

The Care and Condition Monitor: Designing a Tablet Based Tool for Visualizing Informal Qualitative Healthcare Data

Anne Stevens*
OCAD University

Hudson Pridham**
OCAD University

Steve Szigeti†
OCAD University

Sara Diamond‡
OCAD University

Bhuvaneswari
Arunchalan§
OCAD University

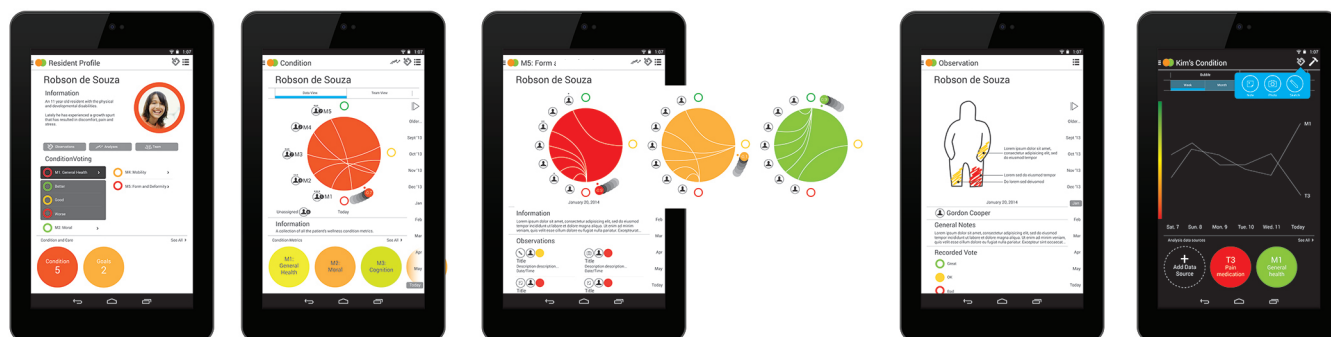


Figure 1: (a) Condition voting page, (b) Large circle colour shows resident's overall condition. Caregivers & metrics around left side. Green/yellow/red states around right, (c) Condition metric 5: Form, changes over time, (d) Observation page, (e) Analysis tool to compare any metric, resident or care team.

ABSTRACT

Visual analytic tools, combined with social networks and mobile platforms, make it possible to create multi-dimensional, holistic pictures of people's health care and condition and expand the scope of information addressed in medical records. The Care and Condition Monitor (CCM) is a tablet-based, networked visual analytics tool for collecting, structuring and analyzing informal and qualitative healthcare data and visualizing it in a circular format. It illustrates how social communication within teams of caregivers enables capturing of longitudinal informal data that can (a) result in rich and meaningful information visualizations, (b) improve comprehension of healthcare data and changes in condition over time, and (c) support medical decision making.

Keywords: Health informatics, informal data, long term care, mobile platforms, qualitative data, visual analytics.

Index Terms: Human Computer Interaction (HCI), Interaction Design, Ubiquitous and Mobile Computing, Visualization Design and Evaluation Methods, Visualization Techniques

1 INTRODUCTION

In practice, a resident's¹ condition is measured by formal diagnostic measures, but also judged by more informal means and subtle cues picked up by the front line caregivers in contact with residents day in and day out. Our research addresses the problem

of how to use visual analytics tools to create a holistic and multi-dimensional understanding of a resident's condition and care, improve the understanding of subtle changes in condition over time and assist with medical decision making using such informal information. CCM is a tablet based visual analytics tool that uses a simple voting strategy to collect and structure informal and qualitative healthcare data and a circular visualization format to represent the information.

2 CONTEXT

Our research partner is the Clemente Ferreira CAIS hospital in Lins, Brazil, a long term care residential institution for people with a range of congenital mental and physical conditions. Our findings have relevance to both it and residential and community team-based care in the wider context.

