

# Supporting Chronic Headache Patients with Visual Analytics

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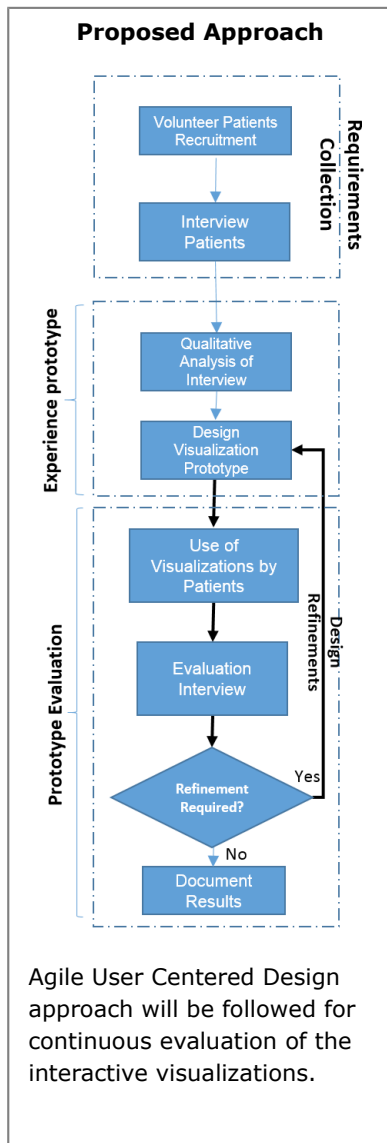
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**Abstract**

Usually chronic headache patients are advised by their care providers to track their headache episodes in a paper or electronic diary. These diaries are primarily used for information extraction by clinicians to prepare proper treatment plan. Patients are generally dependent on clinician's advices to improve their conditions. However, we hypothesize that with help of visual trends and analyses of chronic conditions as a form of personal informatics, patients will be empowered to manage their own conditions. We



propose innovative analytics based interactive visualizations revealing hidden chronic patterns after analyzing limitations of previous work in this area and demonstrate how these visualizations can help patients by providing meaningful insights. We intend to carry out qualitative research involving real chronic patients to verify our hypothesis.

### Author Keywords

Visual Analytics; Personal Informatics; Visualizations; Insights; Qualitative Research; Chronic Patients

### ACM Classification Keywords

H.5.2. Information interfaces and presentation.

### Introduction

Recent research highlights the potential of personal health informatics tools (e.g. a mobile app) to track and monitor chronic health conditions [9, 10]. For example, a mobile app can help patients to monitor the frequency, duration and severity of conditions over time, track medication use and its response and enable them the self-discovery of own conditions to act upon. In this context, our goal is to find suitable interactive data visualizations that are capable to engage and support patients by showing hidden patterns of chronic trends so that the patients can review and correlate how their daily activities impact their chronic conditions. To achieve our goal, we propose a qualitative research study to explore meaningful visualizations for chronic headache patients of *Calgary Headache Assessment and Management Program (CHAMP)*.

### Related Work

Headache tracking and monitoring tools have been studied to a great extent in [1, 3, 5, 8] but there is still room for improvement in the following areas. Our key findings from a review of existing works are: i) patients often feel the lack for suitable tools to understand their headache conditions [9, 10], ii) although there has been certain progress in visualizations for clinicians, those are not suitable for patients due to different perspectives and knowledge levels [4], iii) temporal patient data is hard to visualize in smaller (e.g. mobiles, smartphones) screens if it involves a lot of associated and related variables [11], and iv) influence of various factors (e.g. weather) on headaches should be addressed [2]. We intend to address these issues from visual analytics perspectives to understand suitable visualizations for personal health applications.

### Proposed Approach

The sidebar on the left briefly shows the proposed approach for our research study whereas as “Table 1” summarizes the overall activities in our approach.

Tasks	Timeline	Description
Requirements elicitation	30 days	CHAMP patient recruitment, interviews
Experience Prototyping	45 days	Interview analysis, designing prototypes
Evaluation of visualization prototypes	75 days	Use of visualizations, Evaluation interviews, Design Refinements

**Table 1.** Task breakdown and descriptions

## Research Prospects Discussion

Based on known issues from the literature review, we outlined visualization requirements for headache patients: i) visualizations should be temporal showing correlation among different variables to represent new knowledge on headache pattern, ii) daily activities in terms of triggers should be presented in the temporal data to give idea what activities in the past caused headaches, iii) temporal representation of data should be understandable to patients, iv) weather data can be exploited in the temporal trend to show probable correlation. We developed few imaginary prototypes based on above requirements. Although these prototypes cannot reveal the dynamic nature of the visualizations that we have in mind but we would like to discuss this to assert the prospects of our research proposal.

