ORIGINAL ARTICLE

Visual Analytics Dashboard Promises to Improve Hypertension Guideline Implementation

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BACKGROUND

Primary care management of hypertension under new guidelines incorporates assessment of cardiovascular disease risk and commonly requires review of electronic health record (EHR) data. Visual analytics can streamline the review of complex data and may lessen the burden clinicians face using the EHR. This study sought to assess the utility of a visual analytics dashboard in addition to EHR in managing hypertension in a primary care setting.

METHODS

Primary care physicians within an urban, academic internal medicine clinic were tasked with performing 2 simulated patient encounters for hypertension management: the first using standard EHR, and the second using EHR paired with a visual dashboard. The dashboard included graphical blood pressure trends with guideline-directed targets, calculated atherosclerotic cardiovascular disease risk score, and relevant medications. Guideline-appropriate antihypertensive prescribing, correct target blood pressure goal, and total encounter time were assessed.

RESULTS

We evaluated 70 case simulations. Use of the dashboard with the EHR compared with use of the EHR alone was associated with greater adherence to prescribing guidelines (95% vs. 62%, $P < 0.001$) and more correct identification of blood pressure target (95% vs. 57%, $P < 0.01$). Total encounter time fell an average of 121 seconds (95% confidence interval 69–157 seconds, $P < 0.001$) in encounters that used the dashboard combined with the EHR.

CONCLUSIONS

The integration of a hypertension-specific visual analytics dashboard with EHR demonstrates the potential to reduce time and improve hypertension guideline implementation. Further widespread testing in clinical practice is warranted.

Keywords: blood pressure; decision support system; guidelines; hypertension; primary care; social determinants of health

doi:10.1093/ajh/hpab081

Hypertension is the most common medical condition managed by primary care providers in developed countries and has been identified as the leading risk factor for mortality, and a leading cause of disability-adjusted life-years.[1–3] Hypertension management has become more nuanced under recent treatment guidelines, including the 2017 American College of Cardiology (ACC)/American Heart Association (AHA) updates. An important component of these guidelines is the recommendation to use risk stratification tools to guide decision making.[4,5] The atherosclerotic cardiovascular disease calculation is an example of such a tool. Although new guidelines stand to improve hypertension outcomes in primary care settings, they may place an increased burden on already time-constrained primary care visits, especially among clinics unaccustomed to using such tools.[1,6,7]

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Initially submitted April 19, 2021; accepted for publication May 25, 2021; online publication May 27, 2021.

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Visual analytics facilitate analytical reasoning of abstract data through visual interfaces. While potentially relevant to the management of chronic diseases such as hypertension, these tools have not been extensively studied as a means to enhance healthcare delivery.[8] Nonetheless, they can complement the traditional electronic health record (EHR) and aid clinicians in addressing problems whose complexity can erode decision making and cause an impasse in clinical care. One limitation of EHR decision support tools is that they commonly provide reminders without reducing cognitive load and without improving a clinician's time and ability to communicate with patients. Hence, clinicians ignore or override as many as 90% of EHR alerts.[9] Visual analytics increase cognitive resources to expand working memory and free time for improved clinician–patient interactions.[10,11]

As part of a quality improvement project to introduce visual analytic support into clinical care, we used simulated patient encounters to test how this support in the form of a visual dashboard might improve physician management. Specifically, we sought to determine if a visual analytic dashboard might improve guideline adherence and reduce the time physicians spend consulting the EHR for the management of hypertension.

METHODS

Study design and setting

We performed a prospective quasi-experimental study to investigate the effectiveness of a visual analytics dashboard on the EHR for the management of hypertension in the primary care setting. The setting was an urban, academic medical center. We tested the intervention among primary care physicians. Both attending and resident physicians were eligible. A clinician was ineligible who did not manage hypertension as a primary care provider. We approached primary care clinicians to participate over a 2-month period. The study had exempt determination by the institutional review board.

Intervention

Prior to study initiation, the study team queried primary care clinicians on key factors that would be important in their management of cardiovascular disease and guideline-based care. We then built a simulated visual analytics dashboard with design assistance from Patient Insight (Los Angeles, CA). Design focused on providing data relevant to following current ACC/AHA guidelines for the management of hypertension within a single graphic.[4] This dashboard included a graphic representation of recent blood pressure measurements, a timeline of antihypertensive medication prescribing, the patient's atherosclerotic cardiovascular disease risk score calculated from available EHR data, the target blood pressure based on guidelines, and relevant social or dietary factors.

