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Clinical Knowledge Platform (CKP): A Collaborative Ecosystem to Share Interoperable Clinical Forms, Viewers, and Order Sets with Various EMRs

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Abstract. A large number of Electronic Medical Records (EMR) are currently available with a variety of features and architectures. Existing studies and frameworks presented some solutions to overcome the problem of specification and application of clinical guidelines toward the automation of their use at the point of care. However, they could not yet support thoroughly the dynamic use of medical knowledge in EMRs according to the clinical contexts and provide local application of international recommendations. This study presents the development of the Clinical Knowledge Platform (CKP): a collaborative interoperable environment to create, use, and share sets of information elements that we entitled Clinical Use Contexts (CUCs). A CUC could include medical forms, patient dashboards, and order sets that are usable in various EMRs. For this purpose, we have identified and developed three basic requirements: an interoperable, inter-mapped dictionary of concepts leaning on standard terminologies, the possibility to define relevant clinical contexts, and an interface for collaborative content production via communities of professionals. Community members work together to create and/or modify, CUCs based on different clinical contexts. These CUCs will then be uploaded to be used in clinical applications in various EMRs. With this method, each CUC is, on the one hand, specific to a clinical context and on the other hand, could be adapted to the local practice conditions and constraints. Once a CUC has been developed, it could be shared with other potential users that can consume it directly or modify it according to their needs.

Keywords. Health Information Interoperability, Practice Guideline, Electronic Medical Records, Terminology

1. Introduction

The use of Electronic Medical Records (EMRs) has not only made patients' medical information easier to read and available from almost any location in the world, but also

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changed the format of health records, and thus changed health care [1]. However, clinical cooperation is essential for facing the complex challenges of today's health care. Achieving clinical cooperation among actors could be facilitated but at the same time also constrained by EMRs [2] and it is almost impossible while using different EMRs. Sharing clinical information to align on shared decision making is dependent on adequate EMR derived documentation [3]. If those data originate from various sources, the clinical risk increases, and economic resources get wasted.

Hence, EMR interoperability is a centerpiece for digital medicine. Next to flaws in existing EMRs, processing data stemming from various sources, variances in user interfaces, different data formats, vocabularies, and structures are major shortcomings particularly attributable to multi-EMR environments [4]. During the past years, various studies and scientific initiatives have been carried out to adopt standard models, and harmonize exchanges to ensure interoperability [5,6]. Examples include the possibility of conducting observational studies on a global scale [7] or having interoperable patient records [8], to name a few. Additionally, initiatives to create adherent inter-mapped terminologies, used for different purposes in healthcare, also show promising results [9–11]. However, to date, a digital interoperable environment, providing a "repository" for medical content used in EMRs does not exist.

This paper discusses the concept of a Clinical Knowledge Platform (CKP) with the ambition to provide an environment to configure and use medical content, i.e., clinical forms (questionnaires), order sets, and patient viewers (dashboards) adapted to specific clinical contexts. Additionally, it allows to re-compose existing clinical knowledge to make it executable in various EMRs and improve collaboration among clinicians.

2. Methods

We have introduced the notion of Clinical Use Contexts (CUCs) to configure and use typical types of medical content present in the EMRs. Currently, a CUC could be medical forms (questionnaires: list of data elements to be collected), viewers (dashboards: list of data elements to be displayed to the user), or order sets (list of orderable items to be prescribed or list of actions to be done). Each CUC should be applied in a specific clinical context. Once a CUC is created, it should be usable in any EMR. Therefore, standard FHIR resources [5,6] are used to assure interoperable communication between EMRs and CKP. In order to create interoperable CUCs, we identified three basic requirements:

2.1. A concept dictionary

First, we need to structure and standardize clinical concepts that will be used as building blocks to create CUCs in the CKP. Heterogeneity and non-structured clinical concepts make centralization and interoperability difficult to achieve. Overcoming this barrier needs the integration of multi-terminology servers that provide mappings among the same concepts in various terminologies. We are integrating a custom implementation of the Health Terminology/Ontology Portal (HeTOP; URL: www.hetop.eu), which currently includes more than 100 terminologies and ontologies in 50 languages. We are also integrating the Observational Health Data Sciences and Informatics (OHDSI; URL: https://www.ohdsi.org) interrelated vocabularies provided by the international OHDSI network [7]. Next to exerting close governance on concept creation, technical necessary developments are carried out to avoid the creation of redundant concepts.

