Developing Human-Centred Design Guidelines for Laboratory Trend Graphs

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Introduction

People are increasingly accessing their laboratory (lab) results through patient portals [1-5]. Access to lab results can support patient engagement, shared decision making and understanding of current health status [1-3]. However, lab results, particularly lab graphs, are often difficult for laypeople to interpret and use. Consequently, people may experience confusion, misinterpretation, or unnecessary concern when reviewing their lab results [1, 3, 6-10] These challenges are amplified for individuals with limited health, digital, and/or graph literacy [1-7, 11]. Despite the growing availability of patient facing lab information, lab trend graphs do not consistently leverage design principles to support interpretation. Therefore, the objective of this study was to synthesize evidence to develop design guidelines for patient facing laboratory trend graphs and demonstrate their application through a prototype.

Methods

This project was conducted in three phases: 1) synthesis of evidence and design guideline development, 2) iterative prototype development, and 3) expert review and iterative refinement.

Phase 1- Synthesis of Evidence and Design Guideline Development

A targeted literature review examined patient interpretation and usability of laboratory results. There is a dearth of research specific to patient-facing laboratory trend graphs. Thus, evidence from related areas (singular lab results, reports, and general health data visualizations) were extrapolated where appropriate. Recurring themes were identified and used to generate lab graph specific guidelines.

Phase 2 – Iterative Prototype Development

To begin, the prototype of a lab graph was developed through iterative design cycles by applying the lab graph guidelines. Estimated Glomerular Filtration Rate (eGFR) was selected for prototyping because of its longitudinal trend potential, clinical importance, and documented interpretative challenges [5]. Design decisions focused on reducing cognitive load and improving interpretability through adjustments to labeling, reference range representation, colour use, information placement, and visual cues for clinical significance.

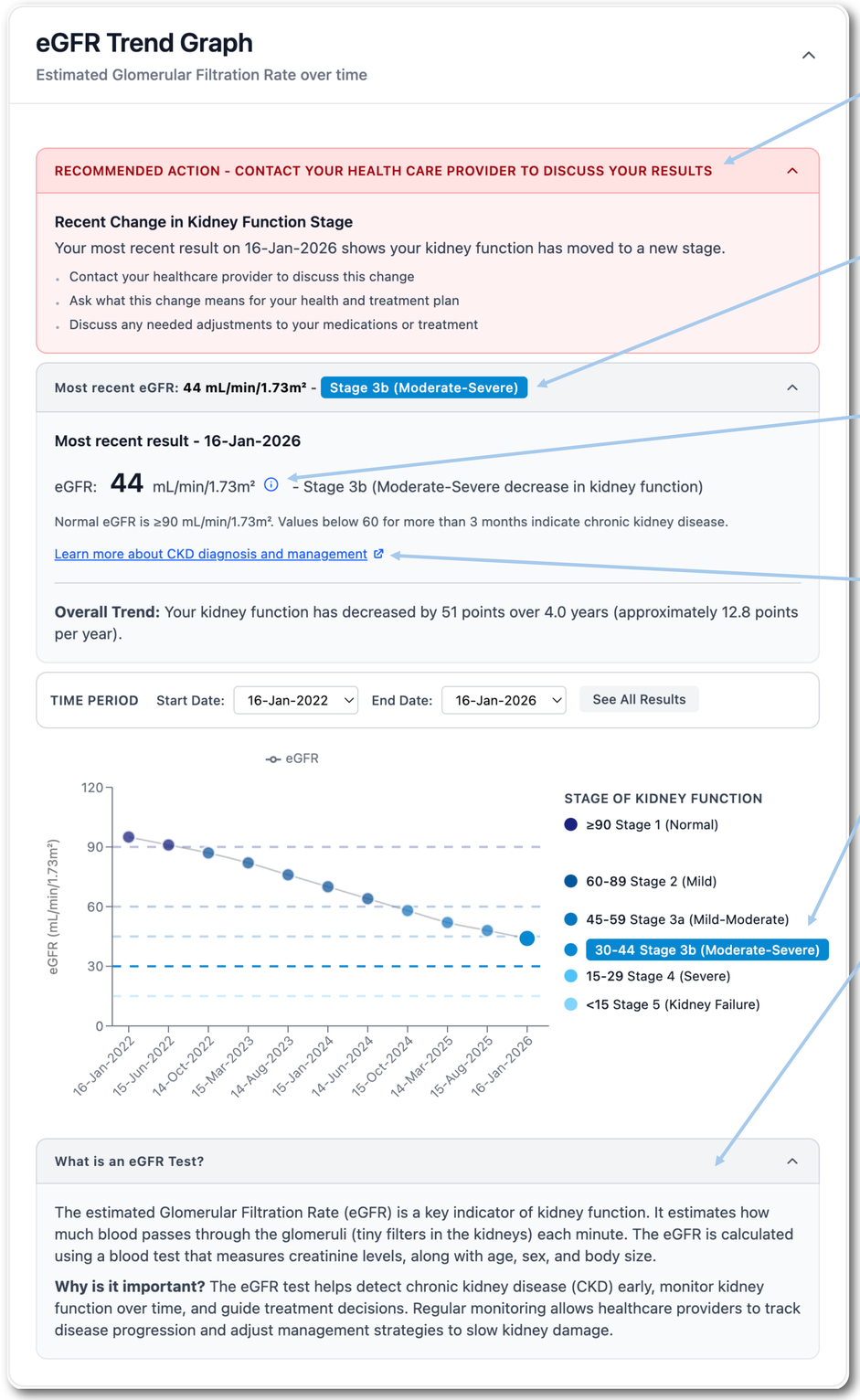
Phase 3 – Expert Review and Iterative Refinement

