883.6.1
LA area_A2C	LA area_A2C	PQ	mm ²	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/m ²	77906-6			LOINC	2.16.840.1.113883.6.1
LA VI_A4C_single plane_MOD	LA VI_A4C_single plane_MOD	PQ	mL/m ²	93639-3			LOINC	2.16.840.1.113883.6.1
LA VI_A2C_single plane_MOD	LA VI_A2C_single plane_MOD	PQ	mL/m ²	93638-5			LOINC	2.16.840.1.113883.6.1
LA VI_biplane_area length	LA VI_biplane_area length	PQ	mL/m ²	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/m ²	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/m ²	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	mm ²	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
IVCD_expiration	IVCD_expiration	PQ	mm	29459-5			LOINC	2.16.840.1.113883.6.1
IVCD_inspiration	IVCD_inspiration	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	LA32-8	Undetected	LOINC	2.16.840.1.113883.6.1
					LA33-6	Detected		
					LA1-0	Unclear		
Estimated RAP	Estimated RAP	PQ	mmHg	82337-7			LOINC	2.16.840.1.113883.6.1
Pericardial effusion	Pericardial effusion	CD	-	93664-1	LA32-8	Undetected	LOINC	2.16.840.1.113883.6.1
					LA33-6	Detected		
					LA1-0	Unclear		

(Table 2 continued the next page.)

Item name	Display name	Data type	Unit	Item code	Option		Code system	
					Code	Meaning	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_ascending	AoD_ascending	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	cm ²	29487-6			LOINC	2.16.840.1.113883.6.1
AVA(Doppler)	AVA(Doppler)	PQ	cm ²	18090-1			LOINC	2.16.840.1.113883.6.1
AVAI(2D)	AVAI(2D)	PQ	cm ² /m ²	81392-3			LOINC	2.16.840.1.113883.6.1
AVAI(Doppler)	AVAI(Doppler)	PQ	cm ² /m ²	79959-3			LOINC	2.16.840.1.113883.6.1
AS severity_semi quanti	AS severity_semi quanti	CD	-	77912-4	LA137-2	None	LOINC	2.16.840.1.113883.6.1
					LA11832-5	Trace		
					LA6752-5	Mild		
					LA23856-0	Mild-to-moderate		
					LA6751-7	Moderate		
					LA23857-8	Moderate-to-severe		
					LA6750-9	Severe		
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	mm ²	77909-0			LOINC	2.16.840.1.113883.6.1
AR EROA_volumetric	AR EROA_volumetric	PQ	mm ²	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	Undetected	LOINC	2.16.840.1.113883.6.1
					LA33-6	Detected		
					LA1-0	Unclear		
Ao holodiastolic flow reversal_abdominal	Ao holodiastolic flow reversal_abdominal	CD	-	93629-4	LA32-8	Undetected	LOINC	2.16.840.1.113883.6.1
					LA33-6	Detected		
					LA1-0	Unclear		
AR severity_semi quanti	AR severity_semi quanti	CD	-	18112-3	LA137-2	None	LOINC	2.16.840.1.113883.6.1
					LA11832-5	Trace		
					LA6752-5	Mild		
					LA23856-0	Mild-to-moderate		
					LA6751-7	Moderate		
					LA23857-8	Moderate-to-severe		
					LA6750-9	Severe		

(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 DcT	LV DcT	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	Undetected	LOINC	2.16.840.1.113883.6.1
					LA33-6	Detected		
					LA1-0	Unclear		
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	cm ²	78179-9			LOINC	2.16.840.1.113883.6.1
MVA PHT	MVA PHT	PQ	cm ²	18097-6			LOINC	2.16.840.1.113883.6.1
MS severity_semi-quantiti	MS severity_semi-quantiti	CD	-	77916-5	LA137-2	None	LOINC	2.16.840.1.113883.6.1
					LA11832-5	Trace		
					LA6752-5	Mild		
					LA23856-0	Mild-to-moderate		
					LA6751-7	Moderate		
					LA23857-8	Moderate-to-severe		
					LA6750-9	Severe		
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_1-3m/s	MR Vel dur_1-3m/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	mm ²	29448-8			LOINC	2.16.840.1.113883.6.1
MR EROA_volumetric	MR EROA_volumetric	PQ	mm ²	77914-0			LOINC	2.16.840.1.113883.6.1
MR severity_semi-quantiti	MR severity_semi-quantiti	CD	-	18113-1	LA137-2	None	LOINC	2.16.840.1.113883.6.1
					LA11832-5	Trace		
					LA6752-5	Mild		
					LA23856-0	Mild-to-moderate		
					LA6751-7	Moderate		
					LA23857-8	Moderate-to-severe		
					LA6750-9	Severe		

(Table 2 continued the next page.)

