DESIGNING DATA VISUALIZATIONS TO SUPPORT SHARED DECISION MAKING ABOUT BLOOD PRESSURE

Pete Wegier PhD[1], Jeffery L. Belden MD[2], Shannon M. Canfield MPH[2], Sonal J. Patil MD[2], Victoria A. Shaffer PhD[1,3], Linsey M. Steege PhD[4], Mihail Popescu PhD[5], KD Valentine MS[3], Akshay Jain MS[6], Andrew Hathaway BS[3], Michael L. Lefevre MD MSPH[2], Richelle J. Koopman MD MS[2]

University of Missouri–Columbia Departments of [1]Health Sciences, [2]Family & Community Medicine, [3]Psychological Sciences, [4]Health Management & Informatics, [6]Electrical and Computer Engineering; [5]University of Wisconsin-Madison, School of Nursing

BACKGROUND

Only about half of the 78 million US adults diagnosed with hypertension have their blood pressure (BP) controlled.

Recent research has identified the important role of home BP measurements, considered equal, or even superior, to clinic BP measurements in their predictive value.

However, home BP data in its numerical form–often provided by patients as written notes or submitted through telehealth applications–may not be used to its fullest potential due to possible information overload.

Visualization of home BP data values may prove to be the solution; however, current EMR systems do not have adequate capabilities for informative visualizations.

OBJECTIVE

Our goal was to develop a display–simple enough for patients but powerful enough for physicians–to allow for rapid assessment of a patient's BP to support shared decision making.

METHODS

We used a rapid prototyping process in which candidate visualizations were iteratively refined based on regular feedback from both patients and physicians.

Several focus groups with hypertensive patients, and family and internal medicine physicians, were held to gather feedback on candidate visualizations.

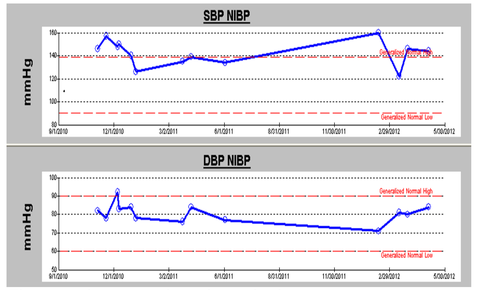
Table: Focus group characteristics

Characteristics*	Patients	Physicians
N	16	24
n female	10	8
Mean age	59.4	47.8
Race		
White	14	22
Black / African-American	1	1
Other	1	1
Ethnicity		
Latino / Latina	0	0
Education (patients)		
Some college or greater	10	–
High school or GED	3	–
Less than high school	3	–
Years in practice (physicians)		
Less than 5 years	–	7
6-20 years	–	8
21–30 years	–	5
More than 30 years	–	4

** Response options included additional categories. Only those reported by participants are shown here.*

WHAT WE ARE UP AGAINST

Current EMR systems have only limited abilities to visualize BP data.



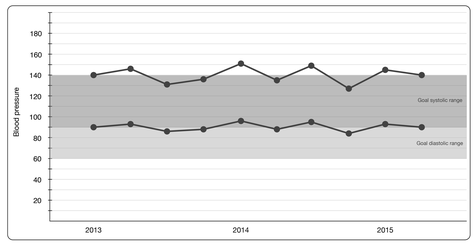
This visualization is less than ideal:

- Data is shown across separate plots, making reading/comparison of values difficult.
- Scales of y-axis on each graph differ, with separation between grid lines representing different ranges.
- Dotted lines for healthy goal ranges require constant visual search to determine if points are out of range.
- Data separated from broader context–no information available regarding medications, patient notes, etc.

GOAL RANGES

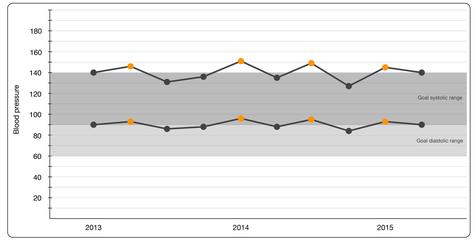
GREYSCALE GOAL REGIONS

Grayscale shaded regions represent healthy goal ranges for systolic and diastolic BP values.



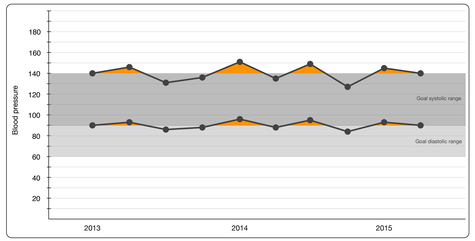
OUT OF RANGE POINTS

Orange points represent out of range values. Confusion arouse from DBP points labelled out of range but appearing within a shaded region–distinction between SBP and DBP unintuitive.



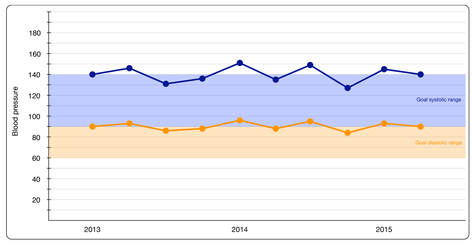
OUT OF RANGE FILLS

Orange fills highlight how far out of range points are. Response largely negative–meaning of orange fills was found to be unintuitive or conveying too little information.



COLOR-CODED REGIONS

Data points, lines, and healthy goal ranges denoted in like colors. Allowed users to match line and goal range color–*like with like*– for rapid evaluation of whether BP measurements were within range. Design received very positive stakeholder support.

