Shared decision making: using health information technology to integrate patient choice into primary care

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Cite this as: *TBM* 2011;1:123–133
doi: 10.1007/s13142-011-0023-5

Abstract

Advances in shared decision making (SDM) have not successfully translated to practice. We describe our experience and lessons learned in translating an SDM process for primary care cardiovascular disease management. The SDM process operationalized recognized SDM elements using workflow modifications, a computerized patient questionnaire, an automated risk calculator to identify at-risk patients, a web-based tool for patients to choose interventions, automated feedback on the personalized benefits of choices, and a web-based tool for providers to view patient risk, patient choice, and expert advice. Although medication was typically the intervention resulting in the greatest risk reduction, the majority of patients preferred dietary and other lifestyle changes. Patients generally favored the opportunity to make and communicate choices. However, providers only viewed patient choice data in 20% of the encounters. Translation of the SDM process was successful for patients and the difference between patient choice and optimal risk reduction points to the importance of engaging in an SDM process. Lack of engagement by providers may be due to “alert fatigue” or to the failure of the SDM process to improve efficiency in the office visit.

Keywords

Shared decision making, Translation, e-Technology

BACKGROUND

Shared decision making (SDM) is widely recognized as a desirable form of patient-provider interaction [1–3]. In theory, the SDM process seems straightforward. In practice, there is limited success in translating tested SDM protocols to routine clinical practice [4, 5].

SDM tools (e.g., a decision aid) and processes are intended to foster a consideration of the risk, benefits, and tradeoffs associated with a decision, and the way in which a patient’s preferences are incorporated into the discussion and decision process [6, 7]. There is growing interest in conceptual models, methods for communicating information, and tests of the utility and impact of tools and processes. There has been relatively little focus, however, on how SDM tools and processes can be successfully deployed and integrated into clinical practice. In general, SDM has not been

Implications

Practice: Key elements of shared decision making (e.g., defining the problem, presenting options, eliciting treatment preferences) can be efficiently integrated into the clinical workflow using web-based tools that improve patient satisfaction, quality of care, and productivity.

Policy: The meaningful use of health information technology for improving care quality and efficiency and for engaging patients in their healthcare will likely be enhanced by using efficient means of obtaining digital data directly from patients on risks, preferences, needs, and outcomes.

Research: There continues to be a significant gap in devising a care model that seamlessly and efficiently integrates shared decision making into the workflow in a manner that is easy for clinical practices to adopt.

translated to practice, in part, because conceptual models, methods, and tools are not framed by what is required for successful adoption [8].

The most frequently cited barriers to adapting SDM to practice include time constraints and determining the applicability of an SDM protocol to a specific patient [4], which may require collection of patient-reported preference and outcome data. These data are challenging to collect and use in real time [9]. Provider self-efficacy is an additional barrier to SDM arising when providers do not feel knowledgeable about or confident in the benefits of available treatment options or the role a patient wants to assume in the SDM process [4, 10].

In this paper, we describe how health information technology (HIT) was used to develop a primary care-based SDM process and related decision aids for educating patients about their cardiovascular disease (CVD) risk, eliciting treatment preferences, and presenting actionable information to the provider. Our results describe the choices made by patients and the degree to which providers participated in SDM. We also discuss the challenges encountered and lessons learned from integrating the HIT-enabled SDM process into a highly efficient clinic workflow.

METHODS

We conducted a randomized clinical trial (RCT) to evaluate an SDM process for risk management of cardiovascular disease in two primary care clinic sites. This paper does not describe the results of the RCT, but rather the SDM process and the experience of patients randomized into the intervention arm. In this section, we describe the study population and provide an overview of the SDM process, the design of the decision aid used to elicit a patient's treatment preferences, and the tool used to engage providers in SDM. The study was approved by the Geisinger Health System Institutional Review Board.

Study setting

Geisinger Health System (GHS) is a large integrated delivery system that serves residents in central and northeastern Pennsylvania. GHS includes the Geisinger Clinic (GC), a network of 40 community-based primary care clinics staffed by employed physicians. All Geisinger clinics have used the EpicCare™ electronic health record (EHR) since 2001. The SDM process was implemented in the family practice department of two GC community practice sites located in the central-western region of the state. Randomization of at-risk patients to either the SDM process (or to usual care) was independently completed within each clinic.

