CDS CHALLENGES AND SOLUTIONS: THE KNOWLEDGE ENGINEERING PROCESS FOR IMPLEMENTING FHIR AND CQL FOR THE STRATIFY AHF RISK ASSESSMENT TOOL

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NTRODUCTION

With the rise of complex clinical processes and the need for interoperable Clinical Decision Support (CDS) systems, FHIR (Fast Healthcare Interoperability Resources) and CQL (Clinical Quality Language) have emerged as pivotal standards for ensuring efficient data integration and sharing.

Vanderbilt University Medical Center (VUMC) has leveraged these frameworks to develop the **STRATIFY AHF Risk Prediction Tool**, a SMART on FHIR app designed to identify patients with acute heart failure (AHF) at low risk of 30-day mortality or complications.

KNOWLEDGE REPRESENTATION CHALLENGES

- Creating a precise, centralized, authoritative **knowledge base (KB)** that represents heterogenous concepts with rich metadata and lineage, ranging from informal requirements to standard-based executable code
- Soliciting shared abstractions with SMEs (e.g.) QRS concept, LOINC:8633-0 and LOINC:44973-6, QRS Duration lab build item in the EHR, Has_Prolonged_QRS input to the risk calculator)
- **Identification of clinical concepts** referenced by the CDS require clinical terminology expertise
- Cross referencing terminologies with the EHR build components requires thorough validation
- Exposing a rich knowledge graph for stakeholders for navigation, exploration, validation and curation
- Creating and maintaining ETL (Extract, Transform, Load) code implementations importing content from many data source systems
- Maintaining accurate and up-to-date **knowledge assets** for which the source data may change daily, but also need SME approval before each update can be used in the CDS implementation

