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Outpatient diabetes clinical decision support: current status and future directions

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Abstract

Outpatient clinical decision support systems have had an inconsistent impact on key aspects of diabetes care. A principal barrier to success has been low use rates in many settings. Here, we identify key aspects of clinical decision support system design, content and implementation that are related to sustained high use rates and positive impacts on glucose, blood pressure and lipid management. Current diabetes clinical decision support systems may be improved by prioritizing care recommendations, improving communication of treatment-relevant information to patients, using such systems for care coordination and case management and integrating patient-reported information and data from remote devices into clinical decision algorithms and interfaces.

Introduction

Clinical decision support (CDS) may be defined as the provision of person-specific information, intelligently filtered, prioritized and presented at the right time to clinicians, patients, staff and others to enhance health and health care [1]. Outpatient diabetes CDS systems have been operative since 1983 [2], but meta-analyses indicate that although outpatient diabetes CDS systems often improve test ordering and preventive services, their impact on key diabetes care outcomes such as the control of glucose, blood pressure, tobacco use or appropriate aspirin use has generally been marginal or inconsistent [3–5]. To improve the impact of diabetes-related CDS systems on key diabetes care outcomes, we review available data and describe our own experience with CDS in order to identify important opportunities to: (1) strengthen the design of outpatient diabetes-related CDS systems and (2) improve implementation and sustained use of such systems in busy outpatient practice settings [6–21].

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Competing interests

None.

Current opportunities for diabetes care improvement

There has been major improvement in diabetes care, especially in well-resourced care delivery systems, in recent years. In the United States, recent national data indicate that the proportion of patients who have simultaneously achieved adequate levels of glucose, blood pressure, lipid and tobacco control and appropriate aspirin use has risen from ~ 5% in 2002 to ~ 25% nationally [22]. In leading care delivery systems, this figure has reached 50% and has the potential to reach a ceiling of ~ 65% under ideal conditions. As care has improved, there have been dramatic decreases in the rates of heart attacks, strokes and end-stage diabetes complications due in large part to improved outpatient diabetes care. Dramatic reductions in mortality rates are likely related to improvements in both outpatient and inpatient care [23–26]. Although primary care providers (PCPs), who provide over 80% of care to patients with diabetes in the United States, should be proud of what has been accomplished, it is clear that there is a great deal of room for further improvement.

Many strategies have been shown in various studies to improve diabetes care, and there is evidence that multiple intervention strategies improve diabetes care more than single intervention strategies [27,28]. Outpatient diabetes CDS systems are generally compatible with and may often be integrated with other concurrent diabetes care improvement strategies such as pre-visit coaching of patients [29], opinion leader and other personalized educational interventions [30–32], case management [33,34], use of social media [35], or new and more effective approaches to provider and diabetes patient education [36–38].

Impact of CDS on diabetes care outcomes

The widespread use of electronic health record (EHR) systems in outpatient care has increased hopes that CDS would improve key patient outcomes of those with diabetes and related clinical conditions [39]. Despite slow progress, there is now a sufficient body of evidence from controlled studies of both failed and successful diabetes CDS systems to inform ongoing efforts to improve the design and implementation of outpatient diabetes-related CDS systems (Fig. 1). What evidence is available to assess the impact of diabetes-related CDS on processes and outcomes of diabetes care?

CDS implementation

Rationale and goals for introducing CDS—If a strong case and convincing value proposition for use of CDS cannot be made at the level of the medical group or care delivery system, then it is unlikely that the resources or leadership needed to implement and sustain the use of such CDS systems will be available. Fortunately, at the current time in the United States, there are many potential benefits to medical groups and care systems for introducing CDS. These include the need to improve diabetes quality of care, the desire to perform well on population-based publicly reported quality measures, the desire to maximize payer reimbursements that are linked to quality of care and fulfilling requirements for meaningful use of EHR systems. In addition, market advantages may accrue to delivery systems that can demonstrate high-quality diabetes care and positive patient experience of care.

Role of leadership—If medical group or health system leaders are not fully supportive of CDS implementation and use, long-term success of this endeavour is unlikely. By contrast, strong leadership support and/or the presence of a local champion augers well for successful CDS implementation and use [4].