Item name	Display name	Data type	Unit	Item code	Option		Code system	
					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	mm	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	LA32-8	Undetected	LOINC	2.16.840.1.113883.6.1
					LA33-6	Detected		
					LA1-0	Unclear		
PR severity_semi quanti	PR severity_semi quanti	CD	-	18114-9	LA137-2	None	LOINC	2.16.840.1.113883.6.1
					LA11832-5	Trace		
					LA6752-5	Mild		
					LA23856-0	Mild-to-moderate		
					LA6751-7	Moderate		
					LA23857-8	Moderate-to-severe		
					LA6750-9	Severe		
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	mm ²	81091-1			LOINC	2.16.840.1.113883.6.1
TVA PHT	TVA PHT	PQ	mm ²	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	mm ²	93621-1			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
TR vena contracta	TR vena contracta	PQ	mm	77917-3			LOINC	2.16.840.1.113883.6.1
TR VTI	TR VTI	PQ	m	93620-3			LOINC	2.16.840.1.113883.6.1
TR PISA radius	TR PISA radius	PQ	mm	79932-0			LOINC	2.16.840.1.113883.6.1
Hepatic vein systolic flow reversal	Hepatic vein systolic flow reversal	CD	-	93619-5	LA32-8	Undetected	LOINC	2.16.840.1.113883.6.1
					LA33-6	Detected		
					LA1-0	Unclear		
TR RVol_PISA	TR RVol_PISA	PQ	mL	93618-7			LOINC	2.16.840.1.113883.6.1
TR EROA_PISA	TR EROA_PISA	PQ	mm ²	81093-7			LOINC	2.16.840.1.113883.6.1
TR severity_semi quanti	TR severity_semi quanti	CD	-	18115-6	LA137-2	None	LOINC	2.16.840.1.113883.6.1
					LA11832-5	Trace		
					LA6752-5	Mild		
					LA23856-0	Mild-to-moderate		
					LA6751-7	Moderate		
					LA23857-8	Moderate-to-severe		
LA6750-9	Severe							
s'_septal	s'_septal	PQ	m/s	78187-2			LOINC	2.16.840.1.113883.6.1
s'_lateral	s'_lateral	PQ	m/s	78188-0			LOINC	2.16.840.1.113883.6.1
s'_mean	s'_mean	PQ	m/s	81383-2			LOINC	2.16.840.1.113883.6.1
e'_septal	e'_septal	PQ	m/s	78185-6			LOINC	2.16.840.1.113883.6.1
e'_lateral	e'_lateral	PQ	m/s	78186-4			LOINC	2.16.840.1.113883.6.1
e'_mean	e'_mean	PQ	m/s	81384-0			LOINC	2.16.840.1.113883.6.1
a'_septal	a'_septal	PQ	m/s	81396-4			LOINC	2.16.840.1.113883.6.1
a'_lateral	a'_lateral	PQ	m/s	81397-2			LOINC	2.16.840.1.113883.6.1
a'_mean	a'_mean	PQ	m/s	81385-7			LOINC	2.16.840.1.113883.6.1
E/e'_septal	E/e'_septal	PQ	1	78189-8			LOINC	2.16.840.1.113883.6.1
E/e'_lateral	E/e'_lateral	PQ	1	78190-6			LOINC	2.16.840.1.113883.6.1
E/e'_mean	E/e'_mean	PQ	1	81386-5			LOINC	2.16.840.1.113883.6.1
RV s'	RV s'	PQ	m/s	79926-2			LOINC	2.16.840.1.113883.6.1
RV e'	RV e'	PQ	m/s	79924-7			LOINC	2.16.840.1.113883.6.1
Peak strain_longitudinal(2D)	Peak strain_longitudinal(2D)	PQ	%	81399-8			LOINC	2.16.840.1.113883.6.1
Peak strain_circumferential(2D)	Peak strain_circumferential(2D)	PQ	%	81401-2			LOINC	2.16.840.1.113883.6.1
Peak strain_radial(2D)	Peak strain_radial(2D)	PQ	%	81400-4			LOINC	2.16.840.1.113883.6.1
Peak strain_longitudinal(3D)	Peak strain_longitudinal(3D)	PQ	%	93617-9			LOINC	2.16.840.1.113883.6.1
Peak strain_circumferential(3D)	Peak strain_circumferential(3D)	PQ	%	93616-1			LOINC	2.16.840.1.113883.6.1
Peak strain_area(3D)	Peak strain_area(3D)	PQ	%	93615-3			LOINC	2.16.840.1.113883.6.1
Peak SR S_longitudinal(2D)	Peak SR S_longitudinal(2D)	PQ	%	81403-8			LOINC	2.16.840.1.113883.6.1
Peak SR S_circumferential(2D)	Peak SR S_circumferential(2D)	PQ	%	81405-3			LOINC	2.16.840.1.113883.6.1
Peak SR S_radial(2D)	Peak SR S_radial(2D)	PQ	%	81404-6			LOINC	2.16.840.1.113883.6.1
Peak SR S_longitudinal(3D)	Peak SR S_longitudinal(3D)	PQ	%	93614-6			LOINC	2.16.840.1.113883.6.1
