MEDINFO 2023 — The Future Is Accessible
J. Bichel-Findlay et al. (Eds.)

doi:10.3233/SHTI231123

Tabular, Annotated, Visual, or Trends + Contextual Information? Preferences for Online Laboratory Results Displays

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Abstract. People are increasingly offered access to their personal health information (e.g., laboratory results, clinical notes, diagnostic imaging results). However, this information is the same as that used by health care providers with clinical expertise and training in medical terminology, which citizens typically do not have. In this study, we examined participants (N = 24) preferences for four different types of displays for online laboratory (lab) results: Tabular, Annotated, Visual, and Trends + Contextual Information. The Friedman test of difference comparing participants' ratings of the four displays was significant, $\chi 2(3)=10.8$, P=.013, and the Wilcoxon signed rank pairwise comparison tests revealed that participants rated the visual lab results display significantly more favourably than the traditional display (Z=-2.746, P=.006). These findings indicate that many people prefer lab results displayed using more visual cues and some perceived this format as easier to understand than the other display formats. Given the importance of people accessing, understanding, and using their own health information, it is crucial for displays and systems to provide a better user experience. Displaying data (e.g., lab results) visually is one possible way to improve interpretability of personal health information provided to the public.

Keywords. Consumer perspective, data visualization, user-centred design methods, personal health records

1. Introduction

Due to many factors (e.g., shortages of health care providers, increased outpatient services to limit costs) the role of health consumers (or citizens, lay people, patients, caregivers) is changing. Health consumers have new responsibilities in their own care and managing their personal health information [1]. As active participants in their own health care, health consumers are increasingly performing activities such as assessing and monitoring their health as well as making decisions, plans, and actions, that influence their health [2]. To be active participants in their health care, consumers need access to

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their personal health information (e.g., laboratory results, discharge notes) and access to this information is more available than ever before.

Many Canadians access their laboratory (lab) results online using portals offered by ambulatory laboratories (e.g., LifeLabs, Dynacare) or hospital Electronic Health Records (EHRs). People appreciate having access to their online lab results [3–5]. However, there is no current standard and lab result displays typically differ depending on what portal people use. Moreover, lab results were originally intended for interpretation only by health care providers (i.e., experts), but are now offered to the public with few, if any, modifications. Consequently, access to results offers limited value because many people often have difficulty merely detecting abnormal lab results [6]. Further, many people because they do not have the required knowledge or experience to understand them (e.g., what the tests are, why they were ordered, what the results mean, or what to do based on the results). Moreover, for the approximately 60% of Canadians with low health literacy [7], the barriers are even greater to understanding and using their health information (e.g., lab results). Further, providing digital access to online lab results has the potential to impact the user experience positively or negatively. That is, a digital tool could create an additional layer of complexity, or it could instead simplify the experience by leveraging the inherent capabilities of the digital medium (e.g., alternative display formats, personalization, collapsible headings, info buttons, links to quality information). The design of interactions, displays, and the information within consumer facing health information systems can play an important role in whether these systems create value by being understandable and actionable or not. Conversely, these systems have the potential to confuse users and potentially increase anxiety unnecessarily if they misinterpret their results incorrectly. Indeed, studies show that there are opportunities to improve peoples' detection of abnormal results and comprehension of online lab results [6,8,9]. In this study, we explored health consumers' perceptions of 4 different types of online lab results displays (i.e., tabular, annotated, visual, and trends + contextual information) to determine which format participants preferred and why.

2. Methods

The Human Research Ethics Board at the University of Victoria approved this study. We recruited participants from a provincial platform for people interested in participating in health research. To begin, participants interested in our study completed a questionnaire to collect demographic information and information about their previous experiences using online lab results. After completing the questionnaire, participants could volunteer to be interviewed. The lead author (HM) interviewed this subset of participants using Zoom®. The focus of this study is to describe findings from the component of the interview where HM shared her screen so participants could view the Tabular, then Annotated, then Visual (see Figure 1), and finally Trends + Contextual Information online lab results displays (i.e., the stimuli) (see Table 1 for descriptions of the displays). While participants viewed each display, the interviewer asked questions such as "Pretend these are your results. Please think aloud and walk me through how you would use them (e.g., what you look for, understand, find confusing)" and "Are there any values outside the reference ranges?". After viewing all four displays, participants ranked the four displays from their favourite to least favourite and were also asked the rationale behind their selection ranking. Participants were compensated $30 CAD in total, $5 for completing the questionnaire, and $25 for their time being interviewed.

Table 1. Summarized descriptions of the four display stimuli.

Stimulus	Summarized Description
1. Tabular	A typical tabular display (very common in Canada), with headings for types of tests (e.g., hematology, urinalysis), columns for flags for out-of-range values, results, reference ranges, and units.
2. Annotated	The tabular display with callouts added to describe acronyms (e.g., WBC = white blood cells), types of tests (hematology = blood test), column labels, and pointing to an example of a flagged result.
3. Visual	Included a summary of out-of-range results, each out of range results was shown on a colour coded range, summary of results within range, a brief explanation of risks based on the results and suggestions for subsequent actions (see Figure 1)
4. Trends + Contextual Information	A trends graph illustrating values for one type of test over time that included additional information explaining the test (e.g., preparing for the test, why the test is commonly ordered, what values indicate).

