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By David W. Bates and Asaf Bitton

The Future Of Health Information Technology In The Patient-Centered Medical Home

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ABSTRACT Most electronic health records today need further development of features that patient-centered medical homes require to improve their efficiency, quality, and safety. We propose a road map of the domains that need to be addressed to achieve these results. We believe that the development of electronic health records will be critical in seven major areas: telehealth, measurement of quality and efficiency, care transitions, personal health records, and, most important, registries, team care, and clinical decision support for chronic diseases. To encourage this development, policy makers should include medical homes in emerging electronic health record regulations. Additionally, more research is needed to learn how these records can enhance team care.

Providing excellent primary care is central to the delivery of high-quality medical care and, more broadly, to the health of populations.¹ However, the United States does not have enough primary care today. Also, the primary care that exists is too often delivered by providers working in small practices without adequate support. These providers face difficulties in coordinating their activities with those of the rest of the health care system.

The patient-centered medical home has been increasingly promoted as a model of improved care that may address many of the failures and delivery gaps within the current primary care system. Medical homes are highly integrated, team-based practices that promote patient-centered care through routine patient feedback and better access. They also promote improved clinical quality and efficiency through increased care coordination. The 2007 Joint Principles of the medical home, produced jointly by the major primary care professional societies, brought together related efforts within each of these organizations to promote a new care model.² A wide range of supporters, including medical specialty societies and large employers, subsequently

endorsed these principles.²

Medical practices and health care networks across the nation began to test and implement the medical home model. Many have relied on qualification standards developed by the National Committee for Quality Assurance (NCQA).³

The electronic health record is widely believed to be central to the medical home concept.⁴ Yet even today's leading electronic health records do not include much of the functionality that will be required to transform the care of chronically ill patients. The requirements for "meaningful use" of health information technology (IT) included in the American Recovery and Reinvestment Act (ARRA) of 2009 do not explicitly address the medical home. However, they do target key domains central to the medical home, such as coordinating care, engaging patients and families, and improving population management.

A medical home that improves outcomes and lowers costs—and thus is truly transformational—will build upon electronic health record innovations in the context of payment reform and patient-centered care.

In this paper we present evidence on the performance of medical homes and the degree to

which they use electronic health records. We then explain that improvements in electronic health records will be critical in seven major domains: clinical decision support, registries, team care, care transitions, personal health records, telehealth technologies, and measurement (Exhibit 1). We discuss these domains in turn, pointing out the electronic health record innovations that will be needed to achieve better results—particularly in the areas of team care, registries, and chronic disease management. Finally, we discuss policy approaches and financing mechanisms that we believe will make these developments possible.

Evaluation Of Medical Homes And The Electronic Health Record

Despite widespread enthusiasm around implementing the medical home, a relatively small body of evaluative data exists on it. Only four peer-reviewed published studies of medical home demonstrations have been published (on North Carolina Medicaid,⁵ Geisinger,⁶ four small practices,⁷ and Group Health⁸).

Although preliminary, the studies by and large show that implementation of the medical home is associated with reduced costs and both lower emergency department usage and fewer hospitalizations for patients with conditions, such as

