Diabetes Prevention, Health Information Technology, and Meaningful Use
Challenges and Opportunities

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Abstract: The U.S. health system has historically been poorly equipped to confront the growing impact of diabetes on the nation's health. The Affordable Care Act legislates a number of new strategies—such as innovative payment and delivery models and increased public health funding—intended to improve diabetes prevention and care quality. Health information technology (IT) is often cited as a critical part of these strategies. Through the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009, the federal government has been supporting the rapid adoption of health IT, and more specifically of electronic health records (EHRs) through the Centers for Medicare and Medicaid Services (CMS) EHR Incentive Program. Health IT has the potential to contribute to diabetes prevention and improved quality of care, but the evidence supporting its benefits is mixed. This article provides a brief overview of the CMS EHR Incentive Program and meaningful-use criteria. Then it examines health IT strategies for diabetes prevention in the context of current evidence and identifies areas of needed research and innovation.
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Introduction

The impact of diabetes on the nation's health, healthcare system, and economy is staggering. Approximately 25.8 million— 8.3% of the population—are afflicted with diabetes, leading to an estimated financial cost in 2007 of $174 billion, one third of which was attributable to indirect costs, such as disability, work loss, and premature mortality.[1] An estimated one third of the U.S. population has prediabetes—a condition that frequently leads to diabetes over 10 years—whereas less than 10% of those people report being told of their prediabetes diagnosis.[1] Moreover, the overall quality of preventive care for diabetics remains suboptimal, with ample room for improvement.[1]

The current health system has been poorly equipped to confront the growing public health crisis of diabetes. The Patient Protection and Affordable Care Act (ACA) contains a number of provisions that generally aim to improve care quality and health and also specifically target diabetes and its complications.[2] The implementation of high-functioning electronic health records (EHRs) and their myriad functions is central to a number of the new models of care supported by the ACA, including primary care medical homes (PCMHs) and accountable care organizations (ACOs).[3–5] Relevant functions include care coordination across multiple providers and settings, the use of clinical decision-support and population health management tools, and the promotion of patient-centered care through engagement. Yet, the evidence supporting the ability of EHRs to improve outcomes, reduce cost, and increase safety remains mixed.[6–19] In addition to EHRs, other growing health IT strategies in the setting of healthcare delivery innovation include the use of social networking tools, mobile applications, telemonitoring devices, and the Internet.

Although the meaningful use of health IT has the potential to contribute to the prevention of the development of diabetes and the reduction of its complications through multiple mechanisms across various settings of care, current evidence supporting its ability to achieve these aims is limited. This article provides a brief overview of the EHR incentive program and meaningful-use criteria. Then it examines specific health IT strategies to improve diabetes prevention and care in light of the available evidence.

Health Information Technology for Economic and Clinical Health and Meaningful Use

The Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 sought to

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modernize the electronic infrastructure of the U.S. healthcare system through a series of federal programs and an EHR incentive program. The assumptions underpinning the passage of this law included the idea that health IT can increase efficiency, reduce costs, and improve quality of care.[20] The law allocated up to $30 billion for the development of federal programs and policies to promote health IT and EHR adoption, including the creation of a $19-billion EHR incentive program for providers.[21,22]

The Centers for Medicare and Medicaid Services (CMS), with input from the Office of the National Coordinator for Health IT (ONC), administers the EHR incentive program, which specifies meaningful-use criteria that adopted EHR systems must meet to qualify for financial payments. In the 3 decades prior to the EHR incentive program, the capabilities of adopted EHRs varied substantially. Although some health systems and vendors created integrated EHRs focused on quality improvement, many of the systems—with objectives focused on optimizing billing—simply automated paper records without adequate discrete data capture and real quality-improvement capabilities. By defining specific meaningful-use requirements, the federal government aims to incentivize providers to implement systems that can achieve the potential benefits of better, more-efficient care, and increase patient engagement.