Workflow integration—Smooth integration of the CDS system with existing clinic and other workflows is absolutely critical to the successful implementation and sustained high use of CDS systems. Workflow integration must be considered both at the clinic and medical group level, and involves tailoring the way the CDS is triggered, displayed and used in various clinical venues or by various team members to achieve CDS goals [16].

Factors that contribute to high CDS use rates—Many diabetes CDS systems have failed or had only marginal benefit primarily because the CDS was never used regularly and on a sustained basis by PCPs. Low CDS use rates have been convincingly linked in meta-analyses to these factors: clumsy design of the CDS itself, problems with the timing of the CDS deployment during the clinical encounter, provider distrust or disagreement with care recommendations, lack of integration with existing clinic workflows or inadequate initial training [5,10].

Targeting patients and the triggering process—One strategy to increase the acceptability of CDS is to only prompt its use in patients with the greatest potential benefit. Some CDS systems target only a subset of patients with diabetes. For example, at a given point in time, 30%–50% of patients with diabetes have simultaneously achieved adequate glucose, lipid, blood pressure, tobacco and aspirin use. Those who have not achieved all these optimal care goals can be automatically targeted to receive CDS at clinical encounters of various types. Targeting high-risk patients reduces the CDS workload for most providers; PCPs are more likely to use CDS that fires three or four times a day for high-risk patients than at every visit for many patients at low risk.

CDS prompts—Garg *et al.* [4], in a review of > 100 randomized studies, notes that systems that automatically prompted users were significantly more likely to be successful than those that required users to activate the system (73% vs. 47%, $P = 0.02$). In addition, busy physicians may misjudge a patient's risk status or have no time to display or print CDS. The best team member to respond to a prompt for CDS may be the office nurse or medical assistant.

CDS design

Minimize clicks to save time—Most EHRs without linked CDS provide an opportunity for providers to collect information related to risk of complications, but the process is inefficient and providers are still required to synthesize the information. Koopman *et al.* have documented in a time–motion study that using EHR algorithms to quantify risk can save a mean of 4.2 min and 57 EHR 'clicks' per encounter, while increasing accuracy of the obtained information [7]. Diabetes CDS can be triggered and displayed in as few as two clicks by an office nurse [40].

Avoid double data entry—Some CDS strategies may require providers to leave the EHR interface, enter clinical data, receive CDS results from a separate website, and then re-enter the EHR in order to save results. CDS strategies that are not integrated with EHRs or that require 'double entry' of data are generally inefficient and unlikely to be used consistently by more than a very small percentage of providers [41].

Implementation considerations such as training, monitoring CDS use rates, soliciting feedback and incentives—Providing adequate training in CDS use, repeating the training at intervals and for new team members, including efficient mechanisms for providers to give feedback on any observed CDS inaccuracies or to suggest process improvements, and monitoring CDS use rates and providing automatically generated 'use reports' to leaders and providers can yield use rates as high as 60%–80% at targeted encounters over long periods. Positive or negative financial incentives may also play a role in sustaining use rates [42]. One might argue that the effectiveness of many diabetes CDS systems has never been adequately tested because the inadequate CDS system design and/or ineffective implementation have often prevented consistent, sustained use. Nonetheless, it is clear that CDS systems that are not regularly used are indeed failures. It is incumbent on developers to incorporate design features that have been shown to increase sustained use of a CDS system.

CDS content

Clinical content—Adequate diabetes care requires attention to management of blood pressure, lipids, smoking, glucose, aspirin and weight; screening for eye, foot, renal and vascular complications; and immunizations. In addition to these 11 basic domains of diabetes care, most patients also have one or more other comorbid conditions, and adults with diabetes take a mean of eight medications. Thus, many clinical issues need to be addressed – and all in an outpatient visit that may last 20 min or less [43–45]. An additional wrinkle is that clinical guidelines often change, and goals of care need to be systematically updated and individualized. This scenario dictates certain issues related to the design of diabetes CDS systems. Evidence-based algorithms must be transparent in their development, address the 11 main domains of diabetes care, identify specific domains that are not at goal and suggest evidence-based clinical actions for each such domain. Providing specific evidence-based treatment options for such domains can save a great deal of time, encourage timely active management of various domains of care, and may reduce the likelihood of unhelpful or risky prescribing events [7].

