Health Digital Twins with Clinical Decision Support

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Abstract. This paper studies the feasibility of incorporating clinical decision support (CDS) into health digital twins (HDTs). A HDT is visualized in a web application, health data are stored in a FHIR-based electronic health record, and an Arden-Syntax-based CDS interpretation and alert service is connected. The prototype focuses on interoperability of these components. The study confirms the feasibility of CDS integration into HDTs and provides insight into possibilities for further expansion.
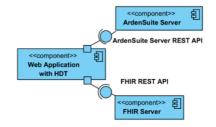
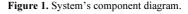**Keywords.** Health digital twin, FHIR, clinical decision support, Arden Syntax

1. Introduction

Health digital twins (HDTs) are virtual representations of patients. Research on how to establish and use them to the benefit of real patients is rapidly gaining traction [1]. Projects to use digital twins in individualized disease management, for instance, for multiple sclerosis [2], are underway. However, a more general approach is lacking. This study explores the general integration of HDTs, selected patient's clinical data, and clinical decision support (CDS).

2. Methods

As HDT, a three-dimensional (3D) avatar constructed from cryosections of the Visible Human Project female [3] was taken. Clinical data were stored in accordance to the Health Level Seven (HL7) standard on Fast Healthcare Interoperability Resources (FHIR) [4]. Two existing CDS systems, both developed by using HL7's knowledge representation and processing

Figure 1. System's component diagram.

language Arden Syntax [5] – namely, Hepaxpert [6] for the automated interpretation of

hepatitis serology test results and cAlerts for worthwhile alerting of specific clinical situations [7] – were adopted to bring CDS into the established HDT.

Technically, the HDT is visualized in an Angular web application (Figure 1) using the Web Graphics Library. Health data are stored in an electronic medical record (EMR) based on the LinuxForHealth FHIR server. The CDS services are implemented using the ArdenSuite CDS platform by Medexter Healthcare.

3. Results

The intended prototype was established and the described components were successfully interconnected. The Visible Human Project HDT shows its anatomical parts separately. It is, for instance, possible to select the liver and transfer this selected information to the FHIR database (containing hepatitis serology laboratory data). These hepatitis specific data are then displayed on the liver rendered by the HDT. Next, if interested in its comprehensive meaning of the laboratory tests, a further click on the liver leads to access Hepaxpert to display the respective interpretive text. In an analogous way, clinical alerts with respect to troponin levels are displayed when selecting the rendered heart. Figure 2 provides an output example.

Figure 2. The VHP-Female (NELLY) V.2.2 model with troponin alert.

4. Discussion and Conclusion

A first step to fuse HDTs, EMRs, and CDS systems was presented. An extension to HDTs from computer tomography or magnetic resonance imaging is planned. Digital twins will help make precision medicine and patient-centered care a reality in everyday life.

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