SDM overview

Makoul and Clayman identified nine essential elements of an SDM process: defining the problem, explaining options, discussing pros and cons for each option, incorporating patient preferences and values, assessing self-efficacy in relation to choice, and a series of provider interactions (e.g., provider knowledge and recommendations, ensure patient understanding, making a final decision or deferring a decision, follow up) [8]. We developed the following five tools to operationalize the first six elements: (1) a computerized patient "Heart Health Questionnaire" (HHQ) to obtain data on behavioral risk factors, administered via a touchscreen computer installed in a designated area of the clinic; (2) an automated protocol for calculating relative risk to identify candidate patients; (3) a patient-focused "Preference-Based Care Tool" (PBCT) designed to allow patients to choose options for managing CVD risk factors, also administered via a touchscreen computer; (4) an automated algorithm that sorted patient choices by the expected net gain in risk reduction given their risk profile; and (5) a web-based, provider-focused clinical decision support (CDS) tool that can be accessed directly from the EHR. The remaining three elements were not directly automated, but were addressed by the design of the care process as described below.

Study population

Using EHR data, we screened all primary care patients ($n=24,767$) at the two clinic sites for elevated risk of cardiovascular disease using guideline-based criteria (i.e., 45–75-year-old males, 55–75-year-old females, and 18 years+ with diabetes or cardiovascular disease) [11, 12]. To integrate into existing clinic workflows, we used an "opportunistic visit" protocol in which we recruited patients at elevated risk who also had a scheduled, routine (i.e., non-urgent) visit at either clinic site between June 2009 and April 2010. We programmed the EHR to automatically send a letter, signed by their provider, to these patients 10 days in advance of their scheduled appointment. The letter invited the patient to arrive 15 min early to complete the HHQ; more patients received the letter than were approached by a research assistant to participate because some patients either canceled or did not arrive early for their scheduled visit. Eligible, consenting patients ($n=2,072$) then completed a brief set of questions to authenticate their identity, after which they completed the HHQ. Moderate and high-risk patients were then randomized to an intervention group (complete the PBCT prior to visit) or a control group (usual care, no PBCT). This paper focuses on the results of those patients completing the PBCT.

Heart health questionnaire and risk assessment—The 24-question HHQ captures data (e.g., family CVD history, smoking and alcohol use, etc.) which is not consistently obtained during encounters or not obtained in a manner that is actionable using automated protocols to quantify risk.

Completion of the HHQ triggered an automatic calculation of a patient's 10-year absolute risk of a heart attack, based on a modified Framingham Risk Score (mFRS) formula. Absolute risk scores were then converted to a relative risk, defined as a patient's risk relative to that of a theoretical patient of the same age and gender with optimally controlled risk factors. Patients with a relative risk greater than or equal to 1.1 and with at least one of four modifiable risk factors (e.g. elevated body mass index (BMI), elevated blood pressure, elevated low-density lipoprotein (LDL), and smoking) were immediately presented with an onscreen demonstration of how to complete the PBCT, after which they were asked to use the PBCT.

PBCT—The PBCT was designed as an interactive web application that presented a graphical display of the patient's 10-year risk for a heart attack and allowed the patient to: (1) learn about their individual CVD risk factors; (2) view a "menu" of options for decreasing their risk; and (3) visualize the risk reductions associated with choices. Patients selected their preferences from a menu of options that were specific to each of four modifiable risk factors. For each risk factor, the PBCT presented patients with general information about the risk factor and offered a "menu" of treatment options and descriptions for

lowering their risk. Each PBCT risk factor screen was organized as follows (see Fig. 1). At the top of each screen was a message alerting patients that they had a specific risk factor. On the right side was a rank ordered list (i.e., options that offered the greater reductions in risk were listed near the top of the menu) of evidence-based interventions for reducing risk. Patients were instructed to select up to three interventions to reduce their individual CVD risk for that specific risk factor. On the left side was both a numerical (e.g., “1 in 8”) and a graphical presentation (i.e., bar charts) of heart attack risk. The graphical presentation consisted of a red bar indicating the patients’ current risk of heart attack, a blue bar indicating the target risk of heart attack based on a theoretical patient of the same age and gender with all risk factors under control, and a dynamic green bar that moved up and down to indicate changes in risk as patients selected different treatment options. Patients could learn the expected benefit of a treatment by simply selecting and de-selecting an option or combinations of options. For each risk factor, patients also had the option to indicate that they did not want to do anything to manage their risk.