2.2. Clinical context definition

A clinical context is a combination of various conditions including disease, symptoms, comorbidities, stage of the problem, period, demographic patient data, etc. that define the applicability of CUCs. These conditions are defined by combining relevant clinical concepts (coming from the dictionary of concepts) with logical operators to form a rule. Such a rule can then be used by consuming systems to identify eligible CUCs for a certain context. For example, if an order set is being created to apply for type 2 diabetic patients, the clinical context definition would mandate that a diagnostic concept of "Diabetes Type 2" is known for this patient.

2.3. Communities for content providers

It is impossible for one person, one hospital, or one organization to create all the CUCs in various medical fields with various clinical contexts. That is why the third pillar of the CKP ecosystem is the inclusion and management of content authoring communities of professionals. The applicative and functional purpose of the CKP is a digital environment in which communities of professionals and medical content providers can register and join the relevant communities according to their specialty and their focus of interest. This community management aspect of the CKP also provides the possibility of personalizing the CKP environment according to the community needs by localizing the application of CUCs within the community of practice. Various rights and roles are defined to manage who can create or use the content at which scale.

3. Results

The creation of the concept dictionary in the CKP is an iterative and incremental task. Thanks to terminology integrations, while creating a concept, the mappings are provided. These mappings include terminology codes, synonyms, acronyms, and definitions in five languages (for the moment). An example of concept mapping for blood pressure is illustrated in figure 1 with four terminologies.

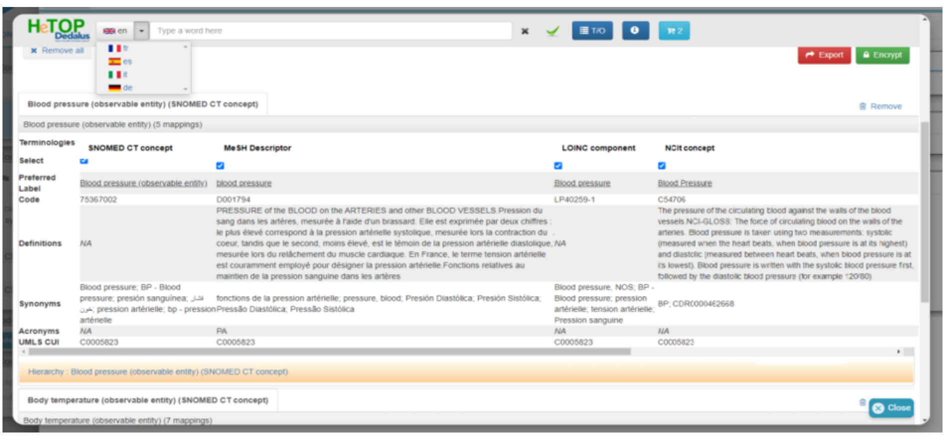

Figure 1. The blood pressure concept is mapped to SNOMED CT, MeSH, LOINC, and NCIt codes, labels, definitions, synonyms, and acronyms

Once a concept is created and added to the concept dictionary of the CKP, it can be used to create CUCs. Therefore, no matter what the target consumer EMR of the CUC internally uses as terminology codes and no matter in which language they talk, the concept could be recognized by the system.

The clinical concepts could also be used as conditions that define the application of a CUC. Figure 2 shows an example of conditions that may be used for the execution of an order set.