There are three planned stages for the EHR incentive program, with each subsequent stage building on the previous one. The final rules for Stages 1 and 2 were published in July 2010 and September 2012, respectively, whereas the Stage-3 rule will likely be released in early 2014.[23] The overarching goal of the Meaningful-Use Stage-1 rule is to create the baseline for electronic data capture and sharing necessary to achieve the five following health outcome policy priorities: (1) improve quality, safety, efficiency, and reduce health disparities; (2) engage patients and families in their health care; (3) improve care coordination; (4) ensure adequate security protections are in place for personal health information; and (5) improve population and public health.[24,25]

Stage 2 requires providers to start using EHRs for continuous quality improvement at the point of care, to demonstrate the ability to share electronic data, and to use health IT to engage patients in the care.[23] In the Stage-2 rule, CMS administrators state that Stage 3 will likely focus on "promoting improvements in quality, safety and efficiency leading to improved health outcomes; focusing on decision support for national high priority conditions; patient access to self-management tools; access to comprehensive patient data through robust, secure, patient-centered health information exchange; and improving population health."[23]

Thus, the EHR incentive program audaciously strives to stimulate the rapid adoption of health IT across an industry historically difficult to change, and to do so in a way that improves outcomes, enables information exchange, and engages patients and their families. Reducing the impact of diabetes on our nation's health requires innovative solutions, and the use of health IT in a meaningful way has the potential to do so; however, data that support the ability of health IT to improve health are limited.

Do Electronic Health Records Improve Diabetes Care Quality?

Similar to the evidence on the impact of EHRs to improve ambulatory care quality more broadly,[6,7] the data on whether EHR adoption leads to better diabetes care quality are mixed. Two recent studies that directly compared practices using EHRs with those using paper-based charts found disparate results. Cebul et al.[26] found in their sample of 46 practices a significant improvement in overall care quality and in improvement rates for practices using EHRs versus those using paper-based charts. However, Crosson and colleagues[27] compared 16 practices with EHRs to 26 practices with paper-based charts and found that practices using EHRs had worse scores on intermediate outcome measures (hemoglobin A1c, low-density lipoprotein [LDL], blood pressure) and similar overall rates of improvement over a 3-year period.

A limitation to these studies—a potential explanation for the equivocal results—is that they aggregate practices using EHRs without differentiating between those with and without high-functioning EHRs systems. The functionalities and usability of different EHR systems vary substantially, and these abilities may affect the ability of EHRs to influence care quality. An observational study of the impact of EHRs on diabetes care quality at Kaiser Permanente in Northern California—an integrated delivery system commonly cited as an advanced health IT user—found improved glycemic and cholesterol control associated with EHR adoption.[28] In addition to improving the design and capabilities of EHRs, more work understanding how to integrate EHRs seamlessly into clinical workflow and to better train and support providers during implementation is needed to realize potential quality improvements from EHR adoption.[29,30]

Health Information Technology Strategies to Improve Diabetes Care and Prevention

Although the use of technology alone does not appear to improve care quality, some diabetes-specific strategies leveraging the various forms of health IT show promise. Many studies have examined health IT strategies to

improve diabetes care and prevention, and overall the evidence on the effectiveness of these strategies is mixed. Barriers to success and innovative uses of health IT need to be better understood. The following sections review specific health IT strategies designed to improve care quality and health.

Use Diabetes-Specific Clinical Decision Support

Using clinical decision-support tools to support guideline adherence constitutes one potential benefit of EHRs. Optimal care for patients with diabetes involves following a number of care recommendations, such as blood pressure, cholesterol, and hemoglobin A1c control, annual eye and foot screenings, smoking-cessation counseling, and healthy-lifestyle education. The literature suggests that diabetes-specific decision support can lead to modest, though variable, improvements in care quality, and many of the studies vary substantially in quality of study design.[31,32]

For example, Meigs et al.[33] found that a web-based diabetes management tool, consisting of organized patient data and specific recommendations available during the patient encounter, led to higher proportions of patients undergoing annual foot exams, cholesterol testing, and hemoglobin A1c testing but did not detect differences in cholesterol and glycemic control between the intervention and control groups. Montori and colleagues[34] found that clinics using an electronic diabetes management program improved on process measures, such as foot and retinal exams, microalbuminuria measurement, and self-management support, but there was no significant difference in glycemic, blood pressure, and LDL control.