EXHIBIT 1

Key Issues For Electronic Health Record (EHR) Domains

EHR domain	Potential benefits for patient-centered medical home	Patient-centered medical home implementation challenges	Examples of research gaps to fill
Clinical decision support	Improved care processes and intermediate disease outcomes; reduced adverse drug events	Insufficient decision-support features in many available EHRs	Clinical decision support in the ambulatory setting, especially how it applies to care transition, medications, and chronic disease support
Registries	Better patient and outcome tracking; improved work-flow efficiency	Highly functional, multidisease tools not widely available	Impact of novel registry tools; how to abstract key registry data from existing EHR; how to train staff to use registries for proactive population health management
Team care	More patient-centered, collaborative care; changed patterns of specialty referral	Communication capacities beyond notes (that is, real-time specialist consultation) often not available in commercial EHRs	Which EHR tools best promote team care; how to create incentives for specialist participation
Care transitions	Promotion of crucial information exchange from inpatient to outpatient settings; helping ensure timely follow-up visits and monitoring	Integration of inpatient and outpatient EHRs required; difficult to accomplish in current highly fragmented environment	How to integrate systems, and whether accountable care organizations may generate the investment that medical homes will need to improve care
Personal health records	Increased patient engagement and self-efficacy; portable and real-time information for patients	Lack of uptake by patients; low health literacy; hesitancy among providers to provide patient information	How to increase use of personal health records among patients with chronic diseases or low health literacy; how to coordinate patient goal setting with provider teams
Telehealth	Improvement in some chronic disease outcomes, such as congestive heart failure; reduced need for in-person visits; increased patient engagement	Currently outside of nearly all EHRs; extra cost; need to help practices select among outside vendors	Need to measure the impact of telehealth technologies on other chronic ambulatory conditions
Measurement	More data on the aggregate and individual patient/provider level; transparent external comparison enabled	Commercial EHRs often unable to abstract data to perform this type of measurement; need for harmonized quality and efficiency measures	Outcome studies on the medical home model; research on the patient and staff impact of patient-centered medical home transformation

SOURCE Authors' analysis of the state of EHR technology.

congestive heart failure, that can often be managed on an ambulatory basis. The studies also found an association with improved intermediate quality outcomes for a number of chronic diseases; examples are the proportion of patients achieving target levels for blood pressure, low-density lipoprotein cholesterol, or glycohemoglobin. Moreover, the published results of these early medical home experiments suggest that many of these improved outcomes are attributable in part to improved use of electronic health records, although we acknowledge that changes outside the electronic health record may have played a role, too.

GEISINGER MODEL In the Geisinger medical home model, the electronic health record featured prominently as a building block for nearly every practice-based and systemwide transformation effort.⁶ Geisinger provided access to the electronic health record for physicians, patients, and care managers as part of the Personal Health Navigator initiative to improve quality and value for each patient. The Geisinger system used its highly functional systemwide electronic health record to improve work flows and appropriately delegate clinical tasks at the clinic level. For instance, the record summarizes patient information before the patient is seen, alerting providers to health maintenance needs, such as a screening mammogram, and chronic disease process deficiencies, such as coronary disease that isn't being treated with a beta blocker.

It also helps providers build individual care plans, which are automatically incorporated into later physician order sets and printed out for patients at the end of the visits. The electronic health record provides each practice with monthly updated reports that give physicians easy access to data on quality. It also gives providers and patients access to after-visit care plans that identify clinical measures requiring improvement before the next visit. In this implementation, providers used clinical decision support, quality measurement tools, and information technology to engage patients and get them involved in their personal care plans.

FOUR SMALL PRACTICES The 2009 review of four small practices that made the transition to the medical home model found that the practices all achieved 20 percent cost reductions without fully functional electronic health records, although all believed that such records would improve care and were actively moving toward full implementation.⁷

GROUP HEALTH MODEL The Group Health medical home model similarly built upon a highly functional, universal electronic health record to improve care coordination, team-based care, and patient engagement.⁸ The interventions in-

Many improved outcomes are attributable in part to improved use of electronic health records.

cluded patient Web-portal functions within the record that allowed patients and providers to exchange e-mail; patients also received "birthday" reminders that alerted them to health maintenance needs in the coming year. Furthermore, the practice held team meetings before patient visits to discuss best practices and health maintenance needs highlighted by the electronic health record.

In addition, specialists were able to consult with primary care physicians in real time via the electronic health record, which meant fewer visits to specialists and, perhaps, less use of emergency departments. Finally, the record's system-tracking features allowed the care team to provide systematic follow-up of emergency department and hospital discharges, as well as better follow-up of abnormal test results.

Seven Domains In Need Of Development

In our examination of electronic health records, we have identified seven domains needing further development. Improvements in these areas would help the medical homes realize their full potential.