Peak SR S_circumferential(3D)	Peak SR S_circumferential(3D)	PQ	%	93613-8			LOINC	2.16.840.1.113883.6.1
Peak SR S_area(3D)	Peak SR S_area(3D)	PQ	%	82596-8			LOINC	2.16.840.1.113883.6.1
Peak SR E_longitudinal(2D)	Peak SR E_longitudinal(2D)	PQ	%	81407-9			LOINC	2.16.840.1.113883.6.1
Peak SR E_circumferential(2D)	Peak SR E_circumferential(2D)	PQ	%	81409-5			LOINC	2.16.840.1.113883.6.1
Peak SR E_radial(2D)	Peak SR E_radial(2D)	PQ	%	81408-7			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
Peak SR_E_longitudinal(3D)	Peak SR_E_longitudinal(3D)	PQ	%	93612-0			LOINC	2.16.840.1.113883.6.1
Peak SR_E_circumferential(3D)	Peak SR_E_circumferential(3D)	PQ	%	93611-2			LOINC	2.16.840.1.113883.6.1
Peak SR_E_area(3D)	Peak SR_E_area(3D)	PQ	%	81410-3			LOINC	2.16.840.1.113883.6.1
Peak SR_A_longitudinal(2D)	Peak SR_A_longitudinal(2D)	PQ	%	81411-1			LOINC	2.16.840.1.113883.6.1
Peak SR_A_circumferential(2D)	Peak SR_A_circumferential(2D)	PQ	%	81413-7			LOINC	2.16.840.1.113883.6.1
Peak SR_A_radial(2D)	Peak SR_A_radial(2D)	PQ	%	81412-9			LOINC	2.16.840.1.113883.6.1
Peak SR_A_longitudinal(3D)	Peak SR_A_longitudinal(3D)	PQ	%	93610-4			LOINC	2.16.840.1.113883.6.1
Peak SR_A_circumferential(3D)	Peak SR_A_circumferential(3D)	PQ	%	93609-6			LOINC	2.16.840.1.113883.6.1
Peak SR_A_area(3D)	Peak SR_A_area(3D)	PQ	%	93608-8			LOINC	2.16.840.1.113883.6.1
Peak apical rotation	Peak apical rotation	PQ	deg	81415-2			LOINC	2.16.840.1.113883.6.1
Peak basal rotation	Peak basal rotation	PQ	deg	81416-0			LOINC	2.16.840.1.113883.6.1
Peak torsion	Peak torsion	PQ	deg	81417-8			LOINC	2.16.840.1.113883.6.1
Peak twist rate	Peak twist rate	PQ	%	81418-6			LOINC	2.16.840.1.113883.6.1
Peak untwist rate	Peak untwist rate	PQ	%	81419-4			LOINC	2.16.840.1.113883.6.1
WMS_basal anterior	WMS_basal anterior	CD	-	18121-4	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_basal anteroseptal	WMS_basal anteroseptal	CD	-	18122-2	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_basal inferoseptal	WMS_basal inferoseptal	CD	-	78192-2	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_basal inferior	WMS_basal inferior	CD	-	18123-0	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_basal inferolateral	WMS_basal inferolateral	CD	-	78193-0	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 system	
					Code	Meaning	Name	OID
WMS_basal anterolateral	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	-	78195-5	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	-	78196-3	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	-	78197-1	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 system	
					Code	Meaning	Name	OID
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 Hlstory 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 system	
					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 system	
					Code	Meaning	Name	OID
Renal failure	Renal failure	CD	–	45678-0	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA1-0	Unknown		
Dialysis	Dialysis	CD	–	45842-2	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA1-0	Unknown		
COPD	COPD	CD	–	45670-7	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA1-0	Unknown		
Peripheral vascular disease	Peripheral vascular disease	CD	–	58264-3	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
Hyperuricemia	Hyperuricemia	CD	–	78924-8	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA4489-6	Unknown		