A more recent RCT by O'Connor et al.[35] involving 11 clinics examined the impact of clinical decision support for providers treating patients with suboptimal glycemic, blood pressure, or cholesterol control. They found that decision support improved glycemic and systolic blood pressure control, slightly improved diastolic blood pressure control, and did not affect cholesterol control. Further, 94% of users were either satisfied or very satisfied with the decision-support tool.[35]

Another RCT[36] employed a shared patient–provider, web-based diabetes tracker of 13 risk factors that also included clinical decision support and reminders and found improvements in process measures, some clinical markers, and patient satisfaction. Thus, some evidence supports the ability of decision support to improve care quality for some process and intermediate outcome measures, although these improvements are small and their impact on outcomes remains uncertain. The continued evolution of EHRs and decision support may potentiate these effects, and more research exploring the decision-support best practices for diabetic care is needed.

Engage Patients in Using Health Information Technology

Some evidence suggests that increasing patient knowledge and engagement can lead to better outcomes and increased satisfaction.[19,37] Health IT has the potential to achieve both of these aims through a variety of mechanisms. Patients can use the Internet to access online patient education, online communities, and social networking tools focused on healthier living. The rapid adoption of smartphones has led to the creation of an entire market of mobile applications dedicated to improving health and wellness. Through the CMS EHR Incentive Programs and other policies created by the ONC to set privacy, security, and interoperability standards, these applications can serve as a direct link to a patient's care team and embed information into his or her EHR, such as glycemic control, weight changes, and dietary and exercise habits.

Providers can also facilitate improved health through directly engaging patients via patient portals, personal health records (PHRs), or third-party systems. Examples of specific strategies include (1) filling out a questionnaire on diet and exercise prior to a visit, to be reviewed during the visit; (2) sending reminders to patients via secure e-mail or text on healthy behaviors or upcoming, preventive visits; (3) uploading glycemic data from patient glucometers for regimen titration; and (4) enabling online medication refill and scheduling.

However, data supporting the benefit of these health IT strategies are limited. Although a number of studies on the use of mobile phones to improve diabetes care show a small benefit, these are often small, low-quality studies over short intervals.[38] A review of mobile diabetes applications found that a substantial proportion of applications lacked personalized patient education and links to social media, two features thought to be potentially of the highest benefit to patients.[39]

Evidence supporting PHR adoption is also scant. Grant et al.[40] explored the use of personal health records linked to practice-based EHRs for type 2 diabetics. The PHR imported patient information from the EHR and then enabled patients, with patient-specific clinical decision support, to create a diabetes care plan to be reviewed at their upcoming clinic visit. Although the study[40] was limited by low online PHR patient registration and good baseline risk factor control, it found no difference in risk factor control between the intervention and control groups. Moreover, Google's decision in Summer 2011 to close down its PHR product, Google Health, underscores the challenges in increasing PHR usage.

Some studies suggest that health IT strategies to increase patient education and engagement may be beneficial. For example, a 2004 review article[41] of health IT in diabetes care found improvements in glycemic and LDL control for patients using online education tools. A small study[42] examined the use of WellDoc™, a dedicated diabetes management tool that provides real-time feedback to patients via cell phones and embeds patient-reported data and treatment recommendations into the patient's EHR. The study found improvements in glycemic control and in patient and provider satisfaction levels. A review[43] by the Agency for Healthcare Research and Quality found that studies examining interactive health IT use by elderly, chronically ill, and underserved populations tended toward positive effects of patient satisfaction and outcomes, although a number of barriers to successful use were also identified.

Patient engagement has become a national priority, as noted in the National Quality Strategy.[44] Health IT can engage patients in myriad ways, but the evidence supporting the widespread adoption remains limited. A better understanding of how to best engage patients in using health IT is needed before the widespread adoption of these strategies.

Focus on Health and Wellness for All Patients

For type 2 diabetes, genetic factors and environmental factors each make up half of an individual's risk.[45] The major environmental risk factors include obesity, which is the leading factor, as well as sedentary lifestyle and poor nutrition.[45] More than one third of U.S. adults, and approximately 17% of children and adolescents, are obese.[46] In light of the high prevalence of obesity and diabetes, it has become increasingly important to focus on health and wellness for everyone prior to the development of chronic diseases. The meaningful use of health IT can support health and wellness programs in multiple ways.