The prioritization problem—One main advantage of a diabetes CDS system is its ability to direct provider and patient attention to the subset of clinical domains that are out of control and that, if addressed, will confer maximum benefit to a particular patient [12,20]. In primary care, the frequency of visits (patients with diabetes average between six and eight primary care visits a year) compensates in some ways for the brevity of the visit. Based on our experience as PCPs, we posit that directing attention to a short list of highly beneficial clinical domains that may be addressed at a visit (followed by re-evaluation of top priorities at each subsequent visit) is preferable to an 'encyclopaedic' approach that attempts to cover

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all the 600+ evidence-based care recommendations that are relevant to at least some patients with diabetes [46].

But identifying domains of concern and suggesting clinical actions may not be enough. Each evidence-based clinical action has a quantifiable potential benefit to a given patient, dependent on distance from goal, current intensity of treatment, medication allergies, adherence to medications, age, comorbid conditions and other factors. Each potential clinical action may be prioritized based on potential benefit to the patient, and the CDS system can bring the issues of greatest concern (and greatest potential benefit) to the attention of the provider and patient at the time of an encounter [47,48]. This type of prioritized CDS can be helpful for visit planning if it is deployed early in the visit so that these issues may be integrated with the patient's concerns of the day to plan a productive and satisfying encounter between a prepared PCP and an informed patient [49,50].

Should CDS be directed to providers, patients or both?—Meta-analyses suggest that providing CDS recommendations to both patients and providers is more effective than providing CDS to providers only [5,51,52]. Providing CDS to patients is congruent with the current emphasis on patient-centred care and shared decision-making [18]. From a practical point of view, giving CDS recommendations to patients presents many practical challenges, and evidence is slowly developing on the best way to present information on the risk and benefits of alternative treatment strategies to patients with varying degrees of numeracy and health literacy [53,54].

Diabetes care is a team effort, and many providers may be involved, including various types of physicians or nurse practitioners, pharmacists, case managers, dentists and others. Sophisticated CDS systems can be used in many care venues beyond traditional office visits and can be triggered and used by any member of the healthcare team including, in some applications, the patient [17].

CDS algorithms, which are typically web-based but EHR-linked, have the ability to provide care that is simultaneously standardized (by reliance on evidence-based algorithms) but highly personalized (because recommendations are tailored to a given patient's clinical state). Moreover, the CDS recommendations evolve over time as the patient's clinical state changes, providing in essence a dynamic, standardized yet personalized care plan that can be easily accessed by any health team member at any point in time [20].

Future directions in diabetes-related CDS

Developing more effective provider and patient interfaces

In Figs 2 and 3, we show examples of a provider interface and two alternative patient interfaces. The provider interfaces provide estimates of absolute risk reduction (for cardiovascular events) related to potential clinical action in six domains (e.g. blood pressure, lipids, glucose, smoking and BMI). Such provider interfaces have been in use for over 6 years and are well understood and well used by PCPs, although further evolution of these tools is clearly needed [55,56]. Patient interfaces are even more challenging because of wide variation in health literacy and numeracy related to culture, education, language and other

factors [20]. We anticipate that tools to communicate evidence-based CDS treatment options to patients need much more development and will need to be tailored to the preferences and needs of various patient subgroups. The patient interfaces shown in Fig. 3 are designed for low-literacy and low-numeracy patients, and some providers give the provider interface to selected patients [57]. A reasonable option may be to display CDS in various formats to meet the needs of a broad spectrum of patients and providers with very different learning styles and literacy [58,59].