(Table 3 continued the next page.)

1-3. Coronary risk factors								
Item name	Display name	Data type	Unit	Item code	Option		Code system	
					Code	Meaning	Name	OID
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		
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	
					Code	Meaning	Name	OID
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	
					Code	Meaning	Name	OID
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	
					Code	Meaning	Name	OID
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.)

Item name	Display name	Data type	Unit	Item code	Option		Code system	
					Code	Meaning	Name	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	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	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	Tirofiban		
					LA28654-4	Warfarin		
					LA28655-1	Dabigatran		
					LA28657-7	Edoxaban		
					LA28656-9	Rivaroxaban		
LA46-8	Others							
Hemoglobin	Hemoglobin	PQ	g/d	718-7	-	-	LOINC	2.16.840.1.113883.6.1
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 system	
					Code	Meaning	Name	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	
					Code	Meaning	Name	OID
Stent thrombosis	Stent thrombosis	CD	-	80988-9	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA1-0	Unknown		
Date of procedure	Date of procedure	TS	-	80989-7	-	-	LOINC	2.16.840.1.113883.6.1
Procedure sequence	Procedure sequence	CD	-	80245-4	LA6662-6	Initial	LOINC	2.16.840.1.113883.6.1
					LA9177-2	Follow-up		
Procedure urgency	Procedure urgency	CD	-	78927-1	LA19759-2	Emergent	LOINC	2.16.840.1.113883.6.1
					LA19760-0	Elective		
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 time	PQ	min	80990-5	-	-	LOINC	2.16.840.1.113883.6.1
Fluoroscopy dose	Fluoroscopy dose	PQ	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 cardiac catheterization	1 st balloon date and time	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	
					Code	Meaning	Name	OID
Coronary angiography	CAG	CD	-	80994-7	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA1-0	Unknown		
Left ventriculography	LVG	CD	-	80995-4	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA1-0	Unknown		
Peripheral angiography	Peripheral angiography	CD	-	80995-4	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA4489-6	Unknown		
Right heart catheterization	Right heart catheterization	CD	-	78930-5	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA4489-6	Unknown		
Spasm load test performed	Spasm load test	CD	-	78931-3	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA4489-6	Unknown		
Blood sampling	Blood sampling	CD	-	80726-3	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA4489-6	Unknown		
Intravascular ultrasound performed	IVUS	CD	-	80996-2	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA1-0	Unknown		
Optical coherence tomography performed	OCT	CD	-	78932-1	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA4489-6	Unknown		

(Table 3 continued the next page.)

