

Henry Ford Health

Henry Ford Health Scholarly Commons

Internal Medicine Articles

Internal Medicine

5-27-2021

Visual Analytics Dashboard Promises to Improve Hypertension Guideline Implementation

Raef A. Fadel

Henry Ford Health, RFADEL2@hfhs.org

Jacob Ross

Henry Ford Health, JROSS1@hfhs.org

Timothy S. Asmar

Henry Ford Health, tasmarr2@hfhs.org

Karthik Sridasyam

Henry Ford Health, ksridas1@hfhs.org

Zachary Demertzis

Henry Ford Health, ZDemert1@hfhs.org

See next page for additional authors

Follow this and additional works at: https://scholarlycommons.henryford.com/internalmedicine_articles

Recommended Citation

Fadel RA, Ross J, Asmar T, Sridasyam K, Demertzis Z, Ahluwalia G, Roumayah T, Scott M, Ibrahim H, Hammoudeh R, Gandhi N, Flynn M, Haftka-George A, Heidemann D, Sims S, Levy P, and Miller J. Visual Analytics Dashboard Promises to Improve Hypertension Guideline Implementation. Am J Hypertens 2021.

This Article is brought to you for free and open access by the Internal Medicine at Henry Ford Health Scholarly Commons. It has been accepted for inclusion in Internal Medicine Articles by an authorized administrator of Henry Ford Health Scholarly Commons.

Authors

Raef A. Fadel, Jacob Ross, Timothy S. Asmar, Karthik Sridasyam, Zachary Demertzis, Guneet Ahluwalia, Tamara Roumayah, Megan Scott, Hanan Ibrahim, Rawan Hammoudeh, Nitesh Gandhi, Meaghan Flynn, Alexis C. Haftka-George, Danielle Heidemann, Sarah Sims, Phillip Levy, and Joseph B. Miller

Visual Analytics Dashboard Promises to Improve Hypertension Guideline

Implementation

Raef Ali Fadel DO¹, Jacob Ross BS², Timothy Asmar BS², Karthik Sridasyam BS², Zachary Demertzis DO¹, Guneet Ahluwalia DO¹, Tamara Roumayah MD¹, Megan Scott MD¹, Hanan Ibrahim MD¹, Rawan Hammoudeh MD¹, Nitesh Gandhi MD¹, Meaghan Flynn BA³, Alexis Haftka-George MD¹, Danielle Heidemann MD¹, Sarah Sims BA⁴, Phillip Levy MD, MPH⁵, Joseph Miller MD, MS^{1,2,5}

¹Department of Internal Medicine, Henry Ford Hospital and Wayne State University, Detroit, MI, United States

²Department of Emergency Medicine, Henry Ford Hospital and Wayne State University, Detroit, MI, United States

³University of Notre Dame, Notre Dame, IN, United States

⁴Patient Insight, Los Angeles, CA, United States

⁵Wayne State University, Detroit, MI, United States

Corresponding author:

Joseph Miller, MD, MS

Henry Ford Hospital Department of Emergency Medicine and Wayne State University

2799 W Grand Blvd, Detroit, MI 48202

Telephone: 313-916-1545, Fax: 313-916-7437, Email: JMiller6@hfhs.org

Disclosure: The following authors report no conflicts of interest relevant to this manuscript:

RF, JR, TA, KS, ZD, GA, TR, MS, HI, RH, NG, MF, AHG, DH, PL, and JM. SS is CEO of Patient Insight, Inc.

Abstract

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 two simulated patient encounters for HTN 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 ASCVD 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 to use of the EHR alone was associated with greater adherence to prescribing guidelines (95% vs. 62%, $p<0.001$) and more correct identification of BP target (95% vs. 57%, $p<0.01$). Total encounter time fell an average of 121 seconds (95% CI 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.

Key Words: Hypertension, Decision Support System, Guidelines, Primary Care, Social Determinants of Health

INTRODUCTION

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 (ASCVD) 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}

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 ASCVD 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 two new patients to their practice with previously diagnosed hypertension. The exact questions posed to physicians are included in the Appendix. For patient one, 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 two, 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). 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. 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 substantially shorter using the visual dashboard in conjunction with the EHR compared to 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 health care 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.

CONCLUSION

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

Accepted Manuscript

Acknowledgments and Contributions:

RF, JM, AHG, and DH conceived and designed the study.

RF, GA, TA, TR, MS, HI, RH, NG, and MF worked on data acquisition.

JM and RF 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:

RF, JR, TA, KS, ZD, GA, TR, MS, HI, RH, NG, MF, AHG, DH, PL, and JM. SS is CEO of Patient Insight, Inc.