Moving from disease-centred to patient-centred CDS

At many primary care encounters, diabetes is only one of many chronic or acute problems that need to be addressed. In the primary care world, it will not be feasible to have a CDS system for each of many chronic diseases or clinical domains. Rather, the goal is necessarily to create a patient-centred CDS system that identifies, for each patient at a given point in time, all the evidence-based actions that may be of benefit. This has been done, and the list is often so long that providers and patients 'opt out' of the exercise altogether. Thus, some sort of prioritization function is necessary to streamline the process and keep provider and patient attention focused on actions with the greatest potential benefit to the patient [20]. It is apparent that patients with diabetes may also benefit from better identification and management of comorbid conditions such as depression, heart failure, coronary heart disease, arthritis and lung disease. What is not apparent is how to accomplish accurate prioritization across multiple clinical domains. Options include rating interventions by impact on quality-adjusted life expectancy, strength of evidence, cost-effectiveness, number needed to treat to extend life by 3 months or other approaches. The prioritization method needs to be transparent and valid, but does not have to be accurate to the second decimal place, because the list will then be further filtered by the ultimate trump card–patient preference.

Incorporating patient-reported data and data from wireless devices into CDS systems

CDS algorithms now incorporate lab tests, vital signs, allergies, current treatment, comorbidities, distance from goal and clinical state (renal, cardiac and hepatic function), as well as other EHR data. However, most do not yet incorporate patient-reported data (e.g. symptoms of hypoglycaemia, screening questions for depression) or data that are collected outside the encounter and can be transmitted wirelessly to the EHR or an associated website. The addition of such data, including data on physical activity from wearable devices or self-reported dietary intake, could considerably expand the scope of diabetes-related outpatient CDS systems [21,35]. For example, home glucose data could be processed through algorithms that suggest specific insulin adjustments in response to certain glucose test patterns or the cardiovascular benefits of lifestyle changes such as more physical activity could be compared with the benefits of certain pharmacological interventions to reduce cardiovascular risk. In settings with access to pharmacy fill data, assessment of medication adherence may also be possible and further enhance the ability of providers and patients to make informed decisions about medication management.

Expanding the applications of CDS technology

Evidence-based algorithms that operate within CDS systems can be modified rapidly in response to advances in knowledge, new consensus guideline recommendations, or the introduction or removal of drugs from the market. This is a major paradigm shift in clinical care – instead of taking 17 years for evidence to be applied in practice, the shift may occur in a matter of several weeks [60]. Advances in secure communication of data between EHRs and websites open up new possibilities for large-scale and efficient regional or national approaches to CDS, provided large numbers of providers and care systems can agree on the content of treatment algorithms.

As we mentioned previously, CDS systems can be used to better coordinate care provided by various care team members, to guide pre- and post-visit care, support integrated case management, and help ensure that very expensive new medications are targeted to the subset of patients in whom the potential benefit justifies the additional expense. CDS applications to improve management of prediabetes, prompt screening for diabetes and integrate preventive care decision support are now being tested in a number of ongoing projects. Future CDS algorithms may also be able to target patients with diabetes, who although still at goal for HbA_{1c}, blood pressure or lipids, are trending upward and may be candidates for proactive care modifications to prolong periods of optimal metabolic control [61].

An exciting future application of EHR-linked CDS is to create a map of care quality at the provider level. We have mapped the clinical decision space for diabetes care in previous work, and clinics or individual PCPs can be ranked alongside their peers on 20 measures of care, such as percentage of patients with uncontrolled diabetes with an insulin start; timely intensification of lipid, glucose or blood pressure medications when indicated; and the recognition and management of depression [38,62,63]. This information can then be used to guide clinic- or PCP-level personalized learning interventions, or changes in clinic workflows, to address areas of suboptimal performance. This process is congruent with calls for development of a 'learning healthcare system' that is designed for ongoing, sustained care improvement.

