User-Centered Development of a Behavioral Economics Inspired Electronic Health Record Clinical Decision Support Module

Sara Kuppin Chokshi[a], **Andrea Troxel**[a], **Hayley Belli**[a], **Jessica Schwartz**[b], **Saul Blecker**[a], **Caroline Blaum**[a], **Adam Szerencsy**[b], **Paul Testa**[b], **Devin Mann**[a,b]

[a]Department of Population Health, New York University School of Medicine, New York, NY, USA,

[b]Medical Center Information Technology, NYU Langone Health, New York, NY, USA

Abstract

Changing physician behaviors is difficult. Electronic health record (EHR) clinical decision support (CDS) offers an opportunity to promote guideline adherence. Behavioral economics (BE) has shown success as an approach to supporting evidence-based decision-making with little additional cognitive burden. We applied a user-centered approach to incorporate BE "nudges" into a CDS module in two "vanguard" sites utilizing: (1) semi-structured interviews with key informants (n=8); (2) a design thinking workshop; and (3) semi-structured group interviews with clinicians. In the 133 day development phase at two clinics, the navigator section fired 299 times for 27 unique clinicians. The inbasket refill alert fired 124 times for 22 clinicians. Fifteen prescriptions for metformin were written by 11 clinicians. Our user-centered approach yielded a BE- driven CDS module with relatively high utilization by clinicians. Next steps include the addition of two modules and continued tracking of utilization, and assessment of clinical impact of the module.

Keywords

user computer interface; clinical decision support; electronic health record; behavioral economics

Introduction

Changing ingrained physician behaviors is difficult [1]. Integrating behavioral economic (BE) strategies into electronic health records (EHR) using various clinical decision support (CDS) tools is a novel approach to improving guideline adherence that also seeks to minimize negative impacts on clinical workflow and cognitive load. This study's hypothesis is that employing a user-centered approach to design a CDS module that incorporates BE strategies will result in a low burden tool to support provider adherence to guideline-based recommendations.

Address for correspondence: Sara Chokshi, DrPH, 227 E. 30th St, New York, NY 10016, Sara.Chokshi@nyulangone.org.

Maximizing the potential of CDS through behavioral economics and user-centered-design

Large, systematic reviews of EHR-based CDS have demonstrated a moderate ability to reduce morbidity, utilization, and costs [2, 3]. These modest improvements, however, are undermined by the well-documented problems of alert fatigue and poor workflow integration, which together blunt the potential of the EHR and CDS to improve healthcare outcomes [4]. New approaches are needed to complement the traditional alerts, reminders, and other CDS tools that disrupt clinical workflow, increase cognitive load, and stress the limited capacity of clinicians to rationally process and evaluate the diverse and competing demands on clinician attention. Behavioral economics has shown success as an approach to support evidence-based decision-making with little additional cognitive burden to clinicians; however BE strategies are rarely leveraged in current CDS tools.

A user-centered design approach employing design thinking strategies is common in digital development projects outside of healthcare. Prior research, including that of the research team, show the value of taking a user-centered approach to development of CDS [5–8]. A user-centered approach employs design thinking exercises designed to identify opportunities to incorporate BE in CDS related to the target user – in this case physicians – to stimulate idea generation. Design thinking strategies are well-suited to exploring physician motivations and workflow opportunities which require understanding for successfully incorporating BE to create feasible, usable decision support solutions likely to achieve adoption.

Choosing Wisely guideline for older adults with diabetes is an opportunity to explore this potential

The objective of this study was to develop a scalable, EHR module that incorporates BE strategies to promote appropriate diabetes care in older adults based on the American Geriatric Society's Choosing Wisely (CW) guideline, which aims to reduce over-treatment to benefit older adults with diabetes.

The CW guideline for older adults with diabetes recommends clinicians "avoid using medications other than metformin to achieve hemoglobin HbA1c<7.5% in most older adults; moderate control is generally better" [9]. This offers an opportunity to explore the potential of BE in the EHR to support guideline adherence for providers. In spite of this guideline, which recommends less aggressive target A1c levels based on older age and lower life expectancy, a substantial number of older adults with diabetes continue to be prescribed more aggressive therapies that may not only be unnecessary but also harmful [10–12].