CAIS caregivers focus on two components of resident well-being—care and condition. Specialists establish treatment objectives, i.e. 'care', which is administered by teams of specialists, therapists, nurses and assistants. In addition to medical forms and notebooks, caregivers rely on informal communication practices to understand the full picture of a resident's status, i.e. 'condition', meeting face-to-face at shift change to pass on resident information and using their feature phone cameras to share treatment details that would not be captured in patient records. Our research focuses on translating these informal practices into a system of qualitative data analysis that supports the caregivers' culture and practices, reinforces CAIS's sense of community, improves collaboration across disciplines and improves overall understanding of care and condition data.

CCM is the outcome of a caregiver centric participatory design process that highlighted the following priorities: visualizing change over time, collaboration, capturing day to day events as well as formal data, and supporting informal communication.

3 BACKGROUND

CCM's design reflects research findings in a number of areas. Walsh and Chi demonstrated that peer voting systems that employ simple, consistent and well understood judgment criteria (e.g.

* astevens@faculty.ocadu.ca, ** hp12pk@student.ocadu.ca,

†sszigeti@ocadu.ca, ‡sdiamond@ocadu.ca,

§barunachalan@ocadu.ca

¹ The term Resident to refers to the hospital residents receiving care, rather than medical staff delivering it.

‘thumbs up/thumbs down’) lead to improved consensus and accuracy [1][2]. Chi and Erickson et al. found that, in collaborative contexts, transparency (i.e. who did what) leads to accountability and adds a layer of meaning [2][3]. Chunara et al. and Barboza et al. demonstrated the accuracy and effectiveness of unstructured, informal and non-expert information from multiple sources in social media and on the Internet for real time surveillance of infectious diseases [4][5]. Zhang et al. identified that most existing EMR systems make it difficult to get a quick assessment of patient status [6]. As noted by Donath and Viegas, people think spatially, not only for physical locations, but also for abstract concepts [7]. Chat Circles used this approach, leveraging circles to aggregate and indicate related dialogues and transparency to show history. The Circos program visualizes data in a circular pattern and facilitates the comparison between data points along the circle [8]. In addition to comparison, such circular layouts allows traditionally static data to be enriched by the use of space. Belden et al. identified a number of reasons why the adoption of EMRs has lagged behind expectations, and established the following usability design principles: (a) minimize caregiver cognitive load, (b) design for UI simplicity, naturalness and consistency, (c) make colour meaningful, and (d) preserve context [9].

4 FINDINGS

CCM is designed to capture and structure two categories of health information: condition and care. Condition is measured by five metrics (general health, morale, cognition, mobility and form), which were derived from CAIS’s records and are standardized for all residents. Care, on the other hand, is individualized and organized around care goals tailored to the needs of each resident. Caregivers collaborate, each in their own way, by shaping their treatments to the goals. In the case of either condition or care, a resident’s status is consistently assessed using a straightforward green/yellow/red voting system, with green indicating improvement, yellow stability, and red decline. CCM sorts and aggregates the votes (condition metric votes aggregate into overall condition, treatment votes into goals, goals into overall care etc.), and maps the resulting colour along the green/yellow/red spectrum in the large coloured dot in the centre of the display. While this dot provides overview, building from Donath and Zhang et al.’s examples, additional detail is also provided. The individual care or condition metrics that the central circle is derived from are arranged around one side of the circle along with the caregiver involved (for transparency). The state of each metric (green, yellow, red) is indicated around the opposite side. Curved lines join the metrics, on one side, to the states, on the other. As per Donath, again, the circular layout spatializes the social relationship between the resident and his or her circle of care and also helps the user build a mental map of the information structure. The horizontal row of dots along the bottom of the display tells the user, at a glance, the status of the individual parts that make up the whole displayed above. (Eg. the observations that go into the treatment, the treatments that go into the goal, the goals that go into overall care etc.)