Summarizing relative benefits of each choice—Each choice made by a patient was evaluated by an algorithm for the net risk reduction benefit given the patient’s risk profile. In brief, the risk formula for the patient was calculated twice for each risk factor, with and without the expected risk reduction for a given treatment option. A final menu rank ordered

all of a patient’s choices by the net risk reduction (see Fig. 2). From this menu, patients selected the two “most preferred” choices that they wanted to try first.

CDS tool—Upon completing the PBCT, patients were roomed and met with their provider as usual. When the provider opened the patients’ EHR, an electronic notification, called a best practice alert, appeared onscreen, alerting the provider that the patient had elevated CVD risk. A hyperlink embedded in the alert allowed the provider to open the CDS, a web-based tool to communicate information to the provider by displaying the following: (1) patient CVD risk factors, including HHQ and EHR data; (2) treatment recommendations that were based on codified, evidence-based guidelines [11, 12] for blood pressure, LDL, and smoking cessation; and (3) choices made by the patient for each risk factor, including “most preferred” choices (see Fig. 3). The goal of the CDS was to facilitate a patient–provider discussion about a mutually agreeable treatment plan that reflected the patient’s stated preferences in the context of evidence-based recommendations. Once the clinic encounter was closed in the EHR, the alert and associated information were no longer accessible at subsequent clinical encounters (i.e., due to limitations associated with importing information into the EHR, clinical decision support and preference information was not saved to the patient’s EHR in this version of the PBCT).

Fig 1 | PBCT risk factor screen

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Our mission is to improve the efficiency and quality of health care to patients.
eCVD

Welcome
Introduction
Instructions
Blood Pressure
Cholesterol
Smoking
Weight
Review
Record
debug

Review the choices you have made to reduce your risk of a heart attack.
Patient:

Choices at the top of the menu will help you more than choices at the bottom.
You will be more successful by starting with one or two choices and then adding others later.
Please check what you want to do first.

☐ I want to take medication to lower my bad cholesterol.
☐ I would like to exercise to help me 1) lose weight, 2) lower my blood pressure and 3) reduce my bad cholesterol.
☐ I want to lower my blood pressure with a low salt diet.

Submit to Record Session
Reset
Clear

Fig 2 | PBCT summary screen

Study outcomes

We describe the time required to complete both the HHQ and the PBCT, as measured by a research assistant (RA). We also describe choices patients made for each risk factor and their reported experience using the PBCT. Immediately after completing the PBCT, an RA conducted brief, semi-structured interviews with each patient. The RA asked the patient three questions, each prefaced with *“thinking about what you just did and saw on the computer”*, [1] *“what did you like”*, [2] *“what did you dislike”*, and [3] *“how would you improve it (make it better) for other patients”*. Two members of the study

team conducted a qualitative analysis of the interview data to identify and summarize common themes.

Statistical analysis

In this paper, our analysis is focused on describing the demographic and clinical characteristics of patients ($n=108$) who completed the PBCT and characterizing the individual treatment choices made by each patient. Categorical variables are described using counts and percentages. Continuous variables are each described using the distribution-

CVD Risk Reduction Recommendations					
Al, Ecvdii					
Risk Factor	Value	Date of Value	Best Practice Recommendations	Patient Preferences	Most Preferred
BP	145/90	05/06/09	HTN not controlled. Pt on calcium channel blocker. Consider increasing dose of calcium channel blocker (if less than maximal) or beginning HCTZ 12.5mg daily, Lisinopril 10mg daily or Metoprolol 50mg twice daily.	Dietician Low-Fat Diet Exercise	Exercise
LDL	140	05/06/09	LDL above target. Statin at maximal recommended dose. Consider switching to stronger statin.	Medication Lose Weight Exercise	Exercise
Smoker	No	02/17/10	Smokes 10 or more cigarettes/day. Consider adding Nicotine Therapy. Consider either Wellbutrin or Varenicline.	Nicotine Replacement Medication Internet Coaching	Nicotine Replacement
Aspirin Use	Never	02/17/10	No documentation of daily aspirin. Consider ordering one aspirin daily (no known ASA allergy) and educating Pt on aspirin and risk reduction value.		
BMI	33	05/06/09	BMI over 30. Consider referring to health coach for wt loss program.	Dietician Low-Calorie Diet Internet Coaching	
Alcohol	8 average/day	02/17/10	Pt with "problem drinking". (Frequent/more than threshold number drinks/one sitting). Consider CBC and LFTs, Thiamine 100mg daily and Folic Acid 1mg daily. Consider offering referral to community resources for alcohol treatment.		