This paper 1) outlines a user-centered approach to the development of a BE inspired EHR-CDS module for promoting guideline-based treatment of older adults with diabetes, and 2) reports on module activity metrics from the 4.5 month development phase of the project (June-October 2018).

Methods

Overview

This study employed a pragmatic (emphasis on real-world clinical workflows), user-centered approach to develop a new BE inspired CDS module (BE-EHR) to improve provider adherence to the CW guideline targeting over-treatment among older adults with diabetes.

To accomplish this, we conducted:

1. semi-structured interviews with key informants (n=8);

2. a two-hour design thinking workshop with a multidisciplinary group of clinicians, informaticists, EHR analysts, product designers and others to derive and refine initial module ideas; and

3. semi-structured group interviews with clinic leaders and clinicians at each of two "vanguard" sites to elicit feedback on three draft module components (inbasket refill, medication preference list, navigator tab).

Setting and population

The intervention was developed by a multi-disciplinary research team at a large academic medical center and deployed in two "vangaurd" ambulatory primary care practices serving patients with a diverse range of socio-demographic characteristics. The BE-EHR module was deployed for internal medicine and endocrinology physicians and nurse practioners.

Two "vanguard" practices were selected purposefully based on key characteristics: a primary care focus, a relevant patient population (i.e. adults over age 76 with diabetes), and a willingness of practice leadership to serve as a test site for implementation of module prototypes and provide periodic feedback.

Life expectancy algorithm

In order to build a user-centered CDS tool that triggers appropriately for the target patient population, algorithms were built into the BE-EHR module to drive the timing and content of module alerts that incorporate both patient life expectancy (high, medium, low) and target glycemic index per the CW guideline. These categories were defined in the algorithm as follows:

1. healthy older adults with an HbA1c target range of 7–7.5% and long life expectancy (defined here as 10+ years);

2. those with moderate comorbidity and a life expectancy of 3+ to 10 years, with a target range of 7.5–8%; and

3. those with multiple comorbidities and life expectancy of less than or equal to 3 years, with a target range of 8–9%. [13]

Analysis

Key informant, group interview data, and insights generated at the design thinking workshop were recorded by research staff in the form of field notes and summarized by usability theme and, when appropriate, by module component for rapid iteration of the prototype. Once findings were incorporated into the module prototype, the module was deployed in the two vanguard sites. EHR-based reports were built to track frequencies of module component firings and action taken (navigator tab component only). These metrics were calculated per number of unique patients and number of unique providers at the vanguard sites throughout the development phase (first 133 days of implementation). EHR reports also served to confirm the module and related outcomes reporting tools were firing as expected.

Results

Module development

Key informant and vanguard clinic group interviews identified the refill protocol and medication preference list as promising candidate CDS tools for the BE-EHR module based on their compatibility with provider workflows. These components were refined based group interview findings combined with current best practices in CDS development (e.g. avoid interruptive alerts) [14].

For example, the medication preference list component leveraged the behavioral economics principle of availability bias (tendency to rely on easy-to-access examples) by placing the CW recommended medication (metformin) at the top of the medication preference list (Figure 1).

Findings from the design thinking workshop included refinements to both the refill protocol and the medication preference list components. Two new ideas were generated that incorporated a combination of behavioral economic principles: one new EHR CDS component (a navigator tab for older adults with diabetes illustrated in Figure 2), and a non-EHR based supportive "campaign," as an adjunct to the BE EHR-CDS module to raise awareness of the CW guideline. The campaign, requiring significant additional design work, was not deployed in the development phase.

Once prototyped, user feedback from site visits confirmed the compatibility of the navigator tab with clinical workflows and contributed to refinement of design and content.