CLINICAL DECISION SUPPORT Clinical decision-support systems are computerized information systems that aim to improve decision making around diagnosis (clinical prediction rules), prevention and disease management (routine care reminders to doctors or patients), and treatment (electronic medication prescribing). Although there is intense interest in these systems, the measured results have not been uniform. A systematic review of decision support in all domains by Amit Garg and colleagues found that decision support improved providers' process performance in sixty-two of ninety-seven studies reviewed (64 percent).⁹ Meanwhile, only seven of fifty-two studies (13 percent) reported improvements in at least one care outcome.⁹ How-

Electronic health record functionality that enables real-time communication among team members is likely to promote the team care approach.

ever, decision-support tools that automatically prompted users to take actions and those that were developed by Garg and colleagues themselves were significantly more likely to be successful than tools that did not prompt.⁹ Another systematic review identified a mean of seventeen features per study that contributed to successful implementation of a decision-support system, but the features contributing to success were not uniform across studies.¹⁰

Computerized physician order entry involves having doctors write all orders—including those for prescriptions and lab tests—on the computer. Particular attention has been given to computerized ordering's role in improving medication safety, although more data are available for inpatients than for outpatients. One rigorous systematic review found that computerized orders with decision support were associated with statistically significant reductions in adverse drug events in 50 percent of the studies examined. In another 40 percent, non-statistically significant reductions were seen.¹¹

A recent systematic review of decision support in the ambulatory and primary care settings confirmed previous findings that pointed toward improved performance, mainly in provider processes such as remembering that a patient is due for a mammogram.¹² Of five nonrandomized and twelve randomized studies in the review, 76 percent found positive or somewhat improved performance related to decision-support interventions; the rest found no significant effects.¹² Most of the positive outcomes were in studies that focused on cardiac diseases (such as coronary artery disease and congestive heart failure), although most were related to process measures.

With respect to the medical home, it appears that decision-support capabilities will be beneficial, although the evidence varies greatly by domain. Most studies show improvement in in-

termediate process outcomes as opposed to disease outcomes. In the short run, medical homes might use decision support most effectively to reduce adverse drug events, especially among recently discharged patients. A key potential limitation is that only a minority of commercially available clinical information systems offer important decision-support features such as renal dosing and reminders for chronic diseases.¹³ This suggests that vendor applications will need to evolve even in this area. In the longer term, it should be possible to use clinical decision support to improve care processes for a variety of chronic diseases, although more work is needed.

REGISTRIES Registries are applications that define patients with specific conditions while also specifying their disease status. Some registries also include tools that facilitate disease management. An example is a registry tool that captures information on which patients have diabetes, whether they completed key lab tests, and how well controlled specific parameters such as blood pressure and glycohemoglobin are for them. The registry functions of most commercially available electronic health records are poorly developed. These functions need to be dramatically improved so that nonphysician team members can identify, communicate with, and proactively track and manage patients with a large number of chronic conditions.

An example of a new tool with medical home applications is the Registry Population Manager.¹⁴ This tool helps identify cohorts of patients with specific criteria, making it easy for nurses and care coordinators to link these cohorts with actionable interventions, such as sending a letter to the entire cohort or adding someone to a list of patients to be called. The tool enables care coordination among providers and has improved the efficiency of nurses on the team in at least one clinical setting. Introduction of the tool there increased the number of patients whose information nurses could review to 300 per hour, from the previous typical work flow of 10–30 per hour.¹⁴ The delay between identifying a patient in need of a reminder and the mailing of that reminder fell from more than thirty days to fewer than two days.

It will be critical to develop such tools for an array of conditions; the tools will need to take into account the fact that many patients have multiple chronic conditions.

TEAM CARE A core concept of the medical home is that care is delivered by teams of providers including nurses, nurse practitioners, pharmacists, medical assistants, and care coordinators who help primary care physicians promote better care. For this model to be effective, it will be essential to develop communication tools that

allow practices to record goals shared by providers and patients alike, and to track medical interventions and progress.