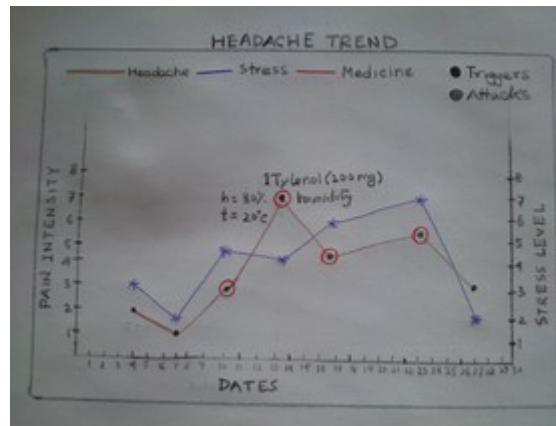


Figure 1. Temporal headache trend correlating factors.

## Empowering patient with knowledge

A temporal visualization that correlates multiple factors can be insightful for patients. In "Figure 1", the headache trend is depicted in the context of pain intensity versus stress level. The black dots (brown line) represent the headaches on several dates. Corresponding stress level for that date is represented by star (violet line). Circles around the headache dot represent the medicine intake. Each headache dot encapsulates information like weather data, medicine taken and trigger to facilitate progressive data exploration due to small mobile screen limitation [6] and to show minimal info for novice patient who can explore further on demand and interactively [7]. Here, the patient can see that humidity might have worked as the trigger for this particular headache. Now, if the patient is curious about all other triggers that are responsible for all headaches represented by the dots, he/she can select "Triggers" in the upper right corner. "Figure 2" shows the next screen.

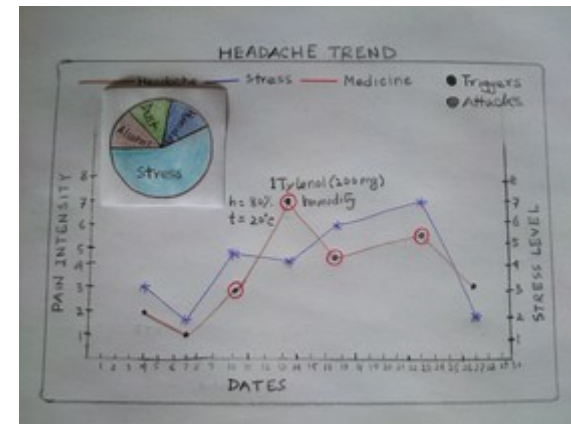
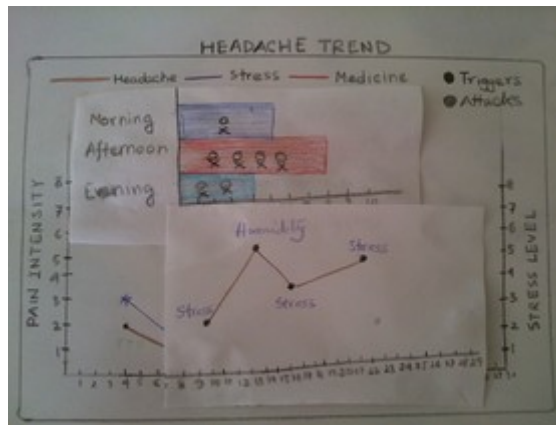


Figure 2. Different headache triggers.

A pie chart shows all the triggers such as stress, alcohol etc. based on automated analysis of previously collected data by the patient. Now this patient can see stress was the frequent trigger for his/her past headaches. Therefore, this patient can be cautious when he/she is about to start stressful work in future. As the triggers may change over time for particular patient so it helps the patient to extract knowledge about his/her triggers continuously so that he/she can take proactive measures to avoid headache attacks.

#### *Engaging patient with interactive visualization*

"Figure 3" shows the headache attacks at different times and associated average pain intensity. The patient can see that headaches in the afternoon give higher pain than other times. He can see that he had four headaches in the afternoon in one month. The patient can select the bar (e.g. touch, click etc) and a pop up will show triggers for these headaches.



**Figure 3.** Time of attacks and associated triggers.

Now the patient can easily correlate his daily stress level with the headache episodes. In general, the patient is unable to see these patterns or insights without suitable interactive information visualizations.

### **Conclusion**

We demonstrated how interactive visualizations can support chronic headache patients based on findings from literature review. We intend to verify our understanding through a qualitative research and we will explore whether these kind of interactive visualizations are applicable in any personal health data visualization context.

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