Essential data elements for electronic cardiovascular medical record systems in Iran

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ABSTRACT

Introduction: Electronic medical records play an important role in the management of patients. In order to develop cardiovascular electronic medical record systems, determining minimum data set is necessary. This study aimed to determine the essential data elements for electronic cardiovascular medical record systems.

Material and Methods: Medical records of patients with cardiovascular diseases and also the literature were reviewed to develop a questionnaire regarding the data elements. 87 cardiovascular specialists and residents as well as 50 nurses working in cardiovascular departments of hospitals affiliated with Iran University of Medical Sciences participated in the study. The data elements with at least 75% of agreement were considered essential for electronic medical records. Data were analyzed using descriptive statistics in SPSS software.

Results: The essential data elements were classified in 29 classes including admission, death, patients' main complaints, clinical signs, observations, medications, cardiac surgery, risk factors, laboratory and pathology results, consultation, resuscitation, anesthetic, electrocardiography, blood transfusion or blood products, rehabilitation measures, angiography/venography, exercise testing, endoscopy/colonoscopy, medical imaging, echocardiography, nursing interventions, allergies and side effects, therapeutic implantations, cardiac examinations, physical examinations, angina, referrals, social backgrounds and history. Totally, out of 276 data elements, 245 elements were identified as the essential data elements for electronic cardiovascular medical record systems.

Conclusion: In this study, essential data elements were defined for electronic cardiovascular medical records. Identifying cardiovascular minimum data set will be an effective step towards integrating and improving the management of these patients' information.

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INTRODUCTION

Cardiovascular diseases (CVDs) are among important causes of disability and death in the world [1]. According to the World Health Organization (WHO), CVDs are the number 1 cause of death in the world and 17.9 million people annually die from CVDs. This accounts 31% of all deaths globally [2]. The 2020 report from American Hospital Association indicates that almost 17.8 million deaths are attributed to CVDs globally, which indicates a 21.1% increase from 2007.

The age-adjusted death rate per 100 000 is 233.1 which represents a 10.3% decrease from 2007. Overall, the crude prevalence of CVDs is 485.6 million cases in 2017, a 28.5% increase and the age-adjusted prevalence rate is 6081.6 per 100 000, and 0.2% increase from 2007 [3]. Based on the WHO, over 75% of CVDs-related deaths are occurred in low and middle income countries [2]. A study in 2017 in Iran showed that cardiovascular disease accounted for 33-38 percent of deaths (approximately 26-30 million) and 23 percent of disabilities (approximately

18 million) [4].

Accurate and exchangeable health information is an essential prerequisite for providing optimal health care and the fragmented information also has undesirable effects on current and future health care for patients and consequently imposes high costs on health care systems [5]. However, most medical records of patients with cardiovascular diseases are also paper-based, and existing information systems support a limited specialized data set in this field [6]. Furthermore, poor and non-standard documentation of health information in medical records of these patients leads to poor management of the disease, which has negative consequences for patients [1].

Paper records do not meet the needed standards for health information systems. Therefore, application of computerized health information systems, especially, electronic medical records (EMR) has expanded [7]. Minimum Data Set (MDS) is required to collect quality data and is a prerequisite for developing electronic medical record systems (EMR) [8-10]. Therefore, the development of data sets in a uniform and standardized format at the national level could be the most important step to develop EMR systems [11, 12].

Some studies have been conducted worldwide to introduce standardized data sets for cardiovascular diseases for different purposes [13-16]; however, only two studies have specifically focused on developing data sets for cardiovascular EMRs/EHRs [13, 14]. Jeffery et al data elements for outpatient EMRs for pediatrics which contained 102 general concepts and eight categories [13]. Weintraub et al. also provided a list of data elements for electronic health records for cardiovascular diseases [14]. In Iran, many studies have been conducted to develop and standardize data sets for documentation of patients' health data in electronic systems [12, 17, 18]; however, to our knowledge, there is no study regarding to the development of data sets for a cardiovascular EMR system.

Considering the importance of cardiovascular diseases and given that to developing an EMR for cardiovascular diseases requires the development of data elements, this study aimed to determine the essential data elements for cardiovascular EMR in Iran so that system developers can develop a cardiovascular EMR system based on agreed-upon data elements.

MATERIAL AND METHODS

This descriptive cross-sectional study conducted in two phases. In the first phase, 50 paper-based medical records of patients with cardiovascular disease from Hazrat Rasoul hospital were randomly selected based on the ICD-10 blocks of cardiovascular diseases (five records from each block). The content

of medical records was reviewed and the data items had been documented in each record were extracted using a data extraction form. In addition, all standardized clinical and administrative forms in this hospital were reviewed. We classified the identified data elements in several categories. Furthermore, the related literature was reviewed to identify related data elements [13-16, 19].