Summary

The ideal outpatient CDS system is one that: (1) identifies the subset of patients with diabetes with the most potential benefit from changes in management, (2) identifies patient-specific clinical domains not at goal, (3) suggests patient-appropriate evidence-based treatment options, (4) prioritizes these treatment options based on potential benefit to the patient, and (5) proactively communicates treatment options to both providers and patients in comprehensible formats at the optimal time during face-to-face or other types of clinical encounters to provide an informed starting point for discussion of a patient's treatment preferences. Such evidence-based CDS algorithms, which can be web-based but EHR-linked, have the ability to provide care that is simultaneously standardized (by reliance on evidence-based algorithms) but highly personalized (because recommendations are tailored to a given patient's clinical state, as well as individual preferences). Moreover, the CDS recommendations evolve over time as evidence and the patient's clinical state evolve, providing in essence a dynamic, standardized yet personalized care plan that can be easily

accessed by any health team member at any point in time. Evidence is accumulating that well-designed, carefully implemented diabetes CDS systems improve not only test ordering and preventive care [9,11,13], but also key outcomes of care [5,14,64]. Evidence further suggests that some such systems are cost-effective from the payer's point of view, have high use rates and are well-liked by both providers and patients [40,65].

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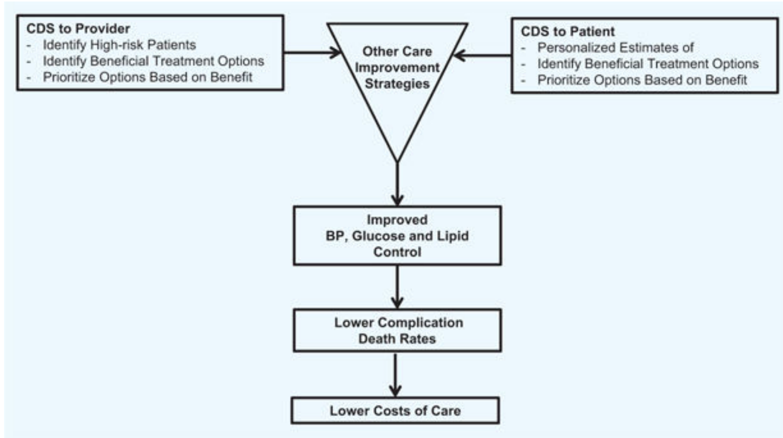

FIGURE 1.

Model illustrating the impact of both provider and patient Clinical Decision Support (CDS) on diabetes care outcomes.