Item name	Display name	Data type	Unit	Item code	Option		Code system	
					Code	Meaning	Name	OID
Fractional flow reserve performed	FFR	CD	-	80997-0	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA1-0	Unknown		
Access site	Access site	CD	-	80243-9	LA24509-4	Femoral artery - left	LOINC	2.16.840.1.113883.6.1
					LA24508-6	Femoral artery - right		
					LA24507-8	Brachial artery - left		
					LA24506-0	Brachial artery - right		
					LA24505-2	Radial artery - left		
					LA24504-5	Radial artery - right		
					LA46-8	Other		
1-9. Assisted circulation								
Item name	Display name	Data type	Unit	Item code	Option		Code system	
					Code	Meaning	Name	OID
Temporary pacing	Temporary pacing	CD	-	78934-7	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA4489-6	Unknown		
Circulatory assistive devices used preoperatively	Preoperative	CD	-	89054-1	LA137-2	Others	LOINC	2.16.840.1.113883.6.1
					LA28959-7	PCPS		
					LA28960-5	IABP		
					LA9994-0	LVAD		
					LA28961-3	IIPD		
Circulatory assistive devices used during surgery	During surgery	CD	-	89056-6	LA137-2	None	LOINC	2.16.840.1.113883.6.1
					LA28959-7	PCPS		
					LA28960-5	IABP		
					LA9994-0	LVAD		
					LA28961-3	IIPD		
Circulatory assistive devices used postoperatively	Postoperative	CD	-	89055-8	LA137-2	None	LOINC	2.16.840.1.113883.6.1
					LA28959-7	PCPS		
					LA28960-5	IABP		
					LA9994-0	LVAD		
					LA28961-3	IIPD		
LA46-8	Others							

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	
					Code	Meaning	Name	OID
Type of right coronary artery catheter	RCA_catheter	ST	-	80224-9	-	-	LOINC	2.16.840.1.113883.6.1
Type of left coronary artery catheter	LCA_catheter	ST	-	80225-6	-	-	LOINC	2.16.840.1.113883.6.1
Type of pigtail catheter	PIG_catheter	ST	-	80226-4	-	-	LOINC	2.16.840.1.113883.6.1

(Table 3 continued the next page.)

2-2. Coronary segment								
Item name	Display name	Data type	Unit	Item code	Option		Code system	
					Code	Meaning	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%		
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%		
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%		
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%		
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%		
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%		
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%		
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	Option		Code system	
					Code	Meaning	Name	OID
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%		
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%		
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%		
2-3. Left ventricle angiography								
Item name	Display name	Data type	Unit	Item code	Option		Code system	
					Code	Meaning	Name	OID
LV basal anterior segmental wall motion by cardiac angiogram	LVG_seg1	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		
LV lateral anterior segmental wall motion by cardiac angiogram	LVG_seg2	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		
LV apex segmental wall motion by cardiac angiogram	LVG_seg3	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	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 basal posterior segmental wall motion by cardiac angiogram	LVG_seg5	CD	-	78955-2	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		
Ventricular septal segmental wall motion by cardiac angiogram	LVG_seg6	CD	-	78956-0	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 posterior segmental wall motion by cardiac angiogram	LVG_seg7	CD	-	78957-8	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 ejection fraction by cardiac angiogram	LVG_EF	PQ	%	8808-8	-	-	LOINC	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
LV end-systolic volume by imaging	LVG_ESV	PQ	mL	8823-7	-	-	LOINC	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
Regurgitation degree aortic valve angiography	AR	CD	-	81431-9	LA137-2	None	LOINC	2.16.840.1.113883.6.1
					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	
					Code	Meaning	Name	OID
Regurgitation degree mitral valve angiography	MR	CD	–	81432-7	LA137-2	None	LOINC	2.16.840.1.113883.6.1
					LA11841-6	1+		
					LA11842-4	2+		
					LA11843-2	3+		
					LA28404-4	I		
					LA28405-1	II		
					LA28406-9	III		
LA28407-7	IV							
Orifice [area] aortic valve cardiac catheterization	AVA	PQ	cm ²	80230-6	–	–	LOINC	2.16.840.1.113883.6.1
Orifice [area] mitral valve cardiac catheterization	MVA	PQ	cm ²	80231-4	–	–	LOINC	2.16.840.1.113883.6.1
2-4. Blood pressure method								
Item name	Display name	Data type	Unit	Item code	Option		Code system	
					Code	Meaning	Name	OID
A wave amplitude of pulmonary artery wedge cardiac catheterization	PCW_A	PQ	mmHg	80232-2	–	–	LOINC	2.16.840.1.113883.6.1
V wave amplitude of pulmonary artery wedge cardiac catheterization	PCW_V	PQ	mmHg	80233-0	–	–	LOINC	2.16.840.1.113883.6.1
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 pressure	RV_dias	PQ	mmHg	8377-4	–	–	LOINC	2.16.840.1.113883.6.1
Right ventricular intrachamber systolic pressure	RV_sys	PQ	mmHg	8432-7	–	–	LOINC	2.16.840.1.113883.6.1
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 catheterization	RA_A	PQ	mmHg	80234-8	–	–	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	
					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	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
2-5. Spasm stress test								
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	LA24503-7	Acetylcholine	LOINC	2.16.840.1.113883.6.1
					LA24502-9	Methylergonovine		
Spasm induced	Spasm induced	CD	–	81433-5	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA1-0	Unknown		
Symptom induced	Symptom induced	CD	–	81434-3	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA1-0	Unknown		