In the second phase, a questionnaire contained different cardiovascular data elements identified from previous phase was developed. The questionnaire included a list of data elements in 29 classes (admission, death, patients' main complaints, clinical signs, observations, medicine, cardiac surgery, risk factors, laboratory and pathology, consultation, resuscitation, anesthetic, electrocardiography, blood transfusion or blood products, rehabilitation measures, angiography/venography, exercise testing, endoscopy/colonoscopy, medical imaging, echocardiography, nursing interventions, allergies and side effects, implantable remedies, cardiac examinations, physical examinations, angina, referrals, social backgrounds and history). The answer of each question had two options: necessary or not necessary. Content of the questionnaire was validated by three cardiovascular specialists, health information management and medical informatics experts. To evaluate the reliability of questionnaire, Richardson's coefficient method was used (0.975) which indicates a very high reliability of the instrument.

The sample consisted of all 87 cardiovascular specialists and residents and 50 nurses of cardiovascular wards of all hospitals affiliated with Iran University of Medical Sciences. The questionnaire was distributed to the physicians and nurses and they were asked to identify the necessity of each data elements. From 137 distributed questionnaires, 99 questionnaires were completed and collected (Response rate was 72.2%).

Data were analyzed using descriptive statistics in SPSS software (version 22) and frequency and percentage were calculated for each data element. Data elements with a high agreement (at least 75% of participants considered it as necessary) were selected as the main data elements for cardiovascular EMRs.

RESULTS

According to Table 1, the total number of participants was 99, 56.5% of whom were female. The highest age group was 30-40 years old (60.6%). Most of the participants had 5-10 years of experiences. Among them, 52.5% were physicians.

Table 2 shows the frequency of data elements for cardiovascular electronics medical records. Most of

the data elements were related to the history class (18%), risk factors (11%) and clinical symptoms (10%). Table 3 also presents the approved data elements as well as the deleted data elements for each class.

Table 1: Characteristics of the participants

Demographic characteristics		Frequency	Percentage
Gender	Male	43	43.4
	Female	56	56.6

Age	<30	15	15.1
	30-40	60	60.6
	>40	24	24.3
Years of experience	<5	35	35.3
	5-10	38	38.3
	>10	27	27.4
Field of study	Medical	52	52.5
	Nursing	47	47.5
Education level	Bachelor	40	40.4
	Master	7	7.07
	Resident	33	33.3
	Specialist	9	9.09
	Fellowship	10	10.14

Table 2: Frequency of identified data elements

Class	Total number of data elements	Number of data elements removed	Number of data elements remained
Admission	11	2	9
Death	6	0	6
Patients' main complaints	7	1	6
Clinical signs	25	2	23
Observations	6	0	6
Medicine	10	2	8
Cardiac surgery	10	2	8
Risk factors	26	3	23
Laboratory and pathology	7	2	5
Resuscitation	3	0	3
Electrocardiography	5	0	5
Anesthetic	10	1	9
Blood transfusion or blood Products	7	0	7
Rehabilitation measures	8	2	6
Angiography / venography	4	0	4
Exercise testing	7	0	7
Endoscopy / colonoscopy	2	0	2
Medical imaging	7	1	6
Echocardiography	3	0	3
Nursing interventions	4	0	4
Allergies and side effects	4	0	4
Therapeutic implants	7	5	2
Cardiac examinations	13	0	13
Physical examinations	11	2	9
Angina	2	0	2
Referrals	10	5	5
Social backgrounds	13	0	13
History (Disease history, Surgical history, Family history)	43	0	43

Table 3: Data elements for electronic cardiovascular medical record systems

Main data classes	Approved data elements	Deleted data elements
Admission	Kind of admission (including outpatient, inpatient, emergency), Admission date and time, Referral from (center name), physician full name, Encounter date, Encounter priority, Reason of admission, Hospitalization place, Diagnosis code	Referral physician name, Referral physician specialty
Death	Main cause of death, Underlying cause of death, External cause of death, Date of death, Patient age at death, Place of death	-
Patients' main	Chief complaint, Onset of chief complaint, Chief complaint period,	Severity of the