As with Chunara et al and Barboza et al, CCM, similarly, relies on informal and qualitative data collected from all the caregivers who come in contact with a resident, expert and non-expert alike.

CCM addresses the usability issues identified by Belden et al. First, simple input and bold use of colour and graphics reduce cognitive load associated with text and encourage real time data entry. Second, redundant coding makes the visualization readable by people with colour blindness. Specifically, this is accomplished by a second smaller dot, the same colour as the first, which is

located around its perimeter at a position along the red-yellow-green spectrum that corresponds to its colour. A number between -1.0 (red) and +1.0 (green) reinforces the position. Third, context is provided by this second dot’s tail which indicates past positions and gives a sense of trajectory and volatility. Overall, the UI is designed for consistency, transparency and context.

The user can scroll back and forwards in time from any status visualization (coloured dot on white background) to understand collaboration and change over time. Additionally, the Analysis function, indicated by the black background shown in Fig. 1(e) allows the user to drill down into the data, to graphically compare any metric, resident, caregiver or team (eg. overall care to overall condition over time, treatments to care goal, care goal to condition metric, resident to resident, treatment to treatment etc.) Both tools facilitate team based assessment. Analysis results and parameters can be saved for future reference.

5 CONCLUSIONS

Our design is a work-in-progress and illustrates how care networks and simply structured informal data, captured over time, can result in rich and meaningful visualizations, improve comprehension of informal data and changes in a resident’s status over time, and support medical decision making.

Future steps include the development of a high-fidelity prototype for testing and evaluation with healthcare workers regarding issues such as ‘voter fatigue’, vote weighting, which condition metrics to use in what context, usability and navigation.

REFERENCES

- [1] K. Walsh and E. Sirer. Experience with an Object Reputation System for Peer-to-Peer Filesharing. In *NSDI ’06*. Volume 3, pg 1-1. USENIX Association Berkeley, 2006.
- [2] H. Chi, Ed. The Social Web: Research and Opportunities. In: *Computer* 41(9). Sept. 2008. pp 88- 91.
- [3] T. Erickson, C. Halverson, W. Kellogg, M. Laff, T. Wolf. Social translucence: designing social infrastructures that make collective activity visible. In *Communication of the ACM*. Volume 45, Issue 4, pages 40-44. ACM, 2002.
- [4] R. Chunara, J. Andrews and J. Brownstein. Social and News Media Enable Estimation of Epidemiological Patterns Early in the 2010 Haitian Cholera Outbreak. In *The American Society of Tropical Medicine and Hygiene*. Volume 86, Number 1, Pages 39-45. 2012.
- [5] P. Barboza, L. Vaillant, Y. Le Strat, D. Hartley, N. Nelson, A. Mawudeku, L. Madoff, J. Linge, N. Collier, J. Brownstein, P. Astagneau. Factors influencing performance of internet-based biosurveillance systems used in epidemic intelligence for early detection of infectious diseases outbreaks. In *PPLoS One*. Volume 9(3). 2014.
- [6] Z. Zhang, B. Wang, F. Ahmed, I. Ramakrishnan, R. Zhao, A. Viccellio and K. Mueller. The Five W’s for Information Visualization with Application to Healthcare Informatics. In *IEEE Trans Vis Comput Graph*, 2013.
- [7] J. Donath and F. Viegas. The Chat Circles Series: Explorations in designing abstract graphical communication interfaces. ACM, 2002.
- [8] M. Krzywinski, J. Schein, I. Birol, J. Connors, R. Gascoyne, D. Horsman, S. Jones, and M. Marra. Circos: Circos: An information aesthetic for comparative genomics. In *Genome Research*. CSH Press, 2009.
- [9] J. Belden, R. Grayson and J. Barnes. Defining and Testing EMR Usability: Principles and Proposed Methods of EMR Usability Evaluation and Rating. In *Healthcare Information and Management Systems Society (HIMSS)*, 2009.

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