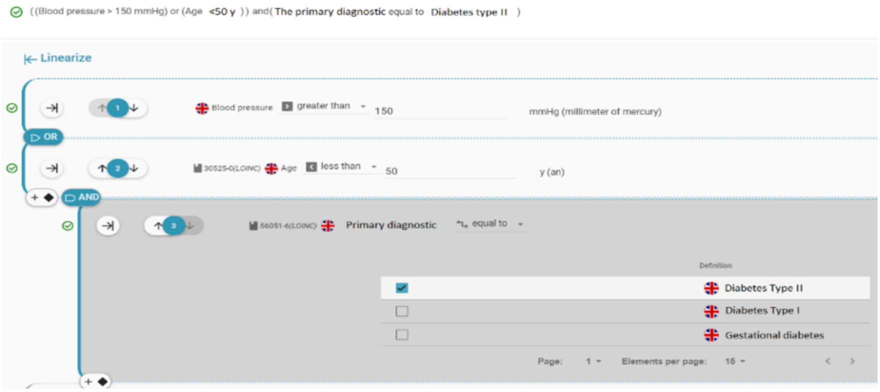

Figure 2. Defining the conditions for an order set addressed to patients with diabetes type 2 who are younger than 50 years old or have systolic blood pressure greater than 150 mmHg

Members of communities of practice work together to create content (CUCs). The content provided by a community could be open (every user can access the content) or close (only community members can access the content). The content could also be set as compensated access, i.e., the users should have a license or subscription to access the content. Communities could belong to nonprofit or public organizations as well as health providers and commercial corporates.

All the CUCs created in the CKP define the list and structure of concepts that should be used in the relevant clinical context in the EMRs. CKP does not provide or include the patient data. The patient data is stored and used in the EMRs.

4. Discussion & Conclusion

In this paper, we have proposed the CKP as a central component of semantic interoperability in healthcare that enables the sharing of medical knowledge used in the EMRs via CUCs and contributes to its dissemination in clinical applications. We have defined a concept dictionary and conditions related to the clinical context that should be provided to the community of health professionals to create various CUCs in various medical fields. A web-based tool including various Application Programming Interfaces (API) is designed to provide easier communication between EMRs and CKP.

Members of a community work together to create/modify CUCs based on different clinical contexts. These CUCs will then be uploaded and used in clinical applications in the EMR. As an example, the emergency department of a hospital in Paris creates a form (information to be collected) for patients arriving with a head injury. The community decides to make this content public and usable by other communities. After the validation, the form is therefore available and usable for download in another hospital in Marseille. In addition, the content in the CKP could be multilingual so the above-mentioned form could also be downloaded in a German version in the University Hospital of Frankfurt, as well as in an Italian version in a clinic situated in Milan. Each community would also be able to locally map or adapt the CUCs according to their own local capacities and requirements (e.g., if a stipulated diagnostic gold standard is not available locally). This allows the local application of international recommendations to happen. CUCs could be used for diagnostic/therapeutic purposes as well as for conducting research studies (e.g., data collection forms).

Several existing studies present various types of frameworks to overcome the problem of specification and application of clinical guidelines and the automation of their use at the point of care [12]. However, to our knowledge, a digital environment, providing dynamic medical content in the EMR according to the clinical contexts does not exist. The CKP initiative by Dedalus is therefore a continuation of the work done on interoperability by adding additional layers that are applied in the everyday life of medical practice. The collaborative approach and the notion of clinical context in EMR are two completely innovative stones that CKP aims to add to the edifice of interoperability in healthcare.

With this perspective, CKP has the ambition to support the strategy of evolution and convergence of the various EMRs including the EMRs of the Dedalus group. This is especially exciting since it would also allow to foster collaboration in terms of establishing quality circles and federated benchmarking. The current use of this tool and further research to test the suitability and reliability of this process should show the effectiveness and applicability of the CKP product.

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