

Integration of Health Digital Twins With Clinical Decision Support Systems: A Feasibility Study

Moritz Grob
BSc

Medical University of Vienna
Student
Spitalgasse 23
A-1090 Vienna

Medexter Healthcare GmbH
Software Developer
Borschkegasse 7/5
A-1090 Vienna
www.medexter.com

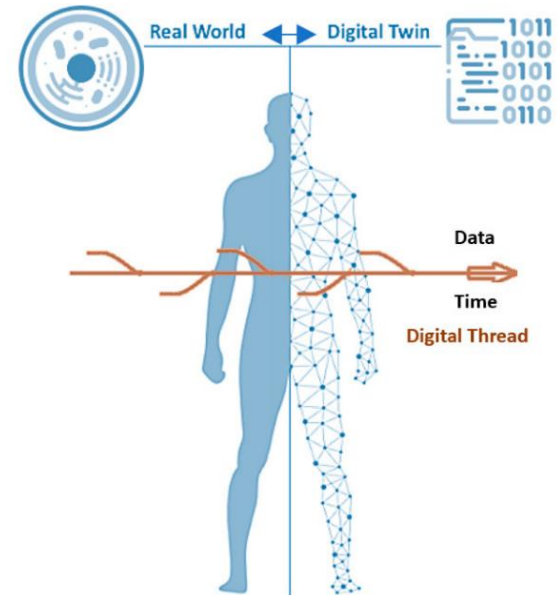
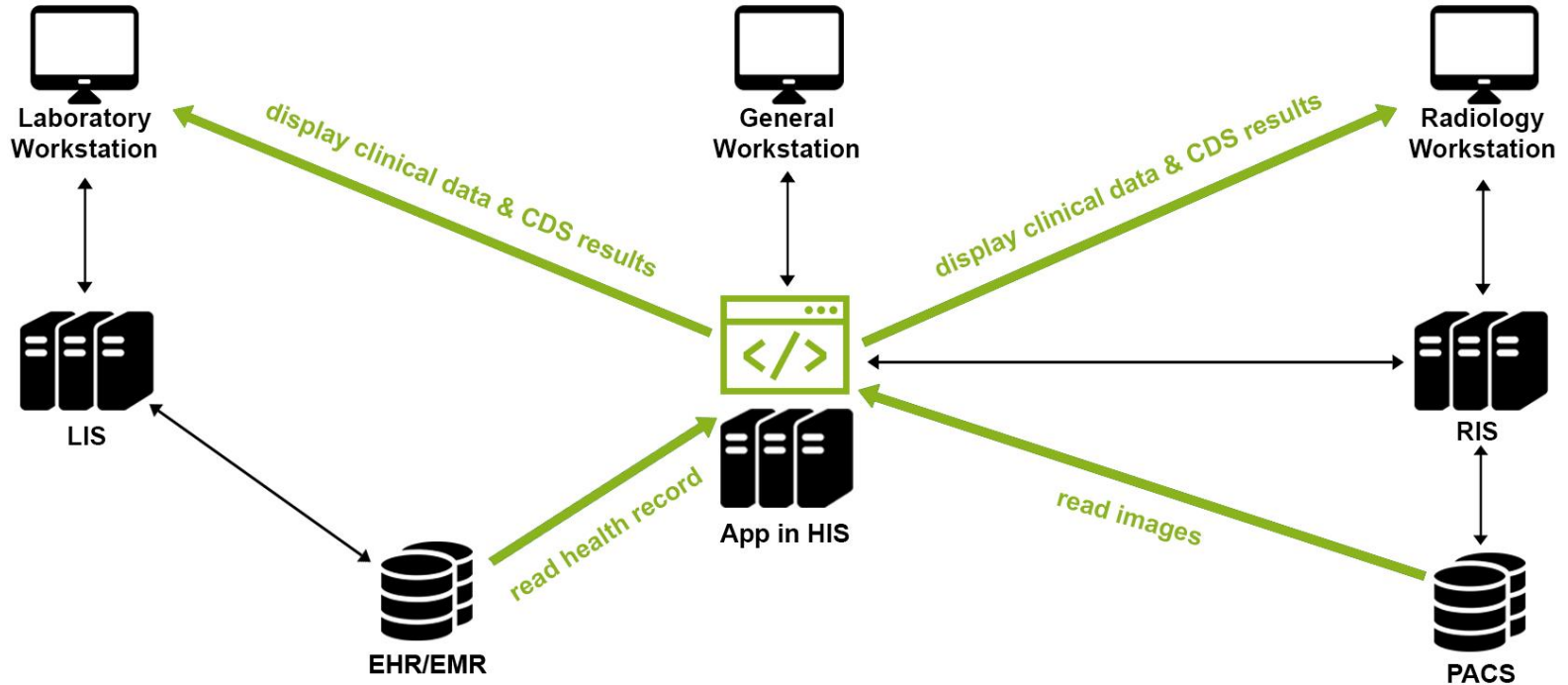
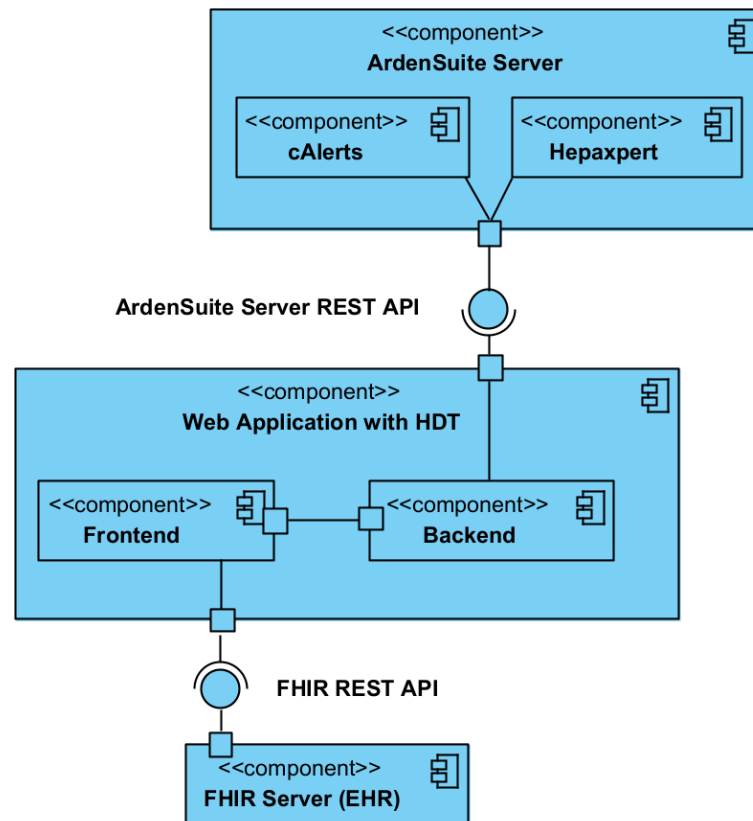