Main data classes	Approved data elements	Deleted data elements
complaint	Frequency of chief complaint, Duration of chief complaint, Disease name, Body temperature, Heart rate, Breathing rate, Oxygen saturation, Chest pain, Location of chest pain, Chest pain quality, Quality of heart palpitations, Tachycardia, Systolic and diastolic blood pressure, Cyanosis, Heart beat	main complaint
Clinical signs	Orthopnea, Dyspnea, Deep Vein Thrombosis, Hematoma, Sinus heart rhythm, AF heart rhythm, Ischemic cardiomyopathy, Asystole rhythm, Murmur, Confusion	Height, Stenosis of mitral valve
Observations	Weight, Body mass index (BMI), Activity related data (patient activity type), Diet data (type of diet), Pregnancy status (Pregnancy status, Gestational age)	-
Medicine	Medication name (Aspirin, Cyclooxygenase Inhibitor, Beta Blocker, Calcium Channel Blocker), Medication dosage, Time to start taking medication, Date of prescription, Start date of medication, Route of administration, Time to stop medication, Side effects	Drug form (solid-liquid), Frequency of drug use
Cardiac surgery	Type of operation (valve replacement, pacemaker, etc), Method of operation, Descriptions of actions and findings, Post-Operative diagnosis, Intraoperative complications, Postoperative complications, Operation date	Surgery code, Surgery time
Risk factors	History of coronary heart disease (CHD), Age at diagnosis for CHD, Symptoms of CHD, Myopathy, Other muscular dystrophies that cause myopathy, Kawasaki disease, Onset time of Kawasaki disease, Patient age at onset of first Kawasaki symptoms, Kawasaki symptoms, interventions for Kawasaki disease, Medications for Kawasaki disease, Patients' reactions to interventions conducted for Kawasaki disease, Complications of Kawasaki interventions, Rheumatic fever, Onset time of rheumatic fever, Patient's age at the onset of the first symptoms of rheumatic fever, Symptoms of rheumatic fever, Surgery conducted for rheumatic fever, Other risk factors, Family history of heart disease	Kawasaki classification by Aneurysm, Laboratory findings of Kawasaki, Time of interventions
Laboratory and pathology	Test name (Creatinine, Total blood cholesterol, Low density lipoprotein, High density lipoprotein, IAN C-Hemoglobin, Sodium, Hematocrit, Nitrogen Urea, etc.), Test results, Patient status, Pathology date, Pathology report	Test result date, Test date
Consultation	Type of consultation, Diagnosis, Consultant physician's advice	Consultation date, Consultation time
Resuscitation	Resuscitation date, Resuscitation time, Resuscitation result	-
Electrocardiography	ECG date, ECG interpretation, Diagnosis, Location of the ECG change, Type of ECG changes	-
Anesthesia	Anesthesia date, Anesthesia type, Anesthesia time, Anesthesia-related care, Patient status at onset of anesthesia, Vital signs during anesthesia, Vital signs at the end of anesthesia, Drugs, Complications	Anesthesia technique
Blood transfusion or blood products	Blood type, Required blood unit, Number of blood products requested, Reason for requesting blood, Taking medications at the time of blood transfusion, Blood transfusion intervals, Blood filter status	-
Rehabilitation measures	Rehabilitation service name, Reactions to treatment, Expected outcome of treatment, Rehabilitation date, Daily evaluation, Methods of rehabilitation	Start time End time
Angiography / venography	Angiography/Venography date, Angiography/Venography result, Targeted vessel, Stenosis severity pre/post procedure	-
Exercise test	Exercise test date, Exercise test time, Exercise stress test interpretation, Diagnosis, Phase, Grade, Speed	-
Endoscopic / colonoscopy	Endoscopy / colonoscopy date, Endoscopy / colonoscopy results	-
Medical imaging	Imaging service name, Organ name, Laterality, Report and interpretation of radiologists, Radiologist diagnosis, Imaging date and time	Technique used
Echocardiography	Echocardiography date, Findings and results	-
Nursing interventions	Nurse observations, Type of actions, Date and time of actions, Nurse reports	-
Allergies and side effects	Allergy, Allergen name, Specific food habit, Description of food habit	-
Implantable remedies	Device name, Number	Manufacturer, Model, Size, Serial Number, Other features
Cardiac examination	Chest tightening, Pericardial touch, PMI type, Heart sounds, S1 heart sound,	-