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

(4) Percutaneous Coronary Intervention								
3-1. PCI complications								
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	LA32-8	No	LOINC	2.16.840.1.113883.6.1
					LA33-6	Yes		
					LA4489-6	Unknown		

(Table 3 continued the next page.)

Item name	Display name	Data type	Unit	Item code	Option		Code system	
					Code	Meaning	Name	OID
Cardiac procedure complication type	Cardiac procedure complication type	CD	-	78937-0	LA20591-6	Died/expired	LOINC	2.16.840.1.113883.6.1
					LA14274-7	Myocardial infarction		
					LA24492-3	Cardiac tamponade		
					LA17687-7	Cardiogenic shock		
					LA24493-1	Stent thrombosis (onset prior to discharge)		
					LA24494-9	Access site hemorrhage requiring blood transfusion		
					LA24495-6	Non-access site hemorrhage requiring blood transfusion		
					LA24496-4	Emergency surgery		
					LA46-8	Other		
Cardiac procedure complication narrative	Other cardiac procedure complications	ST	-	78938-8	-	-	LOINC	2.16.840.1.113883.6.1
Death in the hospital	Death in the hospital	CD	-	CATH-19003-0	LA32-8	Yes	LOCAL	1.2.392.200250.3.2.10 0.300.19358409878
					LA33-6	No		
Date of death	Date of death	TS	-	81954-0	-	-	LOINC	2.16.840.1.113883.6.1
Cause of death	Cause of death	CD	-	79378-6	CATH-A010	Cardiac death related with operation	LOINC	2.16.840.1.113883.6.1
					CATH-A011	Cardiac death related without operation		
					CATH-A012	Non cardiac death		
3-2. PCI procedure								
Item name	Display name	Data type	Unit	Item code	Option		Code system	
					Code	Meaning	Name	OID
Segment(s) affected by lesion coronary artery segment	Lesion segment ACC/AHA	CD	-	80999-6	LA24460-0	RCA1	LOINC	2.16.840.1.113883.6.1
					LA24461-8	RCA2		
					LA24462-6	RCA3		
					LA24473-3	RCA4PD		
					LA24474-1	RCA4AV		
					LA24463-4	LMT5		
					LA24472-5	LAD6		
					LA24471-7	LAD7		
					LA24470-9	LAD8		
					LA24467-5	LAD9		
					LA24468-3	LAD10		
					LA24459-2	LCX11		
					LA24469-1	LCX12		
					LA28662-7	LCX13		
					LA24466-7	LCX14		
					LA28663-5	LCX15		
					LA30559-1	SVG (LAD)		
					LA30560-9	SVG (LCX)		
					LA30561-7	SVG (RCA)		
					LA30562-5	AG (LAD)		
LA30563-3	AG (LCX)							
LA30564-1	AG (RCA)							
LA46-8	Others							

(Table 3 continued the next page.)

