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Application of Standard Terminologies for the Development of a Customized Healthcare Service based on a PHR Platform

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Abstract

The personal health record platform can store and manage medical records, health-monitoring data such as blood pressure and blood sugar, and life logs generated from various wearable devices. It provides services such as international standard-based medical document management, data pattern analysis and an intelligent inference engine, and disease prediction and domain contents. This study aims to construct a foundation for the transmission of international standard-based medical documents by mapping the diagnosis items of a general health examination, special health examination, life logs, health data, and life habits with the international standard terminology systems. The results of mapping with international standard terminology systems show a high mapping rate of 95.6%, with 78.8% for LOINC, 10.3% for SNOMED, and 6.5% when mapped with both LOINC and SNOMED

Key Words: LOINC, Personal Health Record, SNOMED.

I. INTRODUCTION

According to the analysis of industrial accident situation in 2017 [1] by the Ministry of Employment and Labor (MOEL), of the 993 deaths from occupational diseases, 354 died from cardiovascular diseases, of which 215 occurred at workplaces with less than 50 workers. Continuous health management and post-management can improve the cardiovascular health of the workers according to the data from medical check-ups. However, workers in vulnerable classes often cannot benefit from systematic industrial health services because workplaces with less than 50 workers are almost small [2, 3].

Heart, cerebrovascular, and hypertensive diseases are the second, third, and ninth most deadly diseases in the Republic of Korea [4]. The medical expenses for cardiovascular diseases are $ 6.9 billion [5], this is higher than $ 4.7 billion for cancer that is the first cause of death, and the burden of diseases in Korea is large. Mortality from cardiovascular disease has been rising continuously for the last 10 years [6] and this requires effective management. In particular, workers are being drawn to more risk due to stress caused by heavy work and incorrect lifestyles such as lack of exercise and frequent drinking compared to the general public [7]. Efficient prevention and management are essential because cardiovascular disease not only harms the worker's health but also increased medical expenses [8] and adds to the social burden caused by decreased corporate productivity [9].

Interest in personal health management is increasing as aging, and chronic diseases are growing [10]. Recently, active services focused on prevention and health promotion are needed [11] to record life logs such as exercise, food and sleep through various wearable devices [12-14] and measure blood pressure, blood sugar, and weight through personal health devices [15]. Personal Health Record (PHR) means an electronic tool that can securely access, manage and share one's health information [16], which is generally managed by the patient [17]. Patients can easily check the medical records provided at the hospital, information on prescribed medicines and test results, etc. through PHR, and manage exercise and diet information related to health

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promotion together [18]. In particular, patients can use PHR to reduce additional medical expenses and disease management, treatment and prevention activities can be further strengthened as cooperation is improved through communication between medical personnel [19, 20].

However, despite the high interest and expected effect on PHR, it is very difficult to provide services successfully [21]. Typically, Google Health, released in 2008, suspended the service in 2011 because it did not trigger user participation [22], Microsoft also announced that HealthVault will end its service in November 2019. Meanwhile, Apple's HealthRecord offers large-scale services that can be linked with more than 200 medical institutions as of February 2019. These services are offered free of charge, but the technology acceptance of user about PHR is low, which is an issue to be dealt with first [23].

The PHR platform can store and manage medical records and must address the challenge of using international standard terminology systems to provide an international standard-based medical document management service. Research on the use of identical codes between medical institutions is important to accurately interpret personal health records.

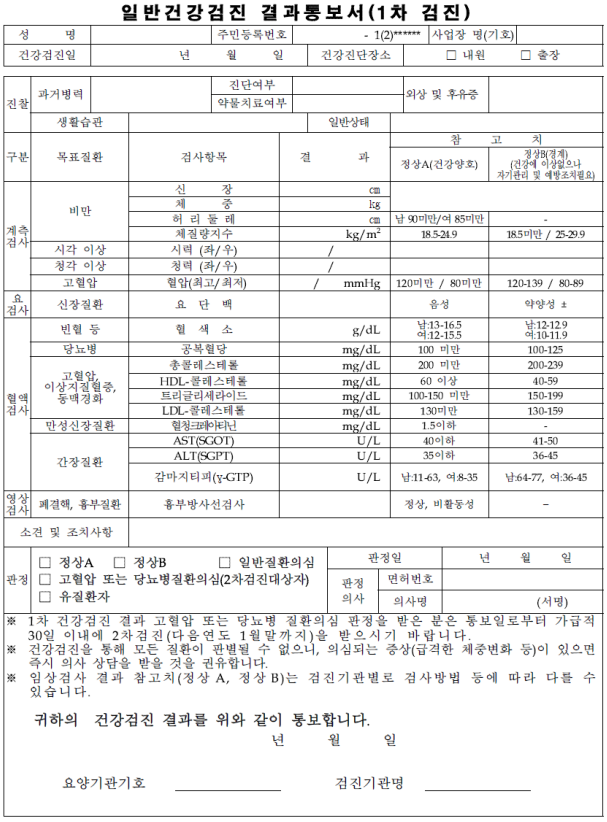
This study aims to develop a foundation for the management of international standard-based medical documents by mapping the diagnosis items of a general health examination, special health examination, life logs, health data, and life habits with the international standard terminology systems for worker-tailored healthcare service.