Main data classes	Approved data elements	Deleted data elements
	S2 heart sound, Location of heart sounds, Heart sounds (murmur phase), Heart sounds (heart murmurs), Heart sounds(time), Heart sounds (heart murmurs), Heart murmurs (features)	
Physical examination	General appearance, Skin examinations, Abdominal examinations, Hearing aids, Abdominal examinations (touch), Abdominal inspection, Examinations of organs, Examination of organs when capillaries are filled, Examinations of organs (pulse amplitude), Examination of the organs (location of the pulse), Examination of organs (delay of radial and femoral artery)	Genital examinations, External genitalia
Angina	Date and time of the first angina, Date and time of the last angina	-
Referrals	Cause of referrals, Date of referrals, Hospital of origin, Destination hospital, Patient triage level	Transmission time, Origin ward, Destination ward, Referral mode, Referral level
Social context	Alcohol/ Drug/ Cigarette/ Hookah consumption, Type of drug, Name of drug used, Dosage of drugs, Caffeine intake, Calorie intake, Liquid consumption, Salt consumption, Experience with chemicals, History of tobacco use, Experience of working in mines, Having pets	Need to a translator
History (surgery history)	Surgery name (coronary artery bypass, angioplasty, Non-cardiac surgery, dialysis), Date of surgery	-
History (family history)	Coronary artery disease, Sudden cardiac death, Myocardial infarction, Stroke, Arrhythmia, Syncope, Hypertension, Increased blood lipids, Cardiovascular disease and cardiovascular risk factors	
Main data classes	Approved data elements	Deleted data elements
History (history of disease)	Renal artery disease, Chest pain or angina, Heart failure, Syncope, Hypertension, Dyslipidemia, Diabetes, Aneurysm, Transient ischemia attack, Chronic pulmonary disease, Chronic kidney disease, History of use of unauthorized drugs and narcotic, AIDS, Atrial rhythm disorder, Supraventricular tachycardia, Irregularity in ventricular heart rate, Venous blood clot, Depression, Coronary artery disease Cerebral artery disease, Peripheral artery disease, Aortic disease, Myocardial infarction, Sudden cardiac arrest, Heart failure, Abnormal heart examinations, Pulmonary hypertension, Lack of weight gain, Pregnancy, Types of syndromes, History of drug use, Allergic reactions	-

DISCUSSION

Information management is one of the most important issues in the diagnosis and treatment of cardiovascular diseases. Developing data elements for cardiovascular diseases facilitate the continuous, accurate and complete documentation of patients' information using standardized terms used to describe cardiovascular diseases and interventions [15]. However no research has been conducted to determine the data elements for Iranian EMRs for cardiovascular diseases. In the first step, it is founded that cardiovascular diseases were not documented very well paper- based medical records. According to our results, among 276 suggested data elements for cardiovascular EMRs, 244 data elements were approved and classified into 29 different classes including admission, death, main complaints, clinical signs, observations, medications, cardiac surgery, risk factors, laboratory and pathology, consultation, resuscitation, anesthesia, electrocardiography, blood

transfusion or blood products, rehabilitation measures, angiography/venography, exercise test, endoscopy/colonoscopy, medical imaging, echocardiography, nursing interventions, allergies and side effects, implants, cardiac examinations, physical examination, angina, transmissions, social backgrounds, and history.

Jeffrey et al. [13] considered an outpatient EMR for congenital and pediatric cardiovascular diseases and suggested different data elements including physical examinations, clinical signs, and cardiac examinations as key data elements. These findings are consistent with our results regarding the required data elements for an EMR for patients with cardiovascular diseases. Additionally, Asselbergs et al. [16] conducted a study to identify standardized clinical data elements in cardiovascular patients for optimal care, quality control, and research. In this study, demographic data elements (date of birth, age, gender, membership date), general aspects (physicians' treatment for referrals), medical history

(acute myocardial infarction, myocardial infarction, aneurysm, coronary artery bypass surgery, ischemia attack), chronic kidney disease, hypertension, high blood lipids, history of delivery, family history of cardiovascular disease, lifestyle (physical activity, alcohol consumption, smoking), physiological measurements (height, weight, blood pressure, heart rate), laboratory measurements (blood lipids, triglycerides, creatine, hemoglobin), heart failure, cerebral ischemia, arterial aneurysm, diabetes and hypertension are considered essential. These data elements are also considered necessary in our study and were included in the medical history data elements, social context, clinical symptoms, and laboratory data classes. Weintraub et al. [14] also introduced a list of data elements including history and physical examinations, family history, patient evaluation data, laboratory data, cardiac therapies, cardiac implants, and medicines which are consistent with our study.

Some limitations of this study should be considered. Reviewing the medical records in the first step was done only at the Hazrat Rasoul Hospital. Additionally the participants were also from hospitals affiliated with Iran University of Medical Sciences. Therefore, the results may not be generalizable to the whole country.

In this study, we considered the data elements for general EMR for cardiovascular diseases and we did not focus on a specific type of disease. CVDs includes a variety of diseases such as coronary heart disease, congenital heart diseases, etc. which may require more specialized data elements. Therefore, more studies in this regard are highly recommended.

CONCLUSION

There is no standard in Iran for necessary data elements for EMRs for cardiovascular diseases. Therefore, introduction and standardization of data elements required for EMRs for patients with cardiovascular diseases are necessary. This study introduced 244 data elements in 29 different classes for electronic cardiovascular medical records.

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AUTHOR'S CONTRIBUTION

The authors agree on this final form of the manuscript, and attested that all authors contributed in the final draft of the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this study.

FINANCIAL DISCLOSURE

No financial interests related to the material of this manuscript have been declared.

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