Image source: [1]



Components

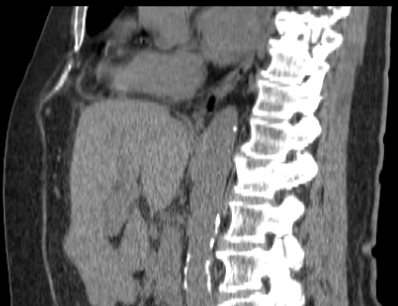
- CDS (Arden Syntax):
 - Hepaxpert – automated hepatitis laboratory result interpretation [2]
 - cAlerts – context-sensitive clinical alerting [3]
- PACS (DICOM): Node.js [4], Open Health Imaging Foundation [5]: Cornerstone3D [6]
- 3D Avatar: Visible Human Project “NELLY” [7], Three.js [8], Angular [9]
- EHR: HAPI FHIR [10]





Select an orientation axis

Sagittal



257 / 512

Laboratory Test Results

Hepatitis A Serology	2023-02-16	
anti-HAV	positive	
IgM anti-HAV	negative	
HAV-RNA	not tested	
Hepatitis B Serology	2023-02-16	
HBsAg	positive	
anti-HBs	positive	
anti-HBc	negative	
IgM anti-HBc	negative	
HBeAg	positive	
anti-HBe	borderline	
anti-HBs titre	-	
Hepatitis C Serology	2023-02-16	
anti-HCV	negative	
HCV-RNA	not tested	

Interpretive Texts

2023-02-16 Hepatitis A Serology Interpretation

Positive results for total anti-HAV antibodies in combination with negative results for IgM anti-HAV antibodies indicate immunity to the hepatitis virus A and exclude the possibility of a recent hepatitis A. This immunity may either have been acquired naturally through an earlier infection or it may have been induced by active vaccination or passively acquired immunization.