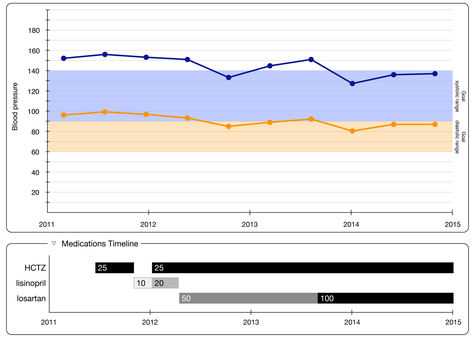


MEDICATION TIMELINE

A medication timeline was introduced based on prior work by members of the team. Includes all patient's current and past medications, prescribed dosages, and when and for how long medications were prescribed.

Differing dosages are displayed as greyscale bars–with lower dosages denoted by lighter shades–and with numeric dosage information.

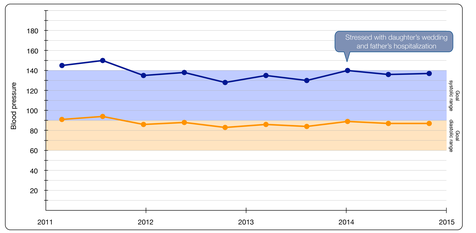
Allowed physicians and patients to see in context the effect of medications on patient BP. Stakeholders responded very positively to this element.

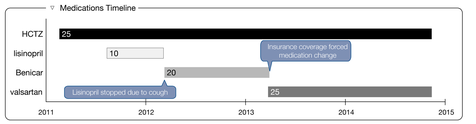


USER ANNOTATIONS

ANNOTATION BUBBLES

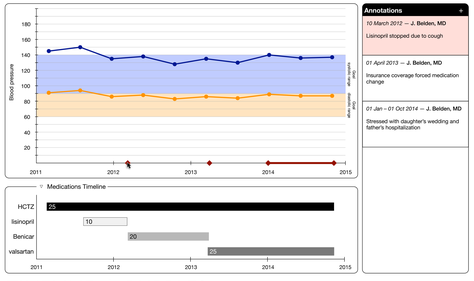
Floating annotation bubbles could be placed wherever a note was required. While physicians and patients were positive towards the concept of annotations, both groups disliked the amount of visual search necessary to read the annotations. Concerns over potential crowding of annotations were raised.





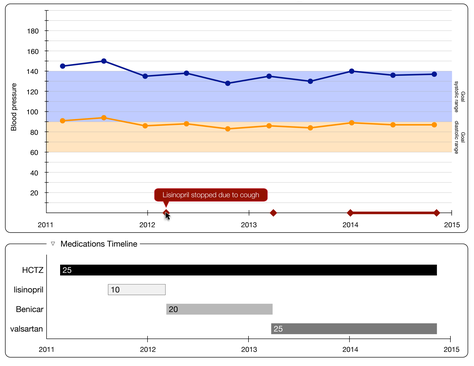
ANNOTATION TIMELINE

Annotations were placed on the x-axis of the BP display, denoting when they occurred. Annotation box displayed all annotations and associated metadata. This reduced visual clutter but visual search required remained similar.



TIMELINE + BUBBLES

Timeline was preserved but bubbles were added as hover-over popups. This combination of techniques proved best, reducing visual clutter and minimizing visual search effort while maintaining ease of use.

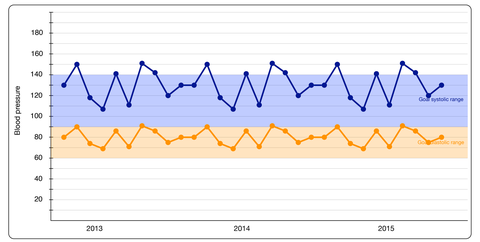


SUMMARIZING INFORMATION

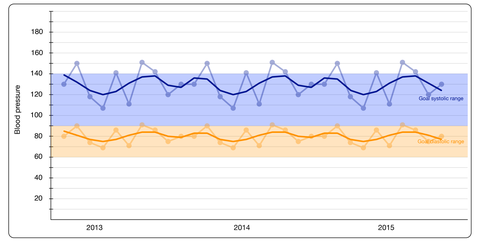
Several elements were designed but have yet to be tested with physicians and patients.

SMOOTHING DATA

In experimental studies, we have found that patients' perceive increased BP variability as decreased control.

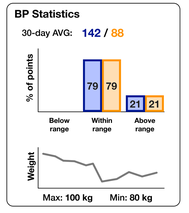


To improve perception of BP control, we smooth raw data using the LOWESS algorithm.



SUMMARY STATISTICS

In addition to the BP visualizations, mean BP over the last 30 days; distribution of raw points below, within, and above the healthy goal ranges; and weight is provided to participants as a separate panel.



RESULTS & CONCLUSIONS

Visualizations for BP data should incorporate both clinic and home BPs. Indicating goal BP ranges and a system for simple and quick evaluation of whether values are in or out of range is critical. The inclusion of context information is important–past and current medications, and physician/patient notes provide crucial contextual information to evaluate BP measurements. Future considerations include data summarization techniques.

Understanding how stakeholders evaluate BP data visualizations, and which factors improve the process, allowed for the development of a simple approach to the visualization of home BP measurements and potential improvement to the shared decision-making process.

This project was supported by grant number R01HS023328 from the Agency for Healthcare Research and Quality (AHRQ). The content is solely the responsibility of the authors and does not necessarily represent the official views of AHRQ.