Electronic health record functionality that enables real-time communication and coordination among team members is likely to promote this team approach. Much of the information exchanged by team members would not need to be placed in the traditional patient notes.

Unfortunately, this type of functionality is largely absent from today's electronic health records and is thus in need of development and testing. More widespread adoption of tools that facilitate consultations would be helpful as well—including, perhaps, real-time specialist consults such as those occurring in the Group Health pilot.⁸ An added benefit is that the tool could tap the expertise of specialists across regions.

CARE TRANSITIONS Transitions, such as from the hospital to a rehabilitation facility or from a rehab facility to home, are particularly vulnerable times for patients. One study found that 12 percent of patients suffered an adverse drug event after being discharged.¹⁵ However, it should be possible to manage these more effectively using modern communication technologies. A key step is ensuring that a patient is seen soon after discharge. Hospitals need to let medical homes know when their patients leave, and medical homes need processes to contact these patients for follow-up. In addition, practices need electronic tools to assist with medication reconciliation, the process of identifying and updating the complete list of medications a patient is taking. Our group is evaluating a tool that enables primary care providers to call up a patient's medication list at discharge and rapidly compare it to the electronic medication list that existed before admission.

PERSONAL HEALTH RECORDS A personal health record is an electronic source of a patient's health information that can be used by the patient or a proxy. When personal health records are linked with patients' electronic health records, they have the potential to transform the care of chronic conditions, particularly because they can help engage people more fully in aspects of their care. However, personal health records also have had a number of limitations to date. Typically only a minority of patients sign up, and patients with chronic illnesses are less likely than those without these conditions to enroll.¹⁶ The information technology itself also has limitations; for example, some interfaces have been too complicated, and reconciling data from different sources is difficult.

When patients with a medical home begin using personal health records, there is a clear opportunity to get them involved in managing

For electronic health records to transform care, they will need to include much better measurement capabilities than they do today.

chronic conditions such as diabetes, which involve meticulous record keeping and goal setting. For this to be effective, these personal health records should include tools that enable patients to communicate with the practice and to track specific parameters, such as weight, blood pressure, and blood sugars. Another useful feature would be one that detects and notifies doctors and patients of worrisome patterns, such as low blood sugars occurring at a particular time of day. From the practice side, it is important that messages be directed to the right individual. For example, many requests for prescription refills can be handled by a nurse, while requests for appointments can be handled by an administrative staff member. About two-thirds of messages can be handled by someone other than the primary care physician, which helps address physicians' resistance to adoption of the technology. More research needs to be done to better define functionalities that will be needed in the personal health record, especially for the management of chronic diseases.¹⁷

TELEHEALTH TECHNOLOGIES Telehealth technologies can be divided into two major forms: (1) a traditional format in which health care practitioners check in with moderately to severely ill patients at a distance to assess vital signs and symptoms; and (2) a newer form of distance monitoring, in which users are typically patients with stable chronic conditions who require regular preventive monitoring.¹⁸

The Center for Information Technology Leadership recently examined the value of telehealth encounters. Extrapolating evidence with the help of a computer simulation, Eric Pan and colleagues found that a model of interactive clinical encounters through real-time video and medical data collection was the most cost-effective model, predicting savings of \$4.3 billion per year if implemented across the United States.¹⁹

(Data collected from these encounters are forwarded to providers for their interpretation.) Julie Polisena and colleagues reviewed twenty-two studies specifically focusing on the impact of telehealth on chronic disease outcomes and similarly found that home telehealth has the potential to reduce costs; however, the societal cost will remain in doubt until higher-quality studies are completed.²⁰

The current body of evidence on telehealth suggests that there is potentially a moderate to large effect on outcomes and costs. Medical homes could use this technology to collect vital signs and symptom reports for patients with chronic illnesses such as congestive heart failure in urban as well as rural settings, if appropriate financial incentives were implemented.