Study procedure

Physicians were tasked with deciding a treatment course for blood pressure management of 2 new patients to their practice with previously diagnosed hypertension. The exact questions posed to physicians are included in Appendix online. For patient 1, a simulated patient was entered into the EHR (EPIC, Verona, WI) with all necessary information available to make guideline-based decisions on management. For patient 2, a different simulated patient with an equal content of EHR data was created. This patient also had the addition of a custom, visual analytic dashboard to aid in management (Appendix Figure 1 online). The visual dashboard used only data available in the EHR. During the simulated encounters, research team members tracked the time that physicians consulted the EHR or the visual dashboard. After each simulated patient encounter, the research team also administered a questionnaire on treatment decisions and overall satisfaction with the EHR or visual dashboard (Appendix Table 1 online). The main outcomes were time that physicians consulted the EHR and the proportion of treatment decisions that followed ACC/AHA guidelines. We secondarily assessed physician preferences for the usual EHR or the analytics dashboard using a 100 mm visual analog scale.

Data collection and analysis

We used the Research Electronic Data Capture system (REDcap) for data entry, and all statistical analysis was performed using the statistical software package, SAS version 9.4 (Cary, NC). Analysis included paired *t*-test to compare continuous variables and McNemar's chi-square for categorical variables.

RESULTS

There were 35 primary care physicians who participated in the study who completed 70 simulated cases. The average time spent completing each patient simulation was

Table 1. Comparison of clinician use of electronic health record alone or with paired visual dashboard

	EHR alone[a]	Visual dashboard with EHR	Difference (95% CI)	*P* value
Ease of finding information to guide treatment decisions, mean VAS (SD)	60 (23)	92 (10)	−32 (−40 to −24)	<0.001
Time to complete EHR review, mean minutes (SD)	88 (98)	201 (220)	−112 (−69 to −157)	<0.001
Ease of determining ASCVD risk, mean VAS (SD)	47 (34)	92 (18)	−44 (−55 to −32)	<0.001
Effectiveness in guiding use of hypertension guidelines, mean VAS (SD	35 (26)	92 (12)	−57 (−67 to −46)	<0.001
Ease of determining BP trend, mean VAS (SD	51 (40)	95 (14)	−44 (−57 to −31)	<0.001

Abbreviations: ASCVD, atherosclerotic cardiovascular disease; CI, confidence interval.
[a]BP, blood pressure; EHR, electronic health record; VAS, visual analog scale.

