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COMMENTARY

The Role of Technology and the Chronic Care Model

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Abstract

Innovative technological approaches offer great promise for enhancing the quality of care and improved access. A chronic care model has been shown repeatedly to improve outcomes. The elements of the model include the health system, community, self-management support, decision support, clinical information systems, and delivery system redesign. Understanding opportunities to apply technology to the chronic care model is critically important as the rates of diabetes escalate and quality care becomes a priority for health systems.

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Technology and the Chronic Care Model

Innovative technology affords a low-cost, flexible means to supplement formal health care and is central in reshaping chronic care. If designed and implemented carefully, technological interventions can be a powerful way to improve provider practice and help patients live more successfully with chronic disease.

Attending to diabetes has become a priority for health care decision makers as rates are reaching epidemic proportions and challenging health systems. Because evidence is mounting that consistent health care intervention for those with chronic disease is more effective in improving outcomes and subsequent costs, models that are focused on outcomes and prevention have been posed as viable alternatives to our current systems.[1] The chronic care model (CCM) provides a paradigm shift from our current system and a multifaceted framework for redefining our current views on health care delivery.[2] The premise of the model is that quality care is not delivered in isolation but that each of the CCM elements works in tandem. In fact, many of the elements share common themes and often overlap. The CCM identifies key elements that are critical to success:

1. Health system—to serve as the foundation by providing structure and goals
2. Community—to link with community resources and establish policy
3. Self-management support—to help patients acquire skills and confidence to self-manage
4. Decision support—to assure that providers have access to evidence-based guidelines

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Abbreviations: (CCM) chronic care model, (CMS) Center for Medicare and Medicaid Services, (EMR) electronic medical record, (IT) information technology, (PHR) personal health record, (VA) Veteran's Affairs

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5. Clinical information systems—to provide timely access to data about patients and patient populations

6. Delivery system design—to restructure medical practices to facilitate team care

The CCM has widespread application. It has been evaluated through quality improvement projects, comparisons of high and lower performing practices, and randomized intervention trials and has been shown to be feasible and improve outcomes.[3–5] It has been implemented in a number of ways, and specific elements of the model have been the focus of study; however, in a review of research showing the extent to which the CCM improves care, Coleman and colleagues[4] recommend additional study. Questions remain whether sequential versus full implementation of the elements results in improved outcomes, are there differences in outcomes when comparing small versus large primary care practices, and how does technology support the process?[6]

Implementing the CCM requires radical changes in the way that health care is delivered. Diabetes technological applications already show great promise. This commentary presents examples of technological approaches that already apply to each of the aforementioned CCM elements. **Table 1** lists additional examples of technology that can conceivably support the model and are published in *Journal of Diabetes Science and Technology*.

Health System

The CCM relies on the use of technology with disease-specific registries for both public and private health systems to facilitate tracking and the provision of quality longitudinal care. Diabetes, in particular, is well suited to the use of clinical information technology (IT) because its management is characterized by easily quantifiable outcomes and process measures. Computerized IT systems can improve care delivery processes by identifying specific populations through the creation of registries and locating patients within the registry who are not meeting treatment goals. Documentation of services and performance is likely to be achieved though submission of records captured in an automatic fashion through electronic health records (EMR).

Several large-scale government programs such as those sponsored in the United Kingdom and Center for Medicare and Medicaid Services (CMS) and a number of private health plans are relying on registries to determine quality.[7–10]

Table 1.
Additional Examples of Technology That Can Conceivably Support the CCM

Chronic Care Model Elements	Associated Technologies Article Title
Health system	Reimbursement for New Diabetes Technologies: Continuous Glucose Monitoring[11] Harnessing Information Technologies to Improve the Delivery of Diabetes Care to Veterans: The Future Is Today[12] Closing the Circle of Care with New Firmware for Diabetes: MyDiaBase+RxChecker[13]
Community	Telemedicine Process Used to Implement an Effective and Functional Screening Program for Diabetic Retinopathy[14] Enhanced 911/Global Position System Wizard: A Telemedicine Application for the Prevention of Severe Hypoglycemia—Monitor, Alert, and Locate[15] Improving Access to Eye Care: Teleophthalmology in Alberta, Canada[16]
Decision support	Multicenter Validation of a Computer-Based Clinical Decision Support Tool for Glucose Control in Adult and Pediatric Intensive Care Units[17] Use of Case-Based Reasoning to Enhance Intensive Management of Patients on Insulin Pump Therapy[18]
Self-management	Veteran Affairs Research on Health Information Technologies for Diabetes Self-Management Support[19] Smart Home-Based Health Platform for Behavioral Monitoring and Alteration of Diabetes Patients[20] A Review of Web-Assisted Interventions for Diabetes Management: Maximizing the Potential for Improving Health Outcomes[21]
Clinical information systems	Performance of Electronic Diaries in Diabetes Clinical Trials Measured Through Overall Satisfaction of Site Coordinators[22] The Role of Electronic Blood Glucose Trending Software in Improving Health Outcomes in a Primary Care Setting[23]
Delivery redesign	Diabetes Connected Health: A Pilot Study of a Patient- and Provider-Shared Glucose Monitoring Web Application[24] Going Mobile with a Multi-*Access* Service for the Management of Diabetic Patients[25]