Close

Fig 3 | Clinical decision support (CDS) screen

appropriate statistic (i.e., mean with standard deviation or median with inter-quartile range).

Analysis of patient preferences

For analytic purposes, we grouped all potential treatment options which a patient could select into six broad “treatment option” categories as follows: (1) medication (e.g., blood pressure or cholesterol-lowering medications, or nicotine replacement, depending on the risk factor), (2) bariatric surgery, (3) diet (including calorie log, reduction in alcohol consumption, low-calorie diet, low-fat diet, or low-salt diet), (4) self-change (including exercise, internet coaching, weight loss, home monitoring, or self-help materials), (5) counseling (including dietician counseling, one-on-one counseling, group counseling, or telephone counseling), or (6) doing nothing. Patient’s treatment preferences were evaluated within each of the four risk factors (blood pressure, cholesterol, BMI, and smoking) addressed by the PBCT. We summarized the number of patients eligible to pick a particular treatment option (which was dependent on a patient having that risk factor) and the proportion who chose each specific treatment option. The counts for specific treatment options did not represent unique patients, as patients could select up to three options per risk factor.

Patient preferences by co-variants

Differences in the proportions of patients selecting a specific treatment option as one of their three choices for managing a given risk factor were evaluated by sex, age group (<55, 55–64, 65+), relative risk score (high (≥ 1.2) versus moderate ($\geq 1.1 \leq 1.2$)), and education (high school or less, some college, college graduate or more). Due to small sample sizes, individual treatment choices were further reduced to three categories; medication (i.e., medication or nicotine replacement), lifestyle (i.e., diet, self-change, or counseling), or doing nothing. *P* values were calculated from Fisher’s exact tests.

RESULTS

A total of 24,767 patient records were screened, of whom 6,720 met inclusion criteria (age, primary care provider at one of the study clinics). Of the 2,072 patients approached by an RA, 88% (*n*=1,826) consented and completed the HHQ. Due to missing data in the EHR, an mFRS was calculated for 1,068 patients, of whom 244 were identified as moderate or high risk and randomized to the SDM process (*n*=108) or to usual care (*n*=136) from the time the PBCT went live (Table 1). Intervention patients were similar in demographic and clinical characteristics to patients in the control arm (*n*=136) of the randomized study (data not shown).

Workflow measurements

To understand the impact of the SDM model on clinic workflow, we measured the time the patient spent using the computer and all non-computer time (i.e., greeting patient, escorting the patient to the room with the touchscreen) in advance of being roomed. Completing the HHQ took an average of 5.25 min (median 5.0; IQR=4.0–6.1) and completing the PBCT required an average of 5.75 min (median 5.5, IQR=4.4–7.0). Non-computer time associated with the SDM protocol required an average of 1.37 min.

Preferences

Table 2 summarizes preferences expressed by patients completing the PBCT. Because patients could select up to three options per risk factor, choices were not mutually exclusive. The PBCT indicated that medication offered the greatest impact in decreasing elevated blood pressure, elevated cholesterol and smoking; yet, only for elevated blood pressure was it most commonly selected as one of the three preferred options for managing that risk factor. Generally, the choices selected most

Table 1 | Demographic and clinical characteristics of patients who completed the PBCT

	Completed PBCT (<i>n</i> =108)	
	<i>n</i>	%*
Demographic		
Age (year)		
<55	34	31.5%
55–64	37	34.3%
65+	37	34.3%
Sex		
Male	71	65.7%
Female	37	34.3%
Education		
High school or less	46	42.6%
Some college	32	29.6%
College graduate	30	27.8%
Race		
White	106	98.2%
Non-White	2	1.8%
Self-report medical history		
Stroke	10	9.4%
Diabetes	66	62.3%
Myocardial Infarction/Angina	16	15.7%
Family History	24	22.9%
Clinical		
	Mean	SD
Risk—absolute	0.133	0.053
Risk—relative (median, IQR)	1.65	(1.35, 2.13)
Body mass index	34.5	6.2
Systolic blood pressure	131.9	15.6
Diastolic blood pressure	77.3	9.7
Cholesterol (LDL)	109.8	41.0
Current smoking (<i>n</i> , %)	14	13.0%