Figure 1. The Visual display stimulus. Reproduced with permission from Mucca Design.

The rankings were analyzed using a Friedman's test (i.e., the non-parametric alternative to a one-way repeated measures ANOVA) as an omnibus and Wilcoxon signed-rank tests (i.e., the non-parametric alternative to repeated-measures t-tests) for post hoc pairwise comparisons using a Bonferroni correction (i.e., $\alpha < (0.05 / 6) = .0083$) to determine significant differences between the display ratings mean ranks.

3. Results

Although, HM interviewed 25 participants, one participant did not have time to complete the study (i.e., did not see the fourth display or complete the ranking) and was excluded from this study (N = 24). Twenty participants were between 25 – 64 years old, one was between 19 – 24 years old, and the remaining 3 participants were between 65 and 74 years old. All participants primarily spoke English at home. Eighteen participants had at least one chronic condition. Nineteen participants took at least 1 prescription medication in the last two days and eight of those had taken five or more. All participants graduated high school and five had completed postgraduate studies.

As shown in Figure 2, 15 participants rated the Visual display as their favourite and 11 participants rated the Tabular display as their least favourite whereas ratings for the Trends and Annotated displays were more mixed. The Friedman test of difference comparing participants' ratings of the four displays was significant, $\chi^2(3)=10.8$, $P=.013$, indicating at least 2 of the display rankings significantly differed. Participants favourite displays were rated 1 and least favorite were rated 4. The Wilcoxon signed rank pairwise comparison tests revealed that only one pair of tests was significantly different. Specifically, more participants rated the visual lab results display as their favourite than the traditional display ($Z=-2.746$, $P=.006$).

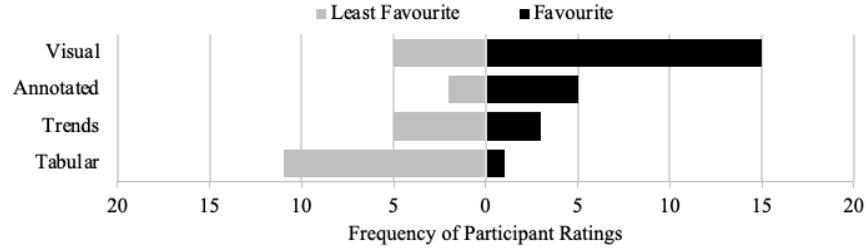

Figure 2. Frequency of Participant Ratings for Each Display Type as Favourite or Least Favourite

When questioned about their choices, participants expressed various aspects of each display that they liked and disliked. For example, participant 12 chose the Visual display as their favourite because:

> *"it's got the most visual indicators; it's got a lot of information. But that actually is conveyed without having to do tons of tons of reading or scrolling through figures. And I do think that that, like people are used to seeing sort of traffic light indicators in lots of areas of life. I like the fact that it's got that sort of like, quick heads up at the top that says, you know, these are the three things that are out of range."*

In contrast, participant 8 chose the Tabular display as their least favourite because:

> *"it's made for doctors, ones who then can understand that because well, they've gone to school for that…And then it goes into explanations of things like we don't know it from our see less than 11 equals two milliliters of this per milligram of this I don't know what that means. No one knows what any of that means unless they've gone to school for it. Like it just gives you unnecessary information and then just confuses you to the point where then you're just gonna get frustrated looking at your results."*

Interestingly, 10 participants expressed wanting to integrate different aspects from the different displays together to create even more effective displays. For example, by taking the colour coding and/or summary from the Visual display and integrating it with the aspects of the Tabular display and/or the Trends + Contextual Information display.

4. Discussion

Despite this small sample size, these findings suggest that we should be exploring alternative ways to display lab results to the public. Specifically, participants appreciated colour-coded visual displays and summaries. However, this visual display stimulus may still have more room for improvement (e.g., access to individual tests and results on reference ranges, trends). Although this study only examined preferences, not performance, there are some indications that these findings align. For example, many of these same participants (plus the excluded one) failed to detect abnormal results in the

traditional tabular display [6]. Further, graphic formats similar to the one in the Visual display of this study have been shown to help people interpret the urgency of their results more effectively than tabular displays [10].

The stimuli in this study were used by convenience and other than the Visual display, the remaining three were drawn from a lab results portal sandbox environment. Consequently, the number of outlying values varied, and some issues could potentially be more alarming than others. Hence, we could not adequately compare performance, only preferences in this study. Thus, future research is warranted to test these display types and other variants with a larger sample and control for abnormal values.

5. Conclusions

This study offers preliminary evidence that people would prefer if their personal health information was displayed more visually. Further, including more visualizations in displays may make the information easier for consumers to understand and apply [6,10]. Moreover, visual displays are also less cognitively taxing for health care providers (e.g., [11]). Finally, people perceive more visually appealing things as more usable [12]. Thus, efforts should be concentrated on including more visual aspects to improve health information displays for both consumers and health care providers.

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