A perfect example of an effective large-scale effort using IT and registries to enhance chronic care is the Department of Veteran's Affairs (VA) quality-improvement

program. Comparison of the overall quality of health care between diabetes patients treated at the VA and patients seen at private hospitals favored the VA, which scored significantly higher for adjusted overall quality.[7,26] Much of the VA's success is due to its effective EMR system.

Many health systems and a number of states are actively linking quality with financial incentives to health care providers.[27–30] While not all pay-for-performance programs are the same, all involve an index of measurements on which providers must report data and strive for improvement. Although it is too early to tell whether reimbursement methodology will lead to sustained improved practice, linkage of economic incentives to provider processes and patient outcomes is promising. It is anticipated that the initiation of performance-based revenue enhancement programs will be a major force for promoting wide-scale adoption of clinical computing.[7]

Community

Beyond tracking data to inform policy change, communities are relying on technology through a variety of venues to inform consumers. Static Web sites are being used to disseminate disease-specific information to a broad patient audience. A California state-sponsored Web site (*www.opa.ca.gov*), for example, posts medical practice results. Consumers can compare factors most relevant to their own needs and discern quality.[7] Virtual communities of care are created through interactive Web sites. Information technology platforms provide a forum to share and disseminate information between providers and patients and to deliver diabetes educational material to target populations.

Outreach to outlying and underserved communities is being served through a number of technological approaches. Biometric devices that include home-based measurement tools used to monitor and collect daily readings and symptom information (e.g., blood glucose and blood pressure readings) are showing great promise. Once patient data are collected, information is uploaded via telephone or Internet and sent to caregivers who can then access patient data through a standard browser or desktop computer.

In a study done at the Pittsburgh VA, veterans living in rural communities had improved diabetes outcomes when they transmitted their weight, blood pressure, and glucose readings through a Viterion appliance where information is automatically downloaded, risk stratified, and available to a nurse practitioner located at the VA academic urban site.[31]

Telemedicine through video conferencing provides the patient and provider with real-time visual interaction to supplement the benefits of face-to-face office visits. Having visible contact with an empathic and knowledgeable health care provider who has first-hand knowledge of the patient's diabetes promotes treatment adherence and positive behavior change.[7] Video conferencing affords access to diabetes specialists, such as endocrinologists and diabetes educators. With the current shortage of diabetes practitioners, beaming specialty services to remote and underserved locations has many advantages.

The Columbia University Informatics for Diabetes Education and Telemedicine project, funded by CMS, is one of the most ambitious technological projects to date. The study is evaluating participants living in medically underserved areas of New York to determine the feasibility, acceptability, effectiveness, and cost-effectiveness of telemedicine in the management of older patients with diabetes.[7,32] Results are expected to have far-reaching impacts on regulatory and reimbursement policies for electronically delivered health care. If the process and outcomes of care for patients are improved and if cost-effectiveness of electronic care delivery is confirmed, favorable reimbursement policies are likely to follow.

Self-Management

A growing body of evidence shows that patients who participate actively in their care achieve valuable and sustained improvement in physical and psychological well-being.[33] The use of technology is making it possible to empower patients to learn new practices and routines related to their illness.

The daily rigors of diabetes self-management that include monitoring eating habits, physical activity, medication taking, and monitoring can best be supported through technology. Technological interventions can facilitate the process of self-care by supporting patients, both educationally and motivationally, in their day-to-day decision making. Incorporation of timely clinical information increases the patient's ability to recognize opportunities for intervention, quick reaction, and meaningful immediate feedback.