2023-02-16 Hepatitis B Serology Interpretation

The simultaneous occurrence of HBe-antigen and anti-HBs antibodies is a rare event in the natural course of a hepatitis B virus infection. This constellation of findings may be attributed to one of the following causes: (a) circulating HBsAg-anti-HBs immune complexes, (b) hepatitis B virus infection coinciding with a hepatitis B vaccination or injection of HB-hyperimmune globulin, or (c) reinfection with a hepatitis virus B with a different HBsAg subtype. Blood and secretions (saliva, sperm, breast milk) of such patients are to be regarded as infectious. In order to obtain conclusive information on the ambiguous negative or positive result, it is recommended to have new material sent in for testing and/or to consult with the head of the laboratory.

2023-02-16 Hepatitis C Serology Interpretation

The findings obtained give no indication of a present or earlier hepatitis C virus infection, but these cannot be definitely excluded. In rare cases despite negative HCV antibodies HCV-RNA may be detected in the serum. Nevertheless, in practice anti-HCV-negative blood (also without information about HCV-RNA) is considered to be not infectious with regard to hepatitis C.

Cardiac Enzymes	2023-02-17	2023-02-16
High sensitive Troponin T	-	0.018 ng/mL
Troponin I	0.48 ng/mL	-

2023-02-17 Increased troponin value! Value indicates myocardial cell damage.

Increased troponin value: 0.48 ng/mL (2023-02-17T10:04)! Value indicates myocardial cell damage.
 Trop I: 0.480 ng/mL (2023-02-17T10:04)
 Trop HS: 0.018 ng/mL (2023-02-16T10:58)

Bibliography

- [1] M. N. Kamel Boulos and P. Zhang “Digital Twins: From Personalised Medicine to Precision Public Health,” J Pers Med, vol. 11, no. 8, p. 745, 2021, doi: [10.3390/jpm11080745](https://doi.org/10.3390/jpm11080745)
- [2] K.-P. Adlassnig, J. Gawrylkowicz, and A. Rappelsberger, “Interpretive Knowledge Engines: A New Service for Pathologists to Bridge the Gap to Clinicians,” in Abstracts 31st Eur. Congr. of Clin. Microbiol. & Infectious Diseases (ECCMID), 2021, ESCMID eLibrary: [516](https://doi.org/10.11859/abstracts-31st-eur-congr-clin-microbiol-infectious-diseases)
- [3] J. Zeckl, K. Adlassnig, R. Fossler, A. Blacky, J. S. de Bruin, W. Koller, A. Rappelsberger, and K.-P. Adlassnig, “Context-Sensitive Clinical Alert Packages Written in Arden Syntax,” in MEDINFO 2017: Precision Healthcare through Informatics, Proc. of the 16th World Congr. on Med. and Health Inform. Amsterdam: IOS Press, 2017, pp. 1190–4, doi: [10.3233/978-1-61499-830-3-1190](https://doi.org/10.3233/978-1-61499-830-3-1190)
- [4] OpenJS Foundation and Node.js contributors, “Node.js,” [Online]. Available: <https://nodejs.org> [Accessed 12 January 2024]
- [5] E. Ziegler, T. Urban, D. Brown, J. Petts, S. D. Pieper, R. Lewis, C. Hafey, and G. J. Harris, “Open Health Imaging Foundation Viewer: An Extensible Open-Source Framework for Building Web-Based Imaging Applications to Support Cancer Research,” JCO Clin Cancer Inform, vol. 4, pp. 336–45, 2020, PMID: [32324447](https://pubmed.ncbi.nlm.nih.gov/32324447/), doi: [10.1200/CCI.19.00131](https://doi.org/10.1200/CCI.19.00131)
- [6] C. Hafey and Open Health Imaging Foundation, “Cornerstone3D,” [Online]. Available: <https://cornerstonejs.org> [Accessed 12 January 2024]
- [7] S. N. Makarov, G. M. Noetscher, J. Yanamadala, M. W. Piazza, S. Louie, A. Prokop, A. Nazarian, and A. Nummenmaa, “Virtual Human Models for Electromagnetic Studies and Their Applications,” IEEE Rev Biomed Eng, vol. 10, pp. 95–121, 2017, PMID: [28682265](https://pubmed.ncbi.nlm.nih.gov/28682265/), doi: [10.1109/RBME.2017.2722420](https://doi.org/10.1109/RBME.2017.2722420)
- [8] three.js contributors, “Three.js — JavaScript 3D Library,” [Online]. Available: <https://threejs.org> [Accessed 12 January 2024]
- [9] Google LLC, “Angular,” [Online]. Available: <https://angular.io> [Accessed 12 January 2024]
- [10] Smile CDR, Inc., “HAPI FHIR – The Open Source FHIR API for Java,” [Online]. Available: <https://hapifhir.io> [Accessed 12 January 2024]