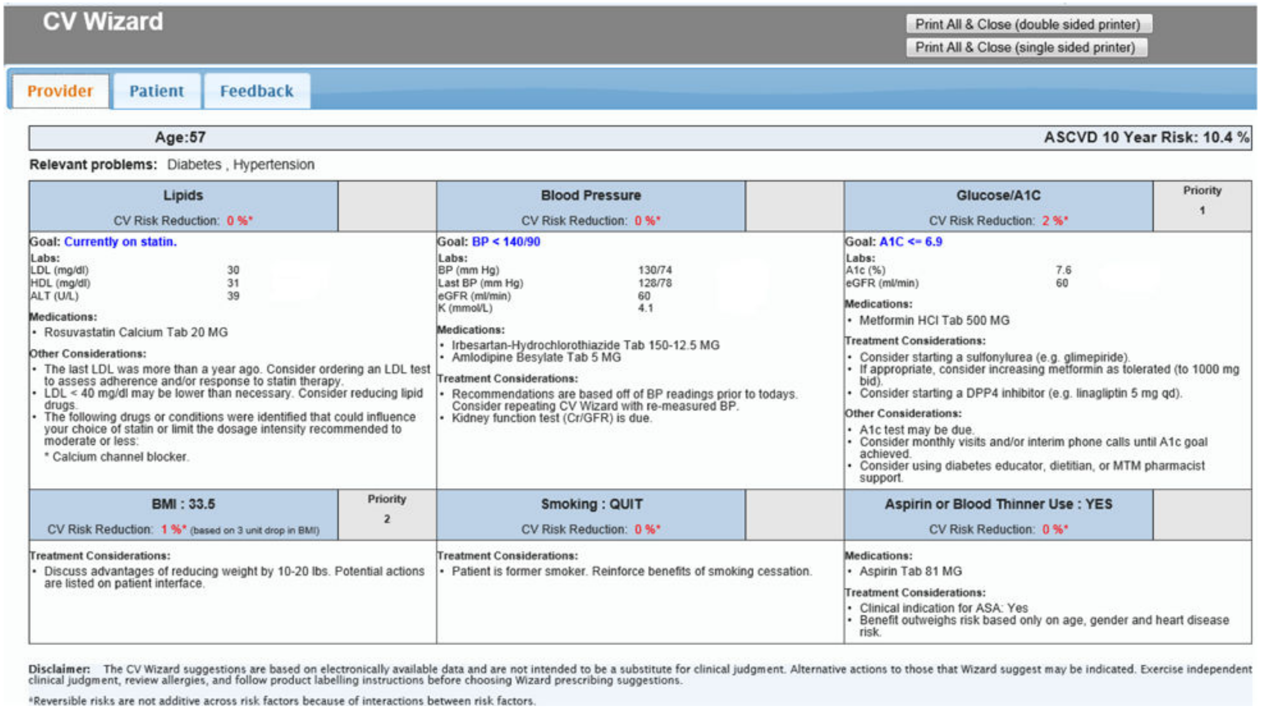

FIGURE 2.

Provider diabetes Clinical Decision Support screen shot.

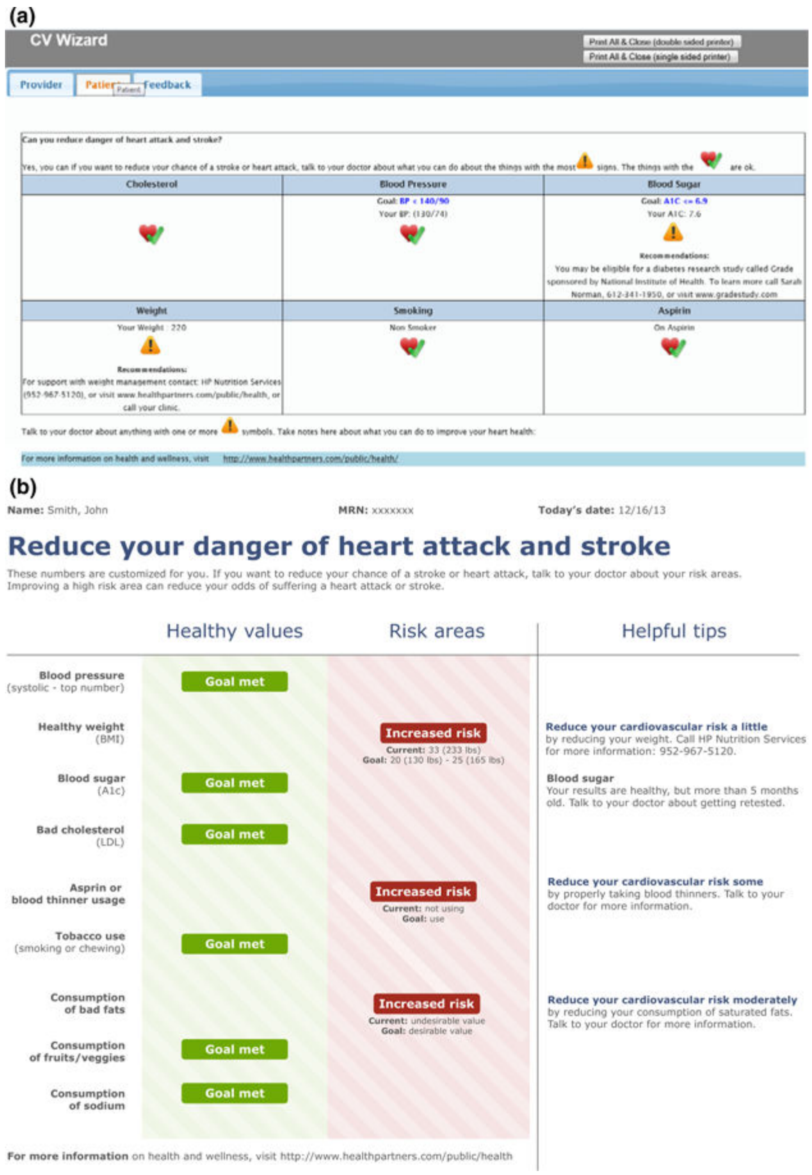

FIGURE 3.

Patient diabetes Clinical Decision Support: (a) screen shot A, (b) screen shot B.