Prototype development and refinement were informed by iterative expert feedback to ensure alignment with User Experience (UX) and User Interface (UI) standards, with ongoing feedback from two reviewers with different areas expertise: 1) consumer health informatics and human factors; 2) UX/UI.

Results

Studies informed the development of guidelines for specific graph elements (e.g., contextualized ranges, harm anchors, visual encodings, explanatory text) and include whether each guideline is required, recommended, or optional (see Figure 1). Additional studies contributed to broader design theory, clinical context, and implementation considerations [25-30]. The resultant prototype illustrates multiple guidelines incorporated into a patient facing eGFR graph prototype (see Figure 1).

Figure 1 – eGFR Prototype and Human-Centred Design Guidelines



Actionable Thresholds
(Recommended)
Use clinically governed urgency cues or anchors to communicate when results may require attention
[1, 3, 6, 9, 10, 11, 14, 20, 21, 22,24]

Contextualized Reference Range
(Recommended)
Add interpretive context to reference ranges (e.g., Low, Normal, High) to clarify what categories within the range mean
[1-8, 12, 15, 16, 19, 21, 22]

Unit Information
(Recommended)
Explain the measurement units used, either directly, or integrated with analyte information
[1, 16]

Provide Resource Links
(Recommended)
Include links to vetted, test-specific educational resources directly from graph review area
[1-3, 5, 9, 15, 17-21]

Coded Labels for Line Graphs
(Required)
Use clear, colour vision deficient, appropriate labels and visual encoding to distinguish values and trends
[2-4, 6, 8-11, 13, 14]

Clear Explanation of Test/Analyte
(Required)
Provide a plain-language explanation of what the test measures and how results are generally interpreted
[1-9, 11, 15-20]

Personalized Reference Ranges*
(Optional)
Adjust reference ranges based on patient-specific factors when clinically appropriate and supported by data
[1, 3, 6, 7, 13, 14, 19, 21]

Concern Thresholds*
(Recommended)
Indicate values that warrant closer monitoring or follow-up without implying immediate action
[1, 3, 5. 6, 9, 10, 14, 21, 23, 24]

**not applicable for this graph*

Discussion

This project developed evidence-informed design guidelines for patient-centred lab graphs and demonstrated their application through a prototype for eGFR. The protype illustrates how multiple guidelines can be integrated within a single visualization to address known challenges in patient interpretation of laboratory data. Design guidelines were categorized as required, recommended, or optional based on evidence strength, relevance to patient interpretation, and feasibility within clinical and technical constraints. Existing research shows that patients struggle to interpret laboratory results due to health literacy, numeracy, and risk communication challenges [1, 3, 6-10]. Many existing studies do not account for the clinical constraints, longitudinal interpretation, and risk communication challenges inherent to laboratory graph interpretation [2, 6, 8, 21]. A key contribution of this work is the systematic translation of display-focused visualization evidence into laboratory graph-specific design guidelines. There were 2 notable limitations of this study. First, the evidence base specific to patient facing laboratory trend graph is limited. Thus, evidence had to be extrapolated from other related domains, and the synthesis was not conducted as a systematic review. Second, the themes were determined by a single evaluator.

Conclusion

This project developed evidence-informed design guidelines for patient-facing lab graphs that yielded a structured yet flexible framework for implementation across diverse laboratory contexts. These guidelines were demonstrated by applying them to an eGFR lab graph prototype. By synthesizing relevant literature, this work addresses a gap in lab graph specific visualization guidance and illustrates how these guidelines can be used to inform human-centred designs. This work offers a foundation for improving the clarity and interpretability of laboratory trend graphs in patient portals and supports future research into evidence-based laboratory data visualization. Future work should explore using the guidelines to develop other lab graphs, include feedback from more experts, and ultimately assess whether the guidelines improve patient comprehension and usability.

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