As noted above, health IT can be used to engage patients in their health through various mechanisms, including mobile applications, patient education modules, text messaging, and online communities and social networking, although the evidence supporting these strategies is limited. EHRs can be used to manage population health. For example, the meaningful-use criteria require the capture of BMI as structured data, which would enable the creation of a list of obese patients who may benefit from targeted interventions. The benefits of population-management analytics remain unproven, and more research on the benefits and drawbacks of EHR population management tools is needed.

Target Prediabetics with Evidence-Based Interventions

Meaningful users of EHRs potentially have the ability to deliver targeted interventions to prediabetics. The Diabetes Prevention Program (DPP), a large RCT, shows that an intensive lifestyle modification program with the goals of 7% weight loss and at least 150 minutes of physical activity per week compared with usual care and with metformin decreases the incidence of diabetes.[47,48] In medicine, evidence-based interventions can take decades to diffuse into practice, as in the case of beta-blocker use after heart attacks.[49,50]

One of the most pressing health services research questions is: how do we accelerate widespread diffusion of evidence-based practices? Health IT has the potential to accelerate diffusion, especially if multiple medical groups use the same, web-based clinical algorithms. More specifically, for diabetes prevention, creative ways are needed to operationalize DPP and other evidenced-based practices; health IT constitutes one potential strategy.

For example, the patient registry feature of an EHR could enable the identification of prediabetic patients. Decision-support tools could be developed to generate referrals to lifestyle intervention programs. Patient progress could be tracked using weight-monitoring tools remotely connected to the PCMH. To further incentivize providers to target these high-risk patients, payers could develop quality measures evaluating either process measures, such as referral rates to lifestyle intervention programs for prediabetics, or outcomes measures, such as percentage of prediabetics who achieve target weight loss or the percentage that progress to diabetes. Linking financial payment to these measures may further focus provider attention on preventing diabetes in this high-risk population. Although there is no current evidence supporting the use of health IT for targeting prediabetics or using financial incentives to improve this type of preventive care, as the usage of health IT evolves over time, this type of strategy may become a viable option if supported by the evidence.

Optimize Care of Diabetics Across Multiple Settings to Prevent Complications

For patients with diabetes, health IT can improve the quality of care across multiple settings. It can potentially facilitate transitions of care among various settings, such as specialist offices, hospitals, and rehabilitation facilities. EHRs could be used to communicate relevant information clinically, ensuring that providers have the necessary information to deliver high-quality care.

As discussed above, health IT can be used to increase patient engagement at home. The meaningful use of EHRs also requires providing patients with electronic access to records, which empowers them to take a leadership role in

their own health. Thus, for patients with diabetes, EHRs can be employed in multiple ways to prevent complications of their disease and optimize their health and wellness. However, these potential gains of interoperability and home EHR access have yet to be realized, and more work identifying how to develop an interface of information among multiple settings is needed.

Leverage Electronic Quality Measures to Drive Quality Improvement

To meet Stage-1 and Stage-2 meaningful-use criteria, providers will have to calculate and report electronically a number of quality measures, many of which pertain to diabetes care and prevention. Examples include glycemic, blood pressure, and cholesterol control; annual foot and eye exams; and weight screening and follow-up.[23,25] These measures could be linked to decision support for quality improvement, which, as discussed above, has the potential to improve quality of care. Third parties, such as public health agencies and payers, could use the reported data to design population-based interventions. However, the ability to leverage electronic quality measures will be limited by the validity and reliability of the measures given the inability of many EHR systems to consistently capture the required structured data elements and calculate accurate quality measures.[51–53] Moreover, the limited capabilities of public health department information systems may hinder their ability to effectively use EHR-reported data.[54]

Discussion

Since the start of the meaningful-use program in 2009, EHR adoption continues to rise. The percentage of office-based practices with EHRs increased from 48.3% in 2009 to 55% in 2011, and in the latter year, 75% of physicians with EHRs stated that their system meets meaningful-use criteria. Moreover, in 2011, of the 45% of physicians without an EHR, one half reported either having already purchased a system or planning to purchase one within the next year.[55,56] In addition to EHR adoption, there has been a concomitant growth in other areas of health IT, such as mobile health and telemonitoring. Although the evidence supporting the ability of health IT to lead to better health, better care, and lower costs remains mixed, the publication of results from advanced and innovative health IT users may elucidate how the best leverage health IT to improve health, engage patients, and reduce costs.

