Rethinking the Design Space of EHRs towards Modeling tools: A pathway for health care to join the “Design Disciplines”

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***Abstract*—**

***Keywords—component, formatting, style, styling, insert (****key words****)***

# Data representation space in healthcare

The electronic health record (EHR) plays a critical role in the modern clinical workflow. From managing patient information to providing clinical decision support, its advancement has caused an undeniable paradigm shift in medicine [(1)](https://www.zotero.org/google-docs/?qFUZUx). That being said, the success of EHRs in the domain of healthcare delivery does not preclude them from having important limitations. In fact, the challenges associated with the mainstream adoption of commercial EHRs have been widely documented [(2–4)](https://www.zotero.org/google-docs/?CxWMIc). One such limitation is the way data is represented.

Scenario I: A mother comes in with her son to the hospital for an IV but forgets the child’s toy. She asks the doctor to wait until she gets the toy before starting the IV.

Scenario II: A doctor wishes to order some labs for a patient and they explain the reasons behind each lab to the involved health care team.

Modern day EHRs are limited in their ability to represent these scenarios with discrete data and narratives in an integrated manner. In scenario I, we face the challenge of whether to classify ‘wait for the mother to bring toys’ as an order or documentation. In the second scenario, the doctor is faced with recording both lab data as well as reasoning in a comprehensive manner.

Healthcare is challenged by an increasingly complex discrete concept space, knowledge space, while also having to incorporate concepts and ideas that resist discretization thus the utility of narrative. Relationships between these spaces are paramount for validation, minimizing cognitive load, team collaboration, automation and data analytics. Historically, healthcare's representation space is heavily dependent on statically arranged widgets to delineate data types, and documentation (which captures the indiscrete but is also used as weak substrate for expressing relationships).

To address these challenges, it is important to recognise the need for representing not only discrete ( i.e. labs, medicines and orders) but also the non-discrete (i.e. the reasoning, narrative and relationships) elements in healthcare. This concept paper aims to explain how Aurora’s solution overcomes these problems. Aurora achieves this feat largely due to the power of domain specific languages. Domain-specific languages (DSLs) are versatile tools that offer a blend of structured representation and expressive capabilities. These languages are characterized by well-defined ontologies (e.g., Snomed or International Classification of Diseases Codes in healthcare), and are therefore adept at optimizing a defined set of tasks within a given field. This article proposes the use of a problem-oriented DSL for healthcare, which can provide a formalized notation for patient care plans.

Let us examine the patient care model as a DSL in the following pseudocode. For the sake of simplicity, let us assume that all shorthand and terms such as nstemi, chf, furosemide and asa are mapped to appropriate ontology terms by the author or local policy elsewhere.

| ProblemList: |
| --- |
| nstemi  ?chf [nstemi] //I am speculating here. the lab analyzer is down and the BNP is still pending |
| Orders: |
| furosemide[chf] 40 mg iv now then bid //looking for improvement within the next 2 hours  asa [nstemi] 81 mg po od  metoprolol [nstemi,chf] 25 mg po bid |

This illustrates how multiple discrete concepts can be laid out in a manner where their data types are delineated by syntax and not just by the static arrangement of widgets. Moreover, relationships between various data types are explicitly encoded as each order is connected to a problem.

Other than building relationships between problems and orders, this combines the discrete and non-discrete using double slashes. The double slashes are inspired by the classical comments used in programming and provide narrative to add to the discrete concept map that emerges. Is this documentation, orders or data entry? Arguably this is all of the above. It is both machine and human readable. In this way clinical documentation could exist in-line with medical orders and prescriptions. The immediate effect is access to the clinical reasoning process of other members of the primary care team, and the elimination of possible confusion resulting from unexplained orders.

Arranging information in this way also reduces data fragmentation and the cognitive load of frontline healthcare workers. Rather than navigating between widgets to gather information, this reshapes the design space to make information more accessible and easily readable.

The tools currently used by clinicians do not encourage a design-centric approach to patient care planning. While other industries have utilised design tools like AutoCAD for engineering, Photoshop for photographers and Magicplan for floor plan modelling by architects, EHRs have not caught up to these tools. In these examples, the typical representation has the overarching synthesis, or how all the various concepts form a whole, as the center point of their design experience. This synthesis can often be "zoomed" for appropriate levels of detail. It is essential to rethink the design space of EHRs using domain specific languages and creating a pathway for healthcare to join these design disciplines.

# Envisioning Patient Care Model as Domain Specific Language (DSL)

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# How Patient Care Model DSLs Reduce Complexity of Care?

# The Aurora Framework

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# Conclusions

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