Item name	Display name	Data type	Unit	Item code	Option		Code system	
					Code	Meaning	Name	OID
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 successful	CD	-	67544-7	LA32-8	Failure	LOINC	2.16.840.1.113883.6.1
					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%		
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%		
TIMI grade coronary artery segment – pre procedure	TIMI grade pre	CD	-	81000-2	LA26047-3	TIMI 0	LOINC	2.16.840.1.113883.6.1
					LA26048-1	TIMI 1		
					LA26049-9	TIMI 2		
					LA26050-7	TIMI 3		
TIMI grade coronary artery segment – post procedure	TIMI grade post	CD	-	81001-0	LA26047-3	TIMI 0	LOINC	2.16.840.1.113883.6.1
					LA26048-1	TIMI 1		
					LA26049-9	TIMI 2		
					LA26050-7	TIMI 3		
New or recurrent stenosis coronary artery segment	De novo or restenosis	CD	-	80729-7	LA24479-0	De novo stenosis	LOINC	2.16.840.1.113883.6.1
					LA24480-8	Restenosis		
Stenosis classification coronary artery segment ACC/AHA	Stenosis classification ACC/AHA	CD	-	80730-5	LA24481-6	Type A	LOINC	2.16.840.1.113883.6.1
					LA24482-4	Type B1		
					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		
					LA26046-5	Rotational ablator		
					LA26045-7	Bioabsorbable scaffold		
					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.

Table 4. Standard Export Data Format (SEAMAT) List for Cardiac Nuclear Medicine Examinations								
Item name	Display name	Data type	Unit	Item code	Option		Code system	Code system OID
					Code	Meaning		
TES LV SPECT	Time to end-systole left ventricle SPECT	PQ	ms	82621-4			LOINC	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			LOINC	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			LOINC	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			LOINC	2.16.840.1.113883.6.1
TPFR at rest LV SPECT	Time to peak filling rate left ventricle SPECT – at rest	PQ	ms	82625-5			LOINC	2.16.840.1.113883.6.1
TPFR/RR at rest LV SPECT	Time to peak filling rate/RR interval left ventricle SPECT – at rest	PQ	L	82653-7			LOINC	2.16.840.1.113883.6.1
SSS.17 myocardium SPECT	Summed stress score for 17 segment model myocardium SPECT	PQ	score	82642-0			LOINC	2.16.840.1.113883.6.1
SRS.17 myocardium SPECT	Summed rest score for 17 segment model myocardium SPECT	PQ	score	82643-8			LOINC	2.16.840.1.113883.6.1
SDS.17 myocardium SPECT	Summed difference score for 17 segment model myocardium SPECT	PQ	score	82644-6			LOINC	2.16.840.1.113883.6.1
SSS.20 myocardium SPECT	Summed stress score for 20 segment model myocardium SPECT	PQ	score	82645-3			LOINC	2.16.840.1.113883.6.1
SRS.20 myocardium SPECT	Summed rest score for 20 segment model myocardium SPECT	PQ	score	82646-1			LOINC	2.16.840.1.113883.6.1
SDS.20 myocardium SPECT	Summed difference score for 20 segment model myocardium SPECT	PQ	score	82647-9			LOINC	2.16.840.1.113883.6.1
SSS myocardium SPECT	Summed stress score myocardium SPECT	PQ	%	82648-7			LOINC	2.16.840.1.113883.6.1
SRS myocardium SPECT	Summed rest score myocardium SPECT	PQ	%	82649-5			LOINC	2.16.840.1.113883.6.1
SDS myocardium SPECT	Summed difference score myocardium SPECT	PQ	%	82650-3			LOINC	2.16.840.1.113883.6.1
Washout myocardium SPECT	Washout rate [ratio] myocardium SPECT	PQ	%	82651-1			LOINC	2.16.840.1.113883.6.1
TID LV SPECT	Transient ischemic dilation left ventricle SPECT	PQ	1	82652-9			LOINC	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			LOINC	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			LOINC	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			LOINC	2.16.840.1.113883.6.1
Phase bandwidth w stress LV SPECT	Phase bandwidth left ventricle SPECT – w stress	PQ	deg	82629-7			LOINC	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			LOINC	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			LOINC	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			LOINC	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			LOINC	2.16.840.1.113883.6.1

(Table 4 continued the next page.)

Item name	Display name	Data type	Unit	Item code	Option		Code system	Code system OID
					Code	Meaning		
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
Ph.sd 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
MDTES 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
SDTES 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.