MEASUREMENT For electronic health records to transform care, they will need to include much better measurement capabilities than they do today, for the purposes of both improving care and exporting data for transparency. Measurement of quality and efficiency is particularly important. Quality process measures include whether or not a practice has provided preventive care, such as immunizations and cancer screenings, and assessed treatment goals (that is, blood sugar and blood pressure) for chronic diseases such as diabetes and atherosclerotic cardiovascular disease. These preventive measures and chronic disease outcomes represent good near-term targets for both internal improvement and external examination and should essentially become by-products of care delivery. To deliver the most efficient care, medical homes will need information about the cost of the care they are delivering as well as about the costs of the specialists and hospitals to which they refer patients. Most practices have little sense of this today. Recent efforts to establish a standard set of metrics for comparing outcomes across medical homes represent one key step forward.

Current Status Of Electronic Health Records

With respect to these seven areas, we believe that today's electronic health records perform most poorly in the domains of team care and care transitions, for which almost no functionality is in place. Major work is also needed to improve clinical decision support, especially for chronic diseases, registries, and measurement. By comparison, personal health records and telehealth technologies are reasonably well developed. In those domains, the needs revolve around building linkages with electronic health records and implementing appropriate incentives for medical homes to use them.

Policy Implications

These issues have a number of policy implications, especially around the definitions of *meaningful use*, which in the next several years will help influence what electronic health record functionalities will be adopted because providers will receive financial incentives from ARRA only if they meet the criteria for meaningful use.

The current *meaningful use* definitions do not directly address medical homes yet, but those that relate most to them center on the coordination of care. However, the current meaningful-use recommendations for 2011 from the Office of the National Coordinator for Health Information Technology address care coordination only by requiring participation in a clinical data exchange if such an exchange is available. This will be a positive step but hardly sufficient to strengthen the coordination of care, much of which has to take place within and across practices. Furthermore, the recommendations for 2013 and 2015 describe only broad "goalposts" for care coordination. That may be reasonable, but recent evidence suggests that current electronic health records do not adequately support even today's care coordination needs²¹ and that practices do not have standard processes in place for this. Research in this specific area is urgently needed.

Conclusions

The electronic health record likely will be a foundational element of the medical home. Together, they will play a key role in reducing costs and improving the quality and safety of care. For the electronic health record to achieve these goals, it will need to evolve substantially. Most commercial record systems available in the United States today are underdeveloped with respect to key areas. We have identified seven key dimensions to address, with three of the most urgent being registry functions, clinical decision support, and tools that enable delivery of team care.

EXTERNAL PAYMENT REFORM From the broader policy perspective, external payment reform will be the key to enabling medical homes to take hold and become financially sustainable. Specifically, what's needed are monetary rewards for providers who manage patients better with respect to quality, safety, efficiency, and the patient experience. Payment reform must make transformation funding available up front to help practices build necessary electronic health record capabilities; providers should also receive incentives to use these new capabilities. Disseminating effective tools to help practices choose electronic health records with the best potential value will also be important.

Payment reform could be either fundamental reform in the longer term, or reform that supports near-term approaches such as accountable care organizations,²² payment bundling,²³ and enhanced pay-for-performance programs.²⁴ The Office of the National Coordinator for Healthcare Information Technology could tighten the linkage between electronic health record use and medical homes by making the meaningful-use criteria recognize medical homes explicitly. The NCQA could also update its criteria for electronic health records and medical homes to ensure that criteria reflect the most recent evidence.

PATIENT-CENTEREDNESS Another lynchpin for the success of medical homes will be the extent to which they are actually patient-centered. We believe that patient-centeredness has so far received inadequate attention in the national discussions around medical home transformation. As the successful Geisinger, Group Health, and small-practice demonstrations show, a distinctly patient- and family-centered approach to providing care within the medical home can yield successful outcomes. In particular, the application of electronic health record innovations should target patient-centered goals such as making patients more involved in their care, or “activated,” through the creation of shared after-visit care plans that evolve in real time.