*excludes unknown/missing

Table 2 | Number and percent of times a treatment option was selected by patients as one of their three options for managing an individual risk factor ($n=108$)

Treatment option	Risk factor															
	Blood pressure				Cholesterol				BMI				Smoking			
	Eligible		Chose		Eligible		Chose		Eligible		Chose		Eligible		Chose	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Medication	93	54	58.1	104	39	37.5	105	14	13.3	14	2	14.3	28.6			
Nicotine replacement	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dietary changes																
Calorie log (diary)	93	0	0.0	104	0	0.0	105	10	9.5	–	–	–	–	–	–	–
Drink less alcohol	93	2	2.2	104	2	1.9	105	0	0.0	–	–	–	–	–	–	–
Low-fat diet	93	38	38.8	104	0	0.0	105	0	0.0	–	–	–	–	–	–	–
Low-salt diet	93	27	29.0	104	0	0.0	105	0	0.0	–	–	–	–	–	–	–
Low-calorie diet	93	0	0.0	104	0	0.0	105	73	69.5	–	–	–	–	–	–	–
Self-change																
Exercise	93	47	50.5	104	69	66.3	105	69	65.7	–	–	–	–	–	–	–
Internet coaching	93	4	4.3	104	5	4.8	105	6	5.7	14	0	0.0	0.0			
Lose weight	93	0	0.0	104	68	65.4	105	0	0.0	–	–	–	–	–	–	–
Monitor at home	93	23	24.7	104	0	0.0	105	0	0.0	14	0	0.0	0.0			
Self-help materials	93	0	0.0	104	0	0.0	105	0	0.0	14	3	21.4				
Counseling																
Dietician	93	19	20.4	104	28	26.9	105	28	26.7	–	–	–	–	–	–	–
One-on-one counseling	93	4	4.3	104	0	0.0	105	0	0.0	14	0	0.0	0.0			
Group counseling	–	–	–	–	–	–	–	–	–	14	0	0.0	0.0			
Telephone counseling	–	–	–	–	–	–	–	–	–	14	0	0.0	0.0			
PT chose to do nothing	93	8	8.6	104	7	6.7	105	10	9.5	14	6	42.9				

Because up to three choices could be made, columns do not total 100%

often as one of the three preferred options were exercise, low fat/calorie diet, and dietician. The percentage of patients who chose “do nothing” ranged from 6.7% for cholesterol to 42.9% for smoking.

Within each risk factor, the proportion of patients who did or did not select a specific treatment category did not differ by age, sex, education, or relative risk level (see Table 3).

Provider response

Of the 108 patients who completed the PBCT, the subsequent provider alert was displayed in the EHR for 95 patients. Technical errors prevented the EHR alert from being displayed for the remaining 13 patients. Of the 95 alerts that displayed, 20% ($n=19$) were opened (i.e., the hyperlink in the alert was selected and the CDS was launched in a browser for viewing by the provider). The two study clinics differed by number of alerts opened by providers; 25.9% of alerts were opened at clinic 1 versus 12.2% at clinic 2.

Qualitative feedback on the PBCT

At the conclusion of the clinic visit, the RA asked each participant to answer three questions about their experience using the PBCT: (1) what did you like, (2) what did you dislike, and (3) how would you improve the PBCT? The questions were open-ended and patient responses were free form with no prompts from the RA. All responses were recorded by the RA and our analysis sought to identify common themes. A total of 84% of patients answered one or more of the three questions. Even with the open-ended question format, close to one third (32%) of respondents indicated that they liked being able to view and select from a set of treatment options. Other common responses to the “what do you like about the PBCT” question included: it provided educational or “common sense” information and/or reinforced what they already knew or were already doing (31% of respondents), and that it was easy to use (14%). To the second question (i.e., “what did you dislike”), the most common response was “nothing” (59%). In contrast, 7% of the “dislike” responses were related to the idea that the PBCT did not account for their current treatments (e.g., the option to take medication was presented even if the patient was taking medication). Of the patients who responded to the question about ways to improve the PBCT, 35% said “nothing”, while 14% said the full screen should be viewable without scrolling.