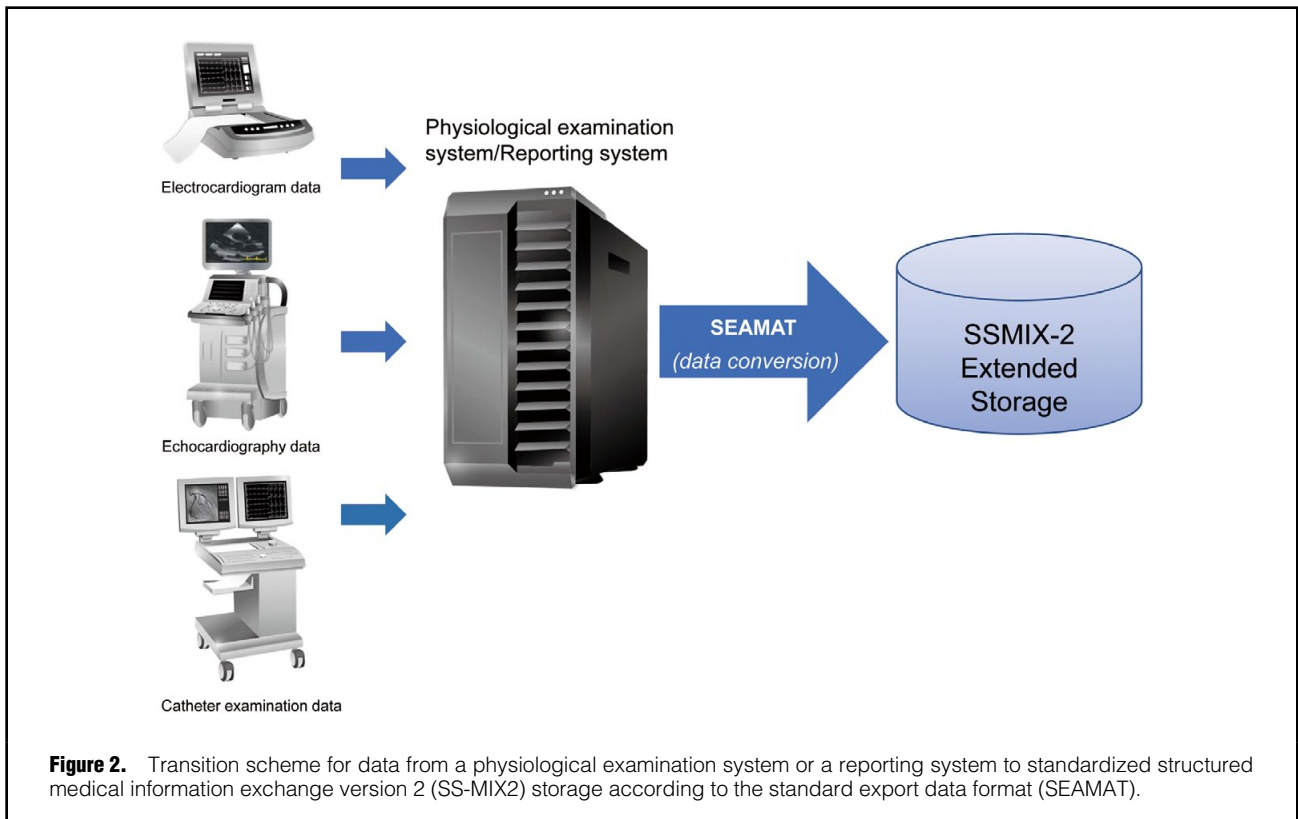
Results

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.

Physiological examination systems that comply with the SEAMAT guidelines can transfer data from the system to SS-MIX2 extension storage. In fact, such systems were implemented in Tohoku University Hospital in March 2020, and we validated the accuracy of data transition from the systems into SSMIX2 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 code was modified to a standard format (e.g., from 123 as a vendor-specific code to 1-2-3 as a standard code). A total of 90,164 units of UCG data obtained from examinations performed between 15 January 2004 and 30 March 2018 were transferred without any problems. In Kyushu University



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,¹⁴ 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,¹⁵ 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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