MORE RESEARCH Substantial research would

lead to new understandings of how electronic health records can improve care in medical homes. We suggest that funders such as the Agency for Healthcare Research and Quality (AHRQ, historically the leading funder of this type of work) should target several areas. One is delivering effective clinical decision support for major chronic conditions, particularly in the challenging areas of congestive heart failure, asthma, and chronic obstructive pulmonary disease. Research to evaluate the impact of novel registry-related tools will also be extremely important. Most important, in our view, is research into new ways to promote team care.

Transitions of care have recently been targeted by a portfolio of work supported by AHRQ; evidence from this area should be forthcoming soon. Further evaluation of the impact of personal health records is needed, especially for patients with chronic conditions. Robust evidence already exists for the impact of telehealth technologies for some conditions, such as congestive heart failure.²⁵ However, further evaluation of telehealth’s role in managing other conditions is needed. Finally, we need to better understand what the process of transformation will be like for both patients and health care providers, and whether certain models (such as facilitated transformation or learning collaboratives) improve this experience. ■

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Patent no. 6029138 held by Brigham and Women’s Hospital on the use of decision-support software for medical management, licensed to the Medicolis Corporation. He holds a minority equity position in Medicolis, which develops Web-based decision support for radiology test ordering, and has served

as a consultant to Medicolis. He serves on the board of Care Management International, which is involved in chronic disease management. The authors are grateful to Jennifer Love for assistance in preparation of the manuscript.

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David W. Bates

Cauthors and collaborators David W. Bates and Asaf Bitton have worked together on the topics of informatics and medical homes for several years. Bates is a professor of medicine at Harvard Medical School and a professor of health policy and management at the Harvard School of Public Health, where he codirects the Program in Clinical Effectiveness.

A practicing general internist, he is also chief of the Division of General Internal Medicine at Brigham and Women's Hospital and medical director of clinical and quality analysis for Partners HealthCare. He is an internationally recognized

expert on using information technology to improve clinical decision making, patient safety, and quality of care in medical practice, and his research, published in more than 400 peer-reviewed papers, has focused mostly on clinical decision support in ambulatory care.

A graduate of Stanford University and the Johns Hopkins School of Medicine, Bates received a master of science in health policy and management from the Harvard School of Public Health in 1990. He is past chairman of the board of the American Medical Informatics Association and serves as external program lead for research in the World Health Organization's Global Alliance for Patient Safety.



Asaf Bitton

Bitton, 32, is a general medicine fellow at Brigham and Women's Hospital and has known Bates since starting his residency six years ago. A graduate of Brown University and the University of California, San Francisco, Medical School, Bitton completed his internal medicine training at Brigham and Women's Hospital.

Bates and Bitton originally teamed up to plan the evaluation of some of the first medical homes created in Massachusetts, with support from the Commonwealth Fund, and now are working together to integrate health information technology (IT) interventions into new medical home

models.

For Bates, planning the evaluation "was a key introduction to the exciting field of primary care redesign and reform," he says. "Primary care has a central role to play in reducing costs, and improving the quality and safety of care. But the U.S. has invested less in primary care than any other industrialized nation," he says. "If we are to change the way care is delivered, we need to fundamentally restructure practices. And medical homes are the most promising model for doing that."

For his part, Bitton says that the patient-centered medical home model has "catalyzed an impressive group of academic, business, clinical, and government stakeholders around the concept that providing improved primary care is great for patients, better for clinicians, and a fantastic value proposition for purchasers and payers." As his and Bates's article in this issue of *Health Affairs*

observes, if highly functional electronic health records and other health IT are merged successfully with new staffing roles, they will play an important role in making medical homes more patient-centered, "by helping patients and providers work together to improve outcomes like glycemic control, blood pressure, and patients' overall engagement in their care." Bitton says.

He attributes his interest in the intersection of medicine, public health, and primary care to important personal geographic influences: "I was born in Israel on a kibbutz, which instilled a strong sense of progressive values. When I was five, my family moved to El Paso, Texas, so my father could study engineering. Living there exposed me to the glaring inequalities of life on the border. When I was ten, our family moved to Rochester, Minnesota, home of the Mayo Clinic, where I did an internship in high school, eventually spurring my interest in medicine."