II. SELECTION OF THE APPROPRIATE STANDARD TERMINOLOGY FOR TARGET TERMINOLOGY

The PHR service for workers has a total of 184 target terms, including 41 for the general health examination, 124 for the special health examination, and 19 for life logs, health data, and life habits.

The 184 target terms include diagnosis items and results. A Laboratory Medicine specialist and Medical Information Ph.D. holder, who had studied and mapped the standard terminology for over 10 years, participated in the mapping of target terminology to standard terminologies. They selected LOINC and SNOMED CT as standard terminologies. Cross-validation was performed twice until the final mapping results were derived.

The current status of international standards for health records consists of four categories in total, which are being actively studied (Table 1). We are working on the Group 1 category of the most fundamental structure. The results of Group 1 are included as part of the coding system within Group 3's data structure.



일반건강검진 결과통보서(1차 검진)

성 명		주민등록번호	- 1(2)******	사업장 명(기호)	
건강검진일	년 월 일	건강진단장소	☐ 내원 ☐ 출장		

진찰	과거병력		진단여부		외상 및 후유증	
			약물치료여부			
	생활습관		일반상태			
구분	목표질환	검사항목	결 과		참 고 치	
					정상A(건강양호)	정상B(경계) (건강에 이상없으나 자기관리 및 예방조치필요)
계측검사	비만	신 장	㎝			
		체 중	kg			
		허 리 둘 레	㎝		남 90미만/여 85미만	-
		체질량지수	kg/m²		18.5-24.9	18.5미만 / 25-29.9
	시각 이상	시력 (좌/우)	/			
	청각 이상	청력 (좌/우)	/			
	고혈압	혈압(최고/최저)	/ mmHg		120미만 / 80미만	120-139 / 80-89
요검사	신장질환	요 단 백			음성	약양성 ±
혈액검사	빈혈 등	혈 색 소	g/dL		남:13-16.5 여:12-15.5	남:12-12.9 여:10-11.9
	당뇨병	공복혈당	mg/dL		100 미만	100-125
	고혈압, 이상지질혈증, 동맥경화	총콜레스테롤	mg/dL		200 미만	200-239
		HDL-콜레스테롤	mg/dL		60 이상	40-59
		트리글리세라이드	mg/dL		100-150 미만	150-199
		LDL-콜레스테롤	mg/dL		130미만	130-159
	만성신장질환	혈청크레아티닌	mg/dL		1.5이하	-
	간장질환	AST(SGOT)	U/L		40이하	41-50
		ALT(SGPT)	U/L		35이하	36-45
		감마지티피(γ-GTP)	U/L		남:11-63, 여:8-35	남:64-77, 여:36-45
영상검사	폐결핵, 흉부질환	흉부방사선검사			정상, 비활동성	-
소견 및 조치사항						

판정	☐ 정상A ☐ 정상B ☐ 일반질환의심 ☐ 고혈압 또는 당뇨병질환의심(2차검진대상자) ☐ 유질환자	판정일	년 월 일	
		판정의사	면허번호	
			의사명	(서명)

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※ 건강검진을 통해 모든 질환이 판별될 수 없으니, 의심되는 증상(급격한 체중변화 등)이 있으면 즉시 의사 상담을 받을 것을 권유합니다.
※ 임상검사 결과 참고치(정상 A, 정상 B)는 검진기관별로 검사방법 등에 따라 다를 수 있습니다.

귀하의 건강검진 결과를 위와 같이 통보합니다.

년 월 일

요양기관기호 _____ 검진기관명 _____

Fig. 1. Clinical documents for the general health examination.

Table 1. Four Groups of international standards for health records [24].

Group 1 : Nomenclature and terminology	
LOINC	Code names for identifying medical observations
SNOMED CT	Terminology collection of medical terms
Group 2 : Privacy	
HIPAA	USA legislation for medical information
GDPR	Regulation in European Union (EU) law on data protection and privacy for individuals within the EU and European Economic Area (EEA)
Group 3 : Structural and semantic	
AS X12N	Accredited standards committee X12-INS
CCD	Specification for exchange clinical documents
CCR	Specification for sharing continuity of care content
CDA	Specification for clinical notes
DICOM	Standard for medical digital imaging
Group 4 : Templates and technology platform	
OpenMRS	Platform and reference application named Open Medical Record System
OSCAR	EHR system named Open Source Clinical Application and Resource

III. LOINC AND SNOMED

In July 2013, Regenstrief LOINC and SNOMED International (then known as The International Health Terminology Standards Development Organisation, IHTSDO) signed an agreement to begin the cooperative work.

LOINC and SNOMED International have formed a long-term collaborative relationship with the objective of developing coded content to support order entry and result reporting. The two organizations are building closer links between the SNOMED CT and LOINC terminologies, reducing duplication of effort, and making electronic health records more effective at improving health care. By aligning how the two terminologies represent the attributes of laboratory tests and some types of clinical measurements, this collaboration will provide users a common framework within which to use LOINC and SNOMED CT [25].