DISCUSSION

Our approach to designing and implementing SDM in a practice setting was guided by both a conceptual model and by factors relevant to translating the SDM process to routine clinical practice. Our process encompassed six of nine elements deemed

essential for SDM and it also addressed many of the constraints to translating these elements to practice (Table 4). Moreover, patients had a favorable response. From the outset, we tested an SDM process that was similar to what we expected to use in clinical practice, rather than treating the testing and translation steps as separate endeavors (i.e., where the solution that is tested differs from the solution that is translated to practice). To this end, use of information technology was critical to seamlessly adapt the process to workflows and information systems; yet the translation still fell short. While the clinic workflow was only partially successful (i.e., poor provider adoption), we have identified several important barriers to fully integrating the process in clinical care.

Health services research endeavors traditionally focus on designing, implementing, and testing the impact of an intervention on quality, cost, or clinical outcomes, not on whether the patient or provider would ever use the intervention or whether the intervention could actually be used in clinical practice. The latter is often an afterthought or seen as a separate endeavor. That is, a solution is first tested. Then the solution has to be translated into clinical practice with the risk that much may be lost in translation. To a large degree, the gap between what is tested and what is translated can be addressed by testing a prototype of the ultimate solution for use in clinical practice. To this end, the design of the prototype must be guided by the conceptual model for what is to be done and recognition of the constraints to how it should be done.

Successful translation requires an understanding of the discrete tasks that providers and patients are trying to accomplish and the development of solutions that facilitate the completion of these tasks. Typically, this means that adoption will be strongly influenced by whether the solution: (1) overcomes practical constraints to making it easy to do the tasks, (2) increases efficiency, (3) increases patient satisfaction, and (4) increases quality of care. There is a hierarchy of needs for successful translation. In this and other projects, we have found that constraints to workflow integration and efficiency are a dominant concern. If these needs are not addressed, then there is a high probability that translation will fail (Fig. 4). Efficiency can mean increasing the level of the visit, decreasing the length of the visit, or allowing a task to be completed by a lower-level provider (e.g., nurse), all of which have cost implications.

The time required for SDM [4, 5] in clinical practice is a dominant barrier to adoption. While we attempted to address the time constraint, we were not fully successful. The average time to complete the HHQ, the PBCT, and both were: 5.7, 5.25, and 10.8 min, respectively. To complete these activities prior to the visit, we used an auto-generated reminder letter asking patients to arrive 15 min

Table 3 | Of patients with a particular risk factor,% of patients who selected a treatment category by sex, age, education, and risk (n=108)

Risk factor	Treatment choices	Sex		Age			Education		Relative risk		
		Male	Female	<55	55-64	65+	HS or less	Some college	College grad +	Moderate	High
		n=71, 66%	n=37, 34%	n=34, 31%	n=37, 34%	n=37, 34%	n=46, 43%	n=32, 30%	n=30, 28%	n=18, 17%	n=90, 83%
Blood pressure	Eligible patients (n)	60	33	28	31	34	43	25	25	16	77
	Medication	65%	70%	64%	61%	73%	74%	56%	64%	69%	66%
	Lifestyle	97%	97%	96%	94%	100%	93%	100%	100%	100%	96%
	Nothing	25%	15%	21%	19%	23%	23%	20%	20%	19%	22%
Cholesterol	Eligible patients (n)	67	37	32	37	35	44	31	29	17	87
	Medication	60%	70%	59%	57%	74%	73%	58%	55%	59%	64%
	Lifestyle	97%	97%	97%	95%	100%	93%	100%	100%	100%	96%
	Nothing	19%	13%	19%	16%	17%	18%	19%	14%	12%	18%
BMI ^a	Eligible patients (n)	70	35	34	36	35	44	32	29	18	87
	Medication	60%	71%	59%	56%	77%	75%	56%	55%	61%	64%
	Lifestyle	97%	97%	97%	94%	100%	93%	100%	100%	100%	96%
	Nothing	24%	14%	23%	17%	23%	23%	22%	17%	17%	22%
Smoking	Eligible patients (n)	9	5	6	6	2	7	5	2	3	11
	Medication	78%	60%	67%	83%	50%	86%	40%	100%	67%	73%
	Lifestyle	100%	80%	100%	83%	100%	86%	100%	100%	100%	91%
	Nothing	56%	60%	67%	33%	100%	71%	60%	0%	67%	55%

^a Bariatric surgery was an option for patients with BMI>40; omitted results from table because chosen by one patient only

Table 4 | Constraints associated with translating essential elements of SDM to routine care