Module activity

Table 1 shows the components of the nudges implemented during the development phase along with frequency of module firings. In the first 133 days at the two vanguard clinics, the navigator tab fired 299 times for 193 unique patients and 27 unique clinicians across sites. The inbasket refill alert fired 124 times for 84 unique patients and 22 unique clinicians (Table 1). Fifteen prescriptions for Metformin (guideline recommended medication if appropriate) were written to 14 unique patients by 11 unique clinicians – 31% of all clinicians (n=35) – who prescribed metformin to the target population from the preference list at the two vanguard sites during this time period.

Discussion

Design thinking, employed as an approach to facilitate successful implementation and sustainability of the BE-EHR-CDS intervention, is a useful tool in building an intervention with institutional and clinician buy-in. Our user-centered approach to design yielded a behavioral economics driven CDS module with relatively high engagement by clinicians. The incorporation of behavioral economic principles into EHR CDS tools shows promise as a strategy to improve guideline adherence by addressing stubborn barriers, such as alert fatigue and poor compatibility with workflow, that can prevent CDS from having the desired impact on clinician behavior.

A pilot study incorporating finalized versions of the three module components developed and implemented in this vanguard phase as described here, along with additional components, is recently underway in 4 additional clinics. New module components include, for example, an email message to be sent to clinicians by clinic medical directors with content leveraging the behavioral economic principle of social comparisons (comparing their proportion of patients within CW A1c target range with that of peers at their clinic and institution wide) has been developed and will be sent out monthly throughout the 6 month pilot period.

The proposed BE-EHR module serves as a highly scalable platform for embedding a BE-based CDS into any EHR system. Importantly, this module can be easily applied to many other conditions in older adults and other populations where combining BE with EHR-based clinical decision support will be useful for improving guideline adherence such as CW recommendations related to preventative screening procedures (e.g. colonoscopies), or increasing compliance to tobacco cessation.

Limitations

While the design of the BE-EHR module reflects input from a large number and wide variety of key informants and end users, utilization numbers reflect only the two vanguard practices. This is appropriate, however, for a development phase of such a project and in line with the user-centered design approach which values early, iterative feedback prior to widespread tool deployment. Additionally, key informant and group interviews were recorded with field notes taken by research staff rather than audio-recorded and transcribed. This was a conscious decision by the research team to serve the quick CDS development timeline and to allow for rapid iteration of module components. Finally, measurement of user engagment with or adoption of the module components is difficult given they are built, by design, not to be interruptive (requiring user interaction to resolve); process metrics collected therefore focus on opportunities for users to view module components.

Conclusions

The resulting BE-EHR module establishes a platform for exploring the ability of BE concepts embedded within the EHR to affect guideline adherence for other CW target areas. Moreover, it represents an exciting new channel for influencing provider behavior through less cognitively burdensome methods. Evidence and lessons learned from this study can

potentially inform the design, testing, and implementation of similar interventions for other CW target conditions and beyond.

Acknowledgements

References

[1]. Saddawi-Konefka D, Schumacher DJ, Baker KH, Charnin JE, and Gollwitzer PM, Changing Physician Behavior With Implementation Intentions: Closing the Gap Between Intentions and Actions, Acad Med 91 (2016), 1211–1216. [PubMed: 27008360]

[2]. 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, and Lobach D, Effect of clinical decision-support systems: A systematic review, Ann Intern Med (2012).

[3]. Moja L, Kwag KH, Lytras T, Bertizzolo L, Brandt L, Pecoraro V, Rigon G, Vaona A, Ruggiero F, Mangia M, Iorio A, Kunnamo I, and Bonovas S, Effectiveness of computerized decision support systems linked to electronic health records: a systematic review and meta-analysis, Am J Public Health 104 (2014), e12–22.

[4]. Khalifa M and Zabani I, Improving utilization of clinical decision support systems by reducing alert fatigue: Strategies and recommendations, Stud Health Technol Inform 226 (2016), 51–54. [PubMed: 27350464]

[5]. Feldstein DA, Hess R, McGinn T, Mishuris RG, McCullagh L, Smith PD, Flynn M, Palmisano J, Doros G, and Mann D, Design and implementation of electronic health record integrated clinical prediction rules (iCPR): A randomized trial in diverse primary care settings, Implement Sci 12 (2017), 37. [PubMed: 28292304]

[6]. McCullagh LJ, Sofianou A, Kannry J, Mann DM, and McGinn TG, User centered clinical decision support tools: adoption across clinician training level, Appl Clin Inform 5 (2015), 1015–1025.