The LOINC version 2.65 was used, which had a total of 89,271 terms and was revised on December 14, 2018.

A Web browser was used to obtain the data files from https://loinc.org/ and https://search.loinc.org/searchLOINC/search.zul. For the SNOMED, data of the January 31, 2019 revision were used, and the mapping was performed using an international browser.

IV. RESULTS

It is practical to map diagnosis items with the LOINC terminology because LOINC is a standard terminology system established to describe diagnosis items. SNOMED is suitable to describe the content of corresponding diagnosis items. For example, SNOMED is useful when there are text descriptions of medical opinion and disease history.

Fig. 2 shows a process of mapping using SNOMED for a hepatitis B diagnosis result, where it must be ascertained whether the hierarchy of parents and children is accurate. The hepatitis B diagnosis item shows the immune status, and the standard code is “365863005” as an item having three diagnosis result items.

As shown in Fig. 2, a target term may match with one term of SNOMED or LOINC, but in some cases, they may need to be expressed together (the two terminologies are used). For example, the item for job history can be mapped since it matched with the 11340-7 of LOINC and 394704008 of SNOMED, but when detailed information for the job history needs to be mapped for a computer engineer, as an example, mapping with the LOINC is impossible; therefore, the SNOMED must be used. Figure 2 shows an example of LOINC mapping for the visual anomalies in general health examination, figure 3 shows a LOINC mapping example of LOINC mapping for the white blood cell differential count of hematopoietic type in special health examination.

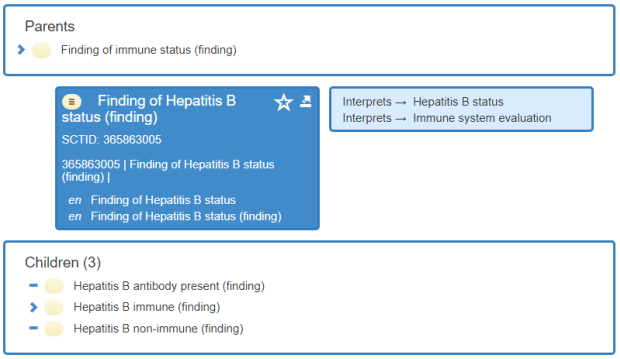

Fig 2. Mapping with SNOMED for a hepatitis B diagnosis result (use of international browser).

Table 2. Examples of LOINC mapping for the visual abnormality in general health examination.

LOINC	LOINC_Component
55987-2	Visual acuity N:LenRto:Pt:Eye.left:Qn:Phoropter
28710-2	Visual acuity distance:Len:Pt:Eye.left:Qn:Phoropter
28719-3	Visual acuity N:LenRto:Pt:Eye.right:Qn:Phoropter
28667-4	Visual acuity distance:Len:Pt:Eye.right:Qn:Phoropter

Table 3. Examples of LOINC mapping for the white blood cell differential count of hematopoietic type in special health examination.

LOINC	LOINC_Component
770-8	Neutrophils/100 leukocytes in Blood by Automated count
35332-6	Band form neutrophils/100 leukocytes in Blood by Automated count
19023-1	Granulocytes/100 leukocytes in Blood by Automated count
736-9	Lymphocytes/100 leukocytes in Blood by Automated count
42250-1	Variant lymphocytes/100 leukocytes in Blood by Automated count
5905-5	Monocytes/100 leukocytes in Blood by Automated count
713-8	Eosinophils/100 leukocytes in Blood by Automated count
706-2	Basophils/100 leukocytes in Blood by Automated count

Table 4 shows the mapping results for the target terminology. The diagnosis items of a general health examination, special examination, life logs, health data, and life habits were mapped with the international standard terminology systems for the worker-tailored healthcare

service, and the results showed that a total of 95.6% items were mapped with the standard terminologies: 78.8% with LOINC, 10.3% with SNOMED, and 6.5% using both.

Table 4. Mapping rate between the target terminology and standard terminologies.

	General Health Examination Items	Special Health Examination Items	Life log, Health Data, Life Habits	Total (%)
LOINC	25	110	10	145 (78.8)
SNOMED	4	6	9	19 (10.3)
LOINC + SNOMED	8	4	0	12 (6.5)
Non Mapping	4	4	0	8 (4.4)
Total	41	124	19	184 (100)

V. CONCLUSION

For the development of a PHR platform-based worker-tailored healthcare service, a total of 184 terms of PHR were mapped with the terminologies of LOINC and SNOMED, and the results showed a high mapping rate of 95.6%. Ten terms were not mapped, which were cases that required specificity because the terms were ambiguous. Nevertheless, it will be possible to map them if the actual cases of workers are investigated.

Based on the mapping results, if data are transmitted using protocols such as HL7 FHIR, CDA, and CCD for medical document exchange in the future, they will be encoded as values of the medical document for transmission. Hence, they will be actively used by different medical institutions for medical treatment of workers without any error.

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