SDM element [8]	Translation challenges	Possible methods to address challenges
Define/explain problem	Provider recognition of problem, especially when screening in primary care	Algorithm in to evaluate data in EHR for basic inclusion criteria
	Patient-reported data not (consistently) available in medical record	Web-based patient questionnaire prior to/during encounter
	Provider explains the problem in general terms; not tailored to patient	HIT applications to present tailored explanation of problem/options using different formats (e.g., graphical)
	Patient understanding of problem	
Present options	Provider knowledge of all treatment options for problem	HIT decision aids to inform/educate patient of all applicable treatment options
	Provider inclination to include non-medication options, especially if medication provides greatest benefit	
Discuss pro/cons (benefits/risks/costs)	Provider time and available modes to show tailored information/calculations	HIT decision aids to inform/educate patient on tailored risk and benefits to treatment options using different formats (e.g., graphical)
	Provider knowledge of detailed benefits of each option	
	Patient understanding of impact to personal risk	
Patient values/preferences	Provider perception of role with patient (e.g., providing guidance versus engaging in discussion)	HIT applications to capture and record preferences for later viewing by patient and/or provider
	Provider perception of patient's interest in shared discussion	
	Provider sense of self-efficacy to prompt patient to make decisions	
	Time to allow patient to think through options and select more than one	
	Patient comfort in telling provider what he/she really wants to do, including doing nothing	
Discuss patient ability/self-efficacy	Provider ability to present options with the greatest impact merged with what patient feels he/she can do	HIT applications to prompt patient to think about incorporating options and to capture and record patient responses for later viewing by patient and/or provider
	Time to allow patient to think through options and impact on lifestyle	
	Patient's desire to please provider versus doing what they think they can/want to do	
Doctor knowledge/recommendations	Provider familiarity with and knowledge of all guidelines	HIT application to present clinical decision support (CDS) tailored to patient that includes data from disparate sources, if applicable.
	Guidelines not actionable	
	Provider ability to incorporate current treatments and patient preferences into guidelines	
	Integrating presentation of guidelines and patient preferences into workflow	EHR alert to provider during appropriate moment in workflow
Check/clarify understanding	Provider sense of self-efficacy or uncertainty in answering patient questions	HIT application to provide easily interpretable information on various aspects of treatment options (e.g., through hyperlinks embedded into CDS)
Make or explicitly defer decision	Time to create detailed progress note of decision or deferment of decision	Automate progress note creation via CDS application
Arrange follow-up	Time to arrange follow up encounter at appropriate visit level	Link to scheduling system for scheduling and tracking follow up

early for their clinic visit. An RA greeted the patient after check in and guided them to a reserved room with a touchscreen computer. The patient check in process triggered a rooming procedure designed to maximize patient flow. We made an a priori

decision that completion of the HHQ and PBCT could not interrupt the clinic flow; as a result, there were patients who were unable to complete the HHQ prior to being roomed. The time required to complete the process is an important limitation. We

Workflow change	Increase quality ^a of care	Improved patient satisfaction	Efficiency					
			Decrease visit length		Increase level of visit		Shift work to lower level staff	
			Yes	No	Yes	No	Yes	No
Integrates with current flows	Yes	Yes						
		No						
	No	Yes						
		No						
Minor Disruption	Yes	Yes						
		No						
	No	Yes						
		No						
Major Disruption	Yes	Yes						
		No						
	No	Yes						
		No						

^a Defined as improvements in process, outcomes, safety, adherence to guidelines, etc.

Decision Key:

	Will not be adopted
	Adoption unlikely but possible
	Will likely be adopted and sustained

Fig 4 | Likelihood that an innovation will be adopted in primary care

considered three approaches to reducing the time requirements: reducing the length/complexity of the HHQ, modifying the workflow, and modifying the PBCT. Almost all of the HHQ questions are required to quantify risk. As such, we could only make minor changes to the HHQ. We have begun to pilot an alternative clinic workflow that involves installation of the touchscreen computers in every exam room. After the nurse checks vitals and completes the rooming protocol (i.e., reason for visit, smoking status, medication reconciliation, etc.) she/he clicks an alert that activates the questionnaire on the touchscreen. The patient has time to complete the questionnaire and PBCT before the physician arrives. This modification to the workflow both simplifies the authentication process and reduces the time required for the HHQ by an average of 1.4 min. In addition, we now recognize that the time required to complete the PBCT can be substantially reduced. In our current iteration of this tool, we are consolidating the presentation of risk information and the selection of preferences into a single, more user-friendly screen. We expect that this modification will reduce the time demand by an average of 3 min or more.