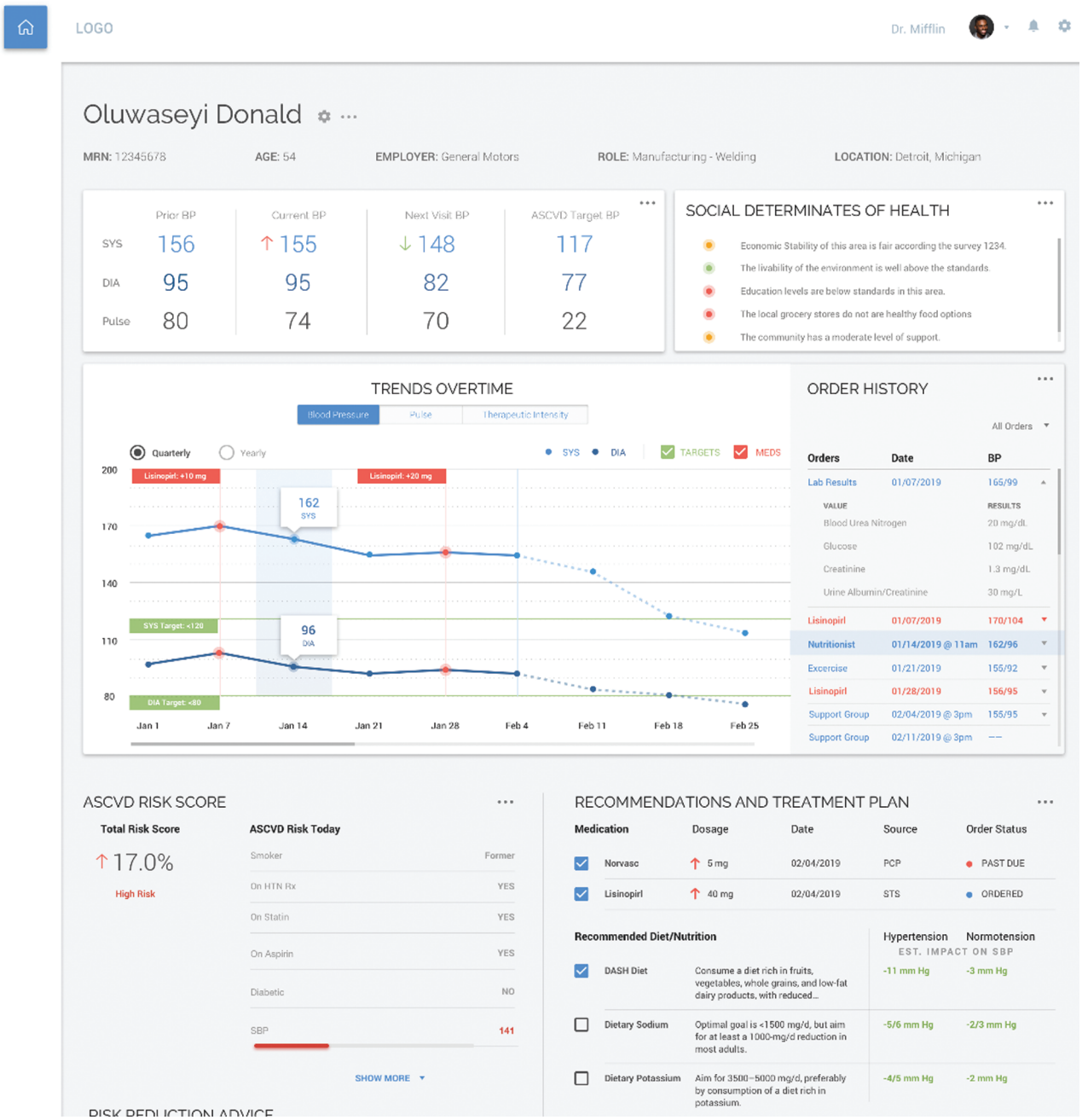

Figure 1. Visual analytic dashboard designed for implementation.

substantially shorter using the visual dashboard in conjunction with the EHR compared with the EHR alone (Table 1). Physicians accurately identified the correct blood pressure target (95% vs. 57%, $P < 0.01$) and made correct prescribing decisions in accordance with current guidelines (95% vs. 62%, $P < 0.001$) significantly more frequently in cases using the visual dashboard compared with the standard EHR.

Furthermore, clinicians rated simulated cases using the visual dashboard as significantly easier for gathering necessary information to treat hypertension (Table 1). Ninety-five percent of physicians responded that they would likely use the visual dashboard for future management of patients with hypertension.

DISCUSSION

Hypertension is the most common medical condition managed in the outpatient setting worldwide, and among the leading causes of morbidity and mortality. Guideline-based care requires careful assessment of patient characteristics that may not be readily viewable within the EHR. Paired with the increasing demand of primary care

physicians to adhere to guidelines while still having time to communicate effectively with patients, there is a critical need for improvements in how physicians interact with the EHR.

The results of our study suggest that the application of visual analytic support that pulls key data from the EHR and displays it in a clear and useable fashion has the potential to improve physician workflow. Within these simulated cases, physician spent less time making clinical decisions in managing hypertension and increased adherence to current guidelines. Nationwide, physicians spend a remarkable amount of time using EHRs to deliver care. In a recent analysis of 100 million patient encounters, physicians spent an average of 16 minutes per encounter, of which 33% of this time was in chart review.[12] Reducing time spent in chart review while improving guideline-based care through use of a visual dashboard has the potential to significantly improve the primary care clinical encounter.

High-quality electronic decision support is needed to support clinicians who have increasing demand for guideline adherence, high-value care, and improved patient outcomes. Multiple studies demonstrate that decision support improves healthcare process measures related to performing preventive services, ordering clinical studies, and prescribing therapies.[13] Visual analytic support additionally holds promise to streamline clinician's interaction with the EHR. Recent literature suggest that visual analytic support can reduce alert burdens, improve appreciation for temporal patient data, and improve care processes.[8,14–16]

Our group is in the process of testing an updated visual dashboard that guides clinicians with guideline-based care and also incorporates information on social determinants of health (Figure 1). We link public and private databases that provide census-tract level data to each patient's address to generate information on social determinants. Understanding and accounting for such factors in healthcare is an integral part of offering reasonable, effective, and long-term therapies to patients, and visual decision support tools can assist providers in recognizing such barriers, further improving patient care.

The main limitation of our study is the simulated nature of the encounters. While our group is in the process of testing a visual cardiovascular dashboard in everyday patient encounters, the true effect in the clinic setting remains to be seen. It is also possible that a visual dashboard will have its greatest impact on time savings when clinicians manage new or unfamiliar patients and less impact on encounters with well-known patients. Furthermore, while successful among a small group of physicians, there is the possibility that other physician groups may find the addition of an added visual dashboard less useful or even contributing to a burden of excess information.

The integration of visual analytic support within the EHR demonstrates potential to improve hypertension guideline implementation while reducing the EHR time burden that clinicians face. Further testing during implementation in primary care is needed.

SUPPLEMENTARY MATERIAL

Supplementary data are available at *American Journal of Hypertension* online.

Appendix Figure 1. Visual analytic dashboard used for simulation.

Appendix Table 1. Questions for physicians on simulated patients.

AUTHORS' CONTRIBUTIONS

R.F., J.M., A.H.G., and D.H. conceived and designed the study. R.F., G.A., T.A., T.R., M.S., H.I., R.H., N.G., and M.F. worked on data acquisition. J.M. and R.F. assisted with the statistical analysis presented. All authors participated in synthesis of the data, manuscript preparation, and manuscript review.

DISCLOSURE

The following authors report no conflicts of interest relevant to this manuscript: R.F., J.R., T.A., K.S., Z.D., G.A., T.R., M.S., H.I., R.H., N.G., M.F., A.H.G., D.H., P.L., and J.M. S.S. is CEO of Patient Insight.

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