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****)***

# Patient Case representation space in healthcare

While Electronic Healthcare Records (EHRs) have shown promise in incommoding care data, their impact on management reasoning, which involves balancing treatment decisions, spend more time on cases and testing strategies while managing risk, is unknown.[1]. The vital roles of EHRs is focused on supporting the accuracy of diagnosis and rationalize the provided care to patients besides facilitating clinical documentation and care coordination and continuity through maintaining updated problem lists, tests, and medications [2]. In fact, the challenges associated with the mainstream adoption of EHRs have been widely documented[3,4]. Physicians have different perspectives on representing patient data compared to EHRs and these perspectives are not well integrated in any EHRs system. To give you some examples, let us take few care scenarios that illustrates the difficulty of using directly the EHRs system:

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 test to the involved health care team.

Modern day EHRs are limited in their ability to represent these scenarios with discrete data using the variety of data attributes available with EHRs system.. 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 recognize the need for representing not only discrete ( i.e. labs, medicines and orders) but also the non-discrete (i.e. the reasoning, narrative andcare orders flow) elements especially from the perspective of the caregiver according the patient case progression.. 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 describes the use of a problem-oriented DSL for healthcare, which can provide a formalized notation for patient care.

Let us examine the patient care model as a DSL in the following pseudo code. 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 certain care problem in the problem list.

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 utilized design tools like AutoCAD or blueprints 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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1. Igwama, Geneva Tamunobarafiri, Janet Aderonke Olaboye, Chukwudi Cosmos Maha, Mojeed Dayo Ajegbile, and Samira Abdul. "Integrating electronic health records systems across borders: Technical challenges and policy solutions." *International Medical Science Research Journal* 4, no. 7 (2024): 788-796.
2. Alanazi, Abdullah, Amal Almutib, and Bakheet Aldosari. "Physicians’ Perspectives on a Multi-Dimensional Model for the Roles of Electronic Health Records in Approaching a Proper Differential Diagnosis." Journal of Personalized Medicine 13, no. 4 (2023): 680.Chen, Chun‑You, Ya-Lin Chen, Jeremiah Scholl, Hsuan-Chia Yang, and Yu-Chuan Jack Li. "Ability of machine-learning based clinical decision support system to reduce alert fatigue, wrong-drug errors, and alert users about look alike, sound alike medication." *Computer Methods and Programs in Biomedicine* 243 (2024): 107869.
3. Duval Jensen, Julie, Loni Ledderer, Raymond Kolbæk, and Kirsten Beedholm. "Fragmented care trajectories in municipal healthcare: Local sensemaking of digital documentation." *Digital Health* 9 (2023): 20552076231180521.

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