Accepted Manuscript

REFERENCES

1. Finley CR, Chan DS, Garrison S, Korownyk C, Kolber MR, Campbell S, Eurich DT, Lindblad AJ, Vandermeer B, Allan GM. What are the most common conditions in primary care? Systematic review. *Can Fam Physician* 2018; **64**(11): 832-840.
2. Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK, He J. Global burden of hypertension: analysis of worldwide data. *Lancet* 2005; **365**(9455): 217-223.
3. Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJ, Comparative Risk Assessment Collaborating G. Selected major risk factors and global and regional burden of disease. *Lancet* 2002; **360**(9343): 1347-1360.
4. Whelton PK, Carey RM, Aronow WS, Casey DE, Jr., Collins KJ, Dennison Himmelfarb C, DePalma SM, Gidding S, Jamerson KA, Jones DW, MacLaughlin EJ, Muntner P, Ovbigele B, Smith SC, Jr., Spencer CC, Stafford RS, Taler SJ, Thomas RJ, Williams KA, Sr., Williamson JD, Wright JT, Jr. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol* 2017.
5. Navar AM, Pencina MJ, Peterson ED. Assessing Cardiovascular Risk to Guide Hypertension Diagnosis and Treatment. *JAMA Cardiol* 2016; **1**(8): 864-871.
6. Gilchrist V, McCord G, Schrop SL, King BD, McCormick KF, Oprandi AM, Selius BA, Cowher M, Maheshwary R, Patel F, Shah A, Tsai B, Zaharna M. Physician activities during time out of the examination room. *Ann Fam Med* 2005; **3**(6): 494-499.

7. Cholesterol Treatment Trialists C, Kearney PM, Blackwell L, Collins R, Keech A, Simes J, Peto R, Armitage J, Baigent C. Efficacy of cholesterol-lowering therapy in 18,686 people with diabetes in 14 randomised trials of statins: a meta-analysis. *Lancet* 2008; **371**(9607): 117-125.
8. West VL, Borland D, Hammond WE. Innovative information visualization of electronic health record data: a systematic review. *J Am Med Inform Assoc* 2015; **22**(2): 330-339.
9. Isaac T, Weissman JS, Davis RB, Massagli M, Cyrulik A, Sands DZ, Weingart SN. Overrides of medication alerts in ambulatory care. *Arch Intern Med* 2009; **169**(3): 305-311.
10. Houts PS, Doak CC, Doak LG, Loscalzo MJ. The role of pictures in improving health communication: a review of research on attention, comprehension, recall, and adherence. *Patient Educ Couns* 2006; **61**(2): 173-190.
11. Dowding D, Randell R, Gardner P, Fitzpatrick G, Dykes P, Favela J, Hamer S, Whitewood-Moores Z, Hardiker N, Borycki E, Currie L. Dashboards for improving patient care: review of the literature. *Int J Med Inform* 2015; **84**(2): 87-100.
12. Overhage JM, Jr DM. Physician Time Spent Using the Electronic Health Record During Outpatient Encounters: A Descriptive Study. *Ann Intern Med* 2020.
13. Bright TJ, Wong A, Dhurjati R, Bristow E, Bastian L, Coeytaux RR, Samsa G, Hasselblad V, Williams JW, Musty MD, Wing L, Kendrick AS, Sanders GD, Lobach D. Effect of clinical decision-support systems: a systematic review. *Ann Intern Med* 2012; **157**(1): 29-43.

14. Basole RC, Park H, Gupta M, Braunstein ML, Chau DH, Thompson M. A Visual Analytics Approach to Understanding Care Process Variation and Conformance. *Proc 2015 Workshop Vis Anal Healthc (2015)* 2015; **2015**.
15. Simpao AF, Ahumada LM, Desai BR, Bonafide CP, Galvez JA, Rehman MA, Jawad AF, Palma KL, Shelov ED. Optimization of drug-drug interaction alert rules in a pediatric hospital's electronic health record system using a visual analytics dashboard. *J Am Med Inform Assoc* 2015; **22**(2): 361-369.
16. Simpao AF, Ahumada LM, Rehman MA. Big data and visual analytics in anaesthesia and health care. *Br J Anaesth* 2015; **115**(3): 350-356.

Accepted Manuscript

FIGURE LEGENDS

Figure 1: Visual analytic dashboard designed for implementation.

Accepted Manuscript

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

	EHR Alone*	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

*EHR, electronic health record; VAS, visual analog scale; BP, blood pressure

Accepted Manuscript

Figure 1