[7]. Mann DM, Kannry JL, Edonyabo D, Li AC, Arciniega J, Stulman J, Romero L, Wisnivesky J, Adler R, and McGinn TG, Rationale, design, and implementation protocol of an electronic health record integrated clinical prediction rule (iCPR) randomized trial in primary care, Implement Sci 6 (2011), 109. [PubMed: 21929769]

[8]. Chokshi S, & Mann D Innovating from within : A process model for user-centered digital development in academic medical centers, JMIR Hum Factors (in press).

[9]. AGS, Choosing Wisely: An initiative of the ABIM Foundation, American Geriatric Society, 2017.

[10]. Lipska KJ, Ross JS, Miao Y, Shah ND, Lee SJ, and Steinman MA, Potential overtreatment of diabetes mellitus in older adults with tight glycemic control, JAMA Intern Med 175 (2015), 356–362. [PubMed: 25581565]

[11]. McAlister FA, Youngson E, and Eurich DT, Treated glycosylated hemoglobin levels in individuals with diabetes mellitus vary little by health status: A retrospective cohort study, Medicine 95 (2016), e3894. [PubMed: 27310986]

[12]. McCoy RG, Lipska KJ, Yao X, Ross JS, Montori VM, and Shah ND, Intensive treatment and severe hypoglycemia among adults with type 2 diabetes, JAMA Intern Med 176 (2016), 969–978. [PubMed: 27273792]

[13]. A.G.S.C.W. Workgroup, American Geriatrics Society identifies five things that healthcare providers and patients should question, J Am Geriatr Soc 61 (2013), 622–631. [PubMed: 23469880]

[14]. Osheroff JA, Teich JM, Middleton B, Steen EB, Wright A, and Detmer DE, A roadmap for national action on clinical decision support, JAMIA 14 (2007), 141–145. [PubMed: 17213487]
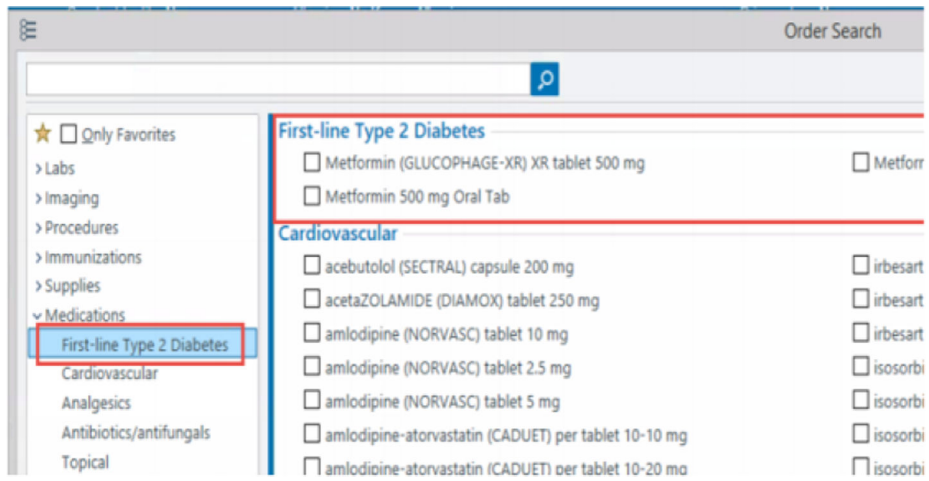
Figure 1-
Medication preference list module component

Figure 2-
Navigator tab module component

Table 1-

BE-EHR module components activity

Module Component	# fire	# patients	# clinicians
Inbasket refill	124	84	22
Navigator tab	299	193	27
	# Rx	**# patients**	**# clinicians**
Preference list Rx	15	14	11(31%)
Metformin Rx total	123	98	35