Patients were willing and able to engage in SDM and were largely positive about the experience. This may suggest that notions of passive or active patient status may not be as relevant as designing processes that make it easy for patients to be in control. We found that patients frequently expressed treatment preferences that differed from guideline recommendations; although medication was typically the intervention that would yield the greatest reduction in risk, the majority of patients preferred dietary and

other lifestyle changes to reduce their risk. This highlights the importance of the SDM process itself; SDM should ideally allow the provider to design a “preference-sensitive” [13] treatment approach that reflects activities that patients want and are likely to do. Where the gap between patient’s preferences (e.g., where the patient indicates they do not want to do anything) and the evidence is significant, the provider has the opportunity to educate the patient. For example, knowing that a patient did not want to take medications would allow the provider to either spend time addressing the concern underlying the patient’s choice or if the patient is unlikely to change, guide the patient to appropriate resources (e.g., a nurse educator, dietitian, etc.) to ensure their success in the treatment options for which the patient has indicated a preference. We did not determine if patients engaged in behaviors consistent with their chosen preferences versus the physician’s recommendation and we did not evaluate other outcomes (e.g., blood pressure, LDL, etc.). We also did not evaluate the degree to which information sharing actually took place between the provider and patient beyond whether the CDS was accessed (in practice, information sharing could take place with or without the alert). We view the evaluation of these outcomes as important only when the SDM process itself has been fully optimized for clinical practice workflow and satisfies the needs of patients and providers. To do otherwise, wastes limited resources on the assessment of an intervention that is not suitable for clinical practice.

The proportion of patients selecting a specific treatment category did not differ by age, sex, education, or relative risk level. This is a surprise,

particularly because it seems reasonable to assume that patients at higher risk might be more willing to consider treatment options that reduce risk more quickly and to a greater degree (e.g., medication vs. dietary counseling for elevated LDL). One explanation may be that our sample size was too small to detect a difference. However, it is also possible that unmeasured factors such as a patient's level of activation or their perceived level of risk, which may impact a patient's behavioral choices [14], are more important determinants of choice than age, education, or mFRS-derived risk.

The most important gap in the design of the SDM protocol and the translation process was our failure to engage the provider. When studying new processes or tools in primary care, incentives (e.g., compensating physicians for time spent on study processes) are often used to motivate adoption by providers. An incentive strategy would have been sensible if our primary interest was to study the impact of patient preferences and expert advice on clinical decision making, in which case artificially maximizing adoption to study this impact would be of critical concern. However, our primary interest in this project was to determine if an SDM protocol worked in practice for both the patient and provider. In our case, use of an incentive would have obscured an unbiased assessment of whether the physicians valued the SDM tool. Provider adoption is a critical measure of success; however, providers only accessed the CDS tool in approximately 20% of eligible visits. We attribute this poor uptake to at least two issues. First, we used an EHR alert as the method by which to engage providers in the SDM process. Alerts are used extensively as a way to both notify and prompt providers, and this may lead to "alert fatigue" when alerts have little relevance to the clinical encounter [15–17]. This, in turn, can lead to alerts being ignored except in cases of "hard stop" alerts that require the provider to take a specific and immediate action. Second, although the information presented in the CDS tool was clinically accurate, tailored, and relevant, the tool itself did little to augment the provider's workflow. A CDS tool that helps the provider complete an office visit more quickly, to deliver higher quality care through actionable evidence, or to facilitate a higher level visit is likely to have better uptake. This can be accomplished by, for example, allowing the provider to automatically create an order based on the best-practice recommendations in the CDS tool or to automatically assemble a progress note based on the content of the CDS and related orders. The current design requires the provider to switch between the EHR and the CDS tool; as noted previously, alterations to the workflow without compensatory efficiencies is a deterrent to adoption. We are conducting qualitative interviews with participating physicians to better understand how to design and integrate CDS into the clinic workflow.

Our results demonstrate that SDM can be translated to routine care and that the process is well received by patients. A critical next step is the development of SDM tools that integrate better with clinical workflows and address efficiency-related outcomes that maximize the likelihood of provider adoption.

Acknowledgments: The authors would like to acknowledge AstraZeneca for funding provided for this project. The authors would also like to acknowledge editorial assistance provided by Ilene Ladd, project coordinator.

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