For example, the Beacon Communities make up a group of healthcare providers across the U.S., supported via federal funding, who are exploring how the meaningful use of health IT can improve outcomes and efficiency.[21] A smoking-cessation program using mobile texting demonstrated benefits in the United Kingdom,[57]

and a similar program using texting to increase diabetes risk awareness is under way in some Beacon communities.[58] Since the inception of the program, the Beacon communities have been evaluating the impact of their health IT strategies,[59] and it is hoped these communities will eventually publish high-quality studies informing best practices for health IT. In addition to the Beacons, there are a number of other health systems, insurance companies, and companies using health IT in innovative ways yet to be fully described in the literature.

The question, as Bitton et al.[4] note, is no longer whether to adopt health IT, but rather how it can best be used.[4] The following strategies would facilitate better understanding of how to use health IT to prevent diabetes and its complications:

1. Invest in EHR design and implementation research: Poor usability and lack of integration into workflow constitute two major impediments to the meaningful use of health IT. Redesigning systems to optimize structured data capture without obstructing workflow is essential to attain the potential benefits of EHR adoption. Moreover, more research on how to better implement new systems and upgrade low-functioning systems is needed to achieve meaningful use.

2. Develop standards to collect patient-reported information and integrate it into EHRs: As care moves away from traditional office-based care to an "automated hovering" approach involving home biometric monitoring, medication adherence interventions, and multidisciplinary home care teams,[60] robust health IT infrastructure is needed. Mobile health, telemonitoring technologies, and delivery models continue to evolve, and seamless integration of the generated data into EHRs would facilitate two-way communication between patients and providers. Given the diversity of products in the EHR market, regulated vocabulary and standards are needed for the incorporation of patient-generated data into EHRs.

3. Develop the next generation of electronic quality measures and clinical decision-support tools: The meaningful use of EHRs enables the shift from traditional quality measures based on chart review and claims data to automatically calculated measures based on electronic health data. Federal programs, such as the EHR incentive program, Physician Quality Reporting System (PQRS), and ACOs, already allow for the reporting of electronic quality measures. Valid and reliable electronic quality measures, coupled with decision support, could be used by providers for quality improvement and by payers to drive providers toward interventions targeting diabetes prevention. These quality measures can identify outliers and then

inform the provider about the patients who need further engagement.

4. **Research the impact of social networking tools on diabetes prevention:** Over the past several years, social networking has emerged as a means for patients to connect with others with similar health problems and share strategies to improve their health. Peer mentoring appears to be an effective mechanism to improve glycemic control, as shown by a recent study using a phone-based, peer-mentoring intervention,[61] but health IT social-networking tools remain unproven. In light of the explosion of social-networking tools and the growing emphasis on patient engagement, a better understanding of how to use these tools to prevent diabetes is needed.

5. **Identify and disseminate hotspots of innovations in diabetic management through the use of health IT in transforming delivery of care:** Various health IT strategies targeting diabetes prevention continue to be adopted across the U.S. In addition to providers in traditional office-based settings, employers, insurance companies, start-ups, and interdisciplinary home care teams are adopting and developing innovative health IT strategies. Rapid-cycle evaluation of advanced health IT users and promising new technologies, coupled with effective dissemination strategies, are needed to ensure the adoption of evidence-based strategies.

6. **Determine health IT best practices to reduce disparities:** Reducing health disparities constitutes one of the goals of the CMS EHR Incentive Programs. Significant gaps exist in current understanding of health IT strategies to improve diabetes outcomes in minority communities.[62] The development and rigorous testing of culturally tailored interventions to prevent diabetes in minority and underserved populations is needed to achieve the vision of disparities reduction articulated in the meaningful-use regulations.

Conclusion

A number of health IT strategies to prevent diabetes and its complications are currently being used, although the evidence supporting many of these is mixed. The capabilities of health IT continue to evolve, especially with growing interest from payers, large employers, and private companies in this area. The meaningful use of health IT has the potential to contribute to the fight against the growing diabetes crisis, but the realization of that potential will require more innovation and research.

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