Breakthroughs in microprocessor technology have allowed the design of small, portable, and inexpensive sensors that measure a wide range of objective clinical indicators and provide instantaneous feedback.[7] Today, everything from glucose levels to the delivery of insulin can be monitored via sensitive devices—some with built-in

response capabilities to send information directly to data stores for clinical evaluation. The gathering and distribution of this clinical information in a reliable, low-cost way open up new opportunities to support the behavior modification process.

With their widespread use, handheld devices, such as cell phones, are also gaining increased attention as an adjunct to self-management. In the United States, 84% of English-speaking Hispanics own a cell phone, while white (74%) and black (71%) Americans are approaching that number rapidly. Income level is not a substantial factor limiting use, thus making this technology a valuable asset to diabetes management.[34] National and international studies demonstrate the benefits of using cell phones in improving nutrition,[35] smoking cessation,[36] and physical activity.[37] Several diabetes-specific studies currently underway are evaluating the usefulness of integrating food items into the phone system so that people can make informed decisions such as counting carbohydrates. Other capabilities include linking patients to their health care provider. Through their phone and an Internet site, patients can upload information to a health care provider and receive appropriate feedback.

Through technology, decision makers can be creative in determining the best methods to motivate patients. A consumer component of a pay-for-performance program is being examined that consists of a Web-based disease management tool that helps patients identify their diabetes needs, while providing personalized support and incentives to promote positive self-care.[38,39] Under the program, patients with diabetes log on to the Internet to access tools for keeping track of essential diabetes self-care activities based on treatment goals established in collaboration with health care providers. Patients who meet target health goals receive points that can be redeemed for coupons used in purchasing diabetes-related products.

Decision Support and Clinical information Systems

Disease management programs have become widely accepted in supporting care delivery, and diabetes patients enrolled in these programs have been shown to have better health, fewer complications and comorbidities, and lower costs.[7,8,40] Effective technology programs ensure that providers have access to expertise facilitated through evidence-based decision support.[41] This requires that recommended standards of care, clinical guidelines, and protocols be embedded into the decision support software to ensure that best practices are available to the clinician. Emerging technologies that add intelligence via guideline-directed alerts and reminders, interactive workflow and care coordination, registries that include a summary of health data used for clinical decisions, and the collection of aggregated, clinical, administrative, and cost data into comprehensive data sets to which predictive modeling analytic tools can be applied provide busy practitioners the necessary support to assure quality. The embedding of biometric devices (digital scales, modem-enabled glucose meters, blood pressure monitoring, etc.) into these programs can further enhance patient–provider communication and time-saving opportunities.[7]

Delivery System Redesign

Effective chronic illness management also requires attention to delivery system redesign.[2,3] In a meta-analysis of diabetes quality improvement efforts, programs that addressed system redesign with team changes showed more robust improvements in glycemia than any other strategy.[42]

Key to successful integrated care is an approach that coordinates care and support being delivered at the appropriate time by creating linkages between all participants in the care delivery process. Gaps in communication between the "silos of care" often create barriers to effective team management.[7,8] Studies that show the benefits of a multidisciplinary approach also report challenges with communication. In the global Diabetes Attitude Wishes and Needs study, patients and providers report lack of communication between team members to be a major barrier to quality diabetes care.[43]

Personal health records (PHRs) provide an ideal environment to address these barriers. By linking the patient and members of the diabetes team through the EMR, the diabetes care team can synchronize care with their patients.[7,40,44] Together they can view portions of the EMR, such as problem lists and medication records, and coordinate goals and action plans. PHRs can help ensure that patients are aware of important aspects of their own disease. Links to information about diabetes and management tools allow patients to explore issues of concern to them. Glucose, blood pressure, and activity logs support patients in their efforts to adhere to treatment plans, whereas integration of glucose and blood pressure logs with the EMR allows the care team to review results and make therapeutic changes. Through a PHR, patients can initiate communication with the office staff, even when the office is closed. They can complete simple tasks, such as scheduling appointments or requesting prescription refills. Important matters can be

addressed though two-way communication, eliminating the need to "catch the busy doctor."

Conclusions

With the increasing prevalence of diabetes, particularly as it affects younger populations who will rely on technological approaches, innovative technology programs must continue to be explored. Although technology has shown promise for improving clinical care for patients with diabetes,[7,40] to date, it has played only a limited role in the delivery of preventive medicine and treatment.[44]

Today's technological environment has the potential to help overcome the myriad of barriers that deter the routine delivery of evidence-based interventions and can facilitate proven principles of effective chronic disease management, such as the chronic care model. The use of technology integrated into an interoperable framework is crucial to enabling chronic care management in a cost-effective and scalable manner.

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