ACKNOWLEDGEMENTS

To all STRATIFY team members, see list at https://www.vanderbiltem.com/stratify

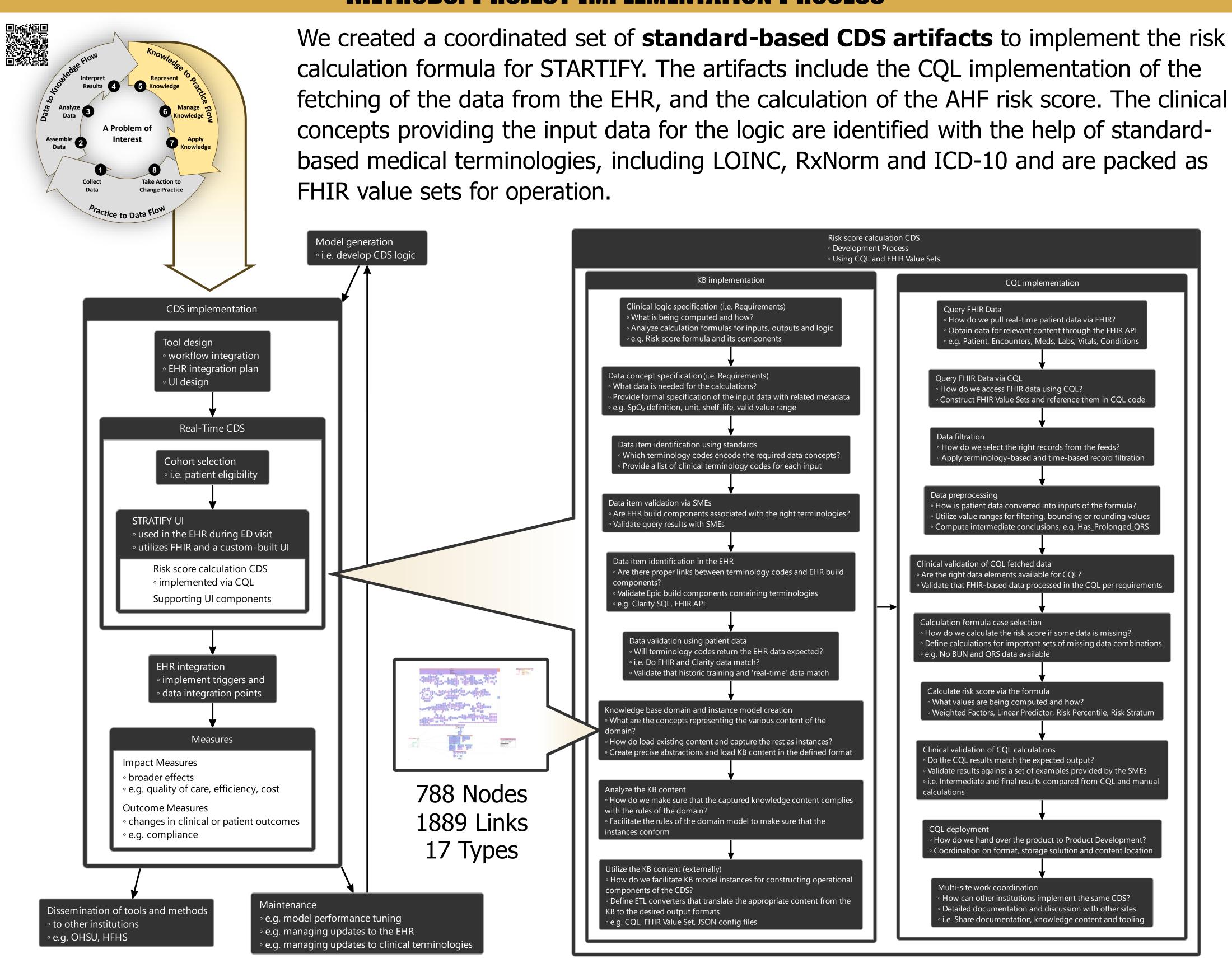




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METHODS: PROJECT IMPLEMENTATION PROCESS

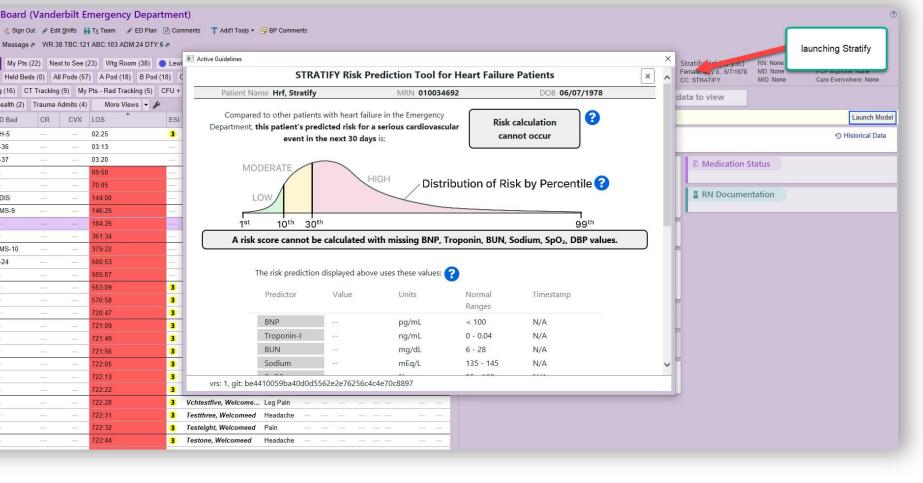


FHIR and CQL data lookup in the VUMC CQL Platform

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	active	true	true		CN.recordedDate)			
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	deceasedBoolean	false	false					
	gender	female	male		🚯 Technical Analysis 🝷			
	generalPractitioner	Philip Ray Harrelson, MD	8					
	identifier	VANRNSC1K9TVKBH	VAN6S489NPHNX2H		Source	TST R4	TST R4	
		E129839	E140696		Id	eZvf4g3 0 3.7s	euc3uwg3 👌 542.000ms	
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		Tm81feTFPyOxH7COsdVisM-	TfilpJVQH50Dn0TekWVNZ9h-		MRN	"010003305"	"010017956"	
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FHIR & CQL CHALLENGES

• CQL interpretation and execution issues, i.e. the execution engine does not implement every CQL feature fully (e.g. missing Array and Tuples concepts) • CQL language maturity issues, such as missing language constructs (e.g. time zone conversion), poorly implemented type conversion, missing documentation examples, inability of sentence-like expressions to facilitate variables (e.g. "Now() - 2 hours'' vs "Now() - OffsetValueVariable hours'')

• CQL development issues, e.g. visualization of complex result sets, comparing multiple patient records for recognizing patterns, understanding query performance and timeouts, debugging error messages

• CQL Platform usability issues: since the tool was codeveloped with the AHF project, a lot of features were only added gradually (e.g. examining the JSON payload and error handling, which were critical for error handling) and other features are still needed

CONCLUSIONS

CQL and FHIR are instrumental and effective platforms for implementing interoperable CDS in modern EHRs. However, there are several key considerations:

• Implementing a tool with complexity comparable to our project **demands substantial knowledge** engineering to ensure clinical accuracy and maintainability.

 Establishing a production-ready solution necessitates advanced technical expertise.

• Due to the incomplete implementation of CQL specifications by existing engines, and inherent limitations within CQL itself, there are **restrictions** on both expressivity and brevity. These limitations may necessitate workarounds, which could obscure the original logic.

• To address the lack of features for efficient CQL development and testing in available tools, we **created** dedicated software to bridge this gap. The resulting VUMC CQL Platform has applications extending beyond the AHF project.

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