Decision Support System in a Patient-Centered Medical Home

Kalyan S. Pasupathy[1, 4], Karl M. Kochendorfer[2, 4], Gordon D. Brown[1, 4], Lanis L. Hicks[1, 4], Linsey M. Barker[3, 4] and Ricky C. Leung[1, 4]

[1]Department of Health Management & Informatics
[2]Department of Family and Community Medicine
[3]Department of Industrial & Manufacturing Systems Engineering
[4]Informatics Institute
University of Missouri
Columbia, MO 65212 USA

Abstract— **Patient-Centered Medical Home is a care delivery model to transform how primary care is delivered in the United States. The information technology revolution has brought about several advancements and solutions for medicine and care delivery, and medical homes are no exception to this. Traditionally, such information technology solutions tend to be isolated in development and fragmented in implementation. However, it is only through a robust decision support system that these medical homes can in fact provide truly coordinated and patient-centered care. The paper describes preliminary work that has been completed at the University of Missouri Health System and next steps in achieving high quality care delivery through a decision support system implementation.**

Keywords- Care Delivery Model, Information Technology, Decision Support System, Medical Home

I. INTRODUCTION

LACK of sufficient primary care to manage chronic diseases has been quoted as a major drawback of the healthcare system within the United States. An estimated 100 million Americans have atleast one chronic condition, and half of these with more than one [1], and management of such patients is often fragmented and ineffective [2]-[4]. This warrants for a coordinated method of care delivery to manage these various chronic diseases over a period of time and between various entities within the healthcare system, like primary care physicians, specialists and hospitals. Patient-Centered Medical Home (PCMH) is currently on most policy agendas as a means of transforming how primary care is delivered in the United States by providing evidence-based and coordinated care [5]. Medical home models have been developed and key capabilities identified that are considered essential for effective performance. Medical homes change the provision of care from encounter-centric to patient-centric, based on principles of the chronic care model, a framework for improving chronic disease care through care coordination, active follow-up for self-management, clinical decision support, and information systems [6]. The National Committee for Quality Assurance [7] has developed standards and capabilities to score medical practices on stages of development. The Centers for Medicare and Medicaid Services is rolling out a demonstration project of medical homes for patients covered under Medicare between January 2010 and December 2012. Similar models are in the process of being studied within the private sector [8]-[9].

With the information technology revolution, new IT systems are designed, developed and implemented to enable flow of information among the various entities within the care delivery system. Individual entities, like hospitals, medical practices, primary care offices, that are part of medical homes are no exception to this, and are implementing information systems to enable care delivery. Medical homes are sure to have an impact on the operations of other entities within the healthcare sector, such as hospitals and other physicians involved in the care delivery process. To be effective, medical homes need to be structured to assure coordination with hospitals and other physicians, including an integrated information network that links all patients/families and all units involved in the clinical process. It is evident that information technology has major implications for provision of patient-centered care in medical homes. This paper provides a background on care delivery and describes the importance of information for effective care delivery. Next, the paper describes preliminary work involving the development of a decision support system at the University of Missouri Health System.

II. BACKGROUND AND LITERATURE REVIEW

An estimated 100 million Americans have atleast one chronic condition, and half of these with more than one [1]. In a recent study among 2002 Medicare beneficiaries, 22 percent were treated for hyperlipidemia, 45 percent for hypertension, 18 percent for diabetes mellitus, and 28 percent for heart disease [11]. Care of individuals with chronic conditions consume an increasing share of healthcare resources, but management of such patients is often fragmented and ineffective [2]-[4]. The care that is provided for these conditions frequently fails to meet targets [12]. For example, with regard to care for people with diabetes mellitus by primary care physicians, a recent study found that only seven percent of patients simultaneously met blood pressure, lipid, and glycohemoglobin targets for preventing complications [13].

According to the Institute of Medicine, the U.S. health care delivery system does not provide consistent, high-quality medical care to all people. Research suggests that only 55% of evidence-based recommended services for acute, chronic, and preventive care are being provided to adults in the United States by our current system of care [13]. Improving Chronic Illness Care (ICIC), a Robert Wood Johnson sponsored organization that is dedicated to bettering care of the nation's chronically ill, identifies these deficiencies in chronic care – rushed practitioners not following established practice guidelines, lack of care coordination, lack of active follow-up to ensure the best outcomes, and patients inadequately trained to manage their illnesses [14].

III. Medical Home and Information as an Enabler of Care Delivery

Medical homes (not to be confused with nursing homes) have been promoted as effective health care delivery entities providing better quality and coordination of services and increased efficiency [12]. These claims make assumptions about how medical homes affect other entities, like hospitals and health systems and specialists that are outside the primary care team, and how it will be supported by them. Most analysis of medical homes has been internal to the primary care unit with little attention to how they will affect other physicians and hospitals [16]-[17]. Others have correctly observed that coordination of care requires "full access to all the necessary clinical information obtained at multiple sites (physicians' offices, laboratories, hospitals and nursing homes)" [18]. Current medical-home models recognize the importance of establishing an electronic health record within the practice; but thus far, it is not necessarily well integrated with other providers within the patient's health network.

Medical homes are not closed systems, but are interdependent on hospitals and other clinical specialties to be effective. Qualification of practices to participate in the Medicare's medical home demonstration project is done using a Physician Practice Connections-Patient Centered Medical Home tool (7). In this tool, NCQA gives considerable weight (almost 50%) to information systems and decision support as determinants of medical home development [19]. It is only through robust information technology capabilities that a significant impact on quality can be achieved.

IV. Preliminary Work on Information Use for Decision Support

To meet the chronic disease challenge, the University of Missouri Health System made a fundamental shift in healthcare delivery. A pilot medical home model was implemented in 2008 in eight Family and Community Medicine clinics through University Physicians. Part of the medical home pilot is the development of a graphic user interface design that was the 2008 winner of the CHIME collaboration award[1] for a medical home clinical information system for the management of diabetes mellitus. This section describes the information system developed and implemented and the decision support tools currently used by the primary care providers.

A. Research Site

University of Missouri Healthcare System's (MU) family medicine physicians provide care at nearly 100,000 patient visits per year at eight teaching clinics, including two serving rural mid-Missouri populations. MU practitioners have had firsthand experience with chronic condition treatment and management.

The design of the medical home was relationship-based and evidence-based, providing alternatives beyond traditional face to face office visits, focusing on continuous improvement of key indicators, utilizing community resources to help provide care, encouraging patient self-management, and using information technology as an enabler. Whenever possible, MU patients now have a primary care (personal) physician who is responsible for their care throughout their lifetimes. This primary care physician, in turn, leads a team of healthcare professionals who play important roles in delivering care to efficiently meet all the patient's health needs at the lowest possible cost. Information technology plays a crucial role in helping MU to accomplish these processes, thus improving chronic disease care.

B. Disease and Decision Support System Developed

The preliminary study was conducted on type-2 diabetes. The study can be generalized for other chronic diseases like heart failure, hypertension, depression, asthma, etc. Providing quality care for type-2 diabetes requires periodic checks of multiple measures, including laboratory work, medications, physical exam components, and an ophthalmology exam. A recent study of care for people with diabetes mellitus by primary care physicians found that only 7% of patients simultaneously met blood pressure, lipid, and glycohemoglobin targets for preventing complications [14], [20-21]. The task of the primary care physician or specialist, at any one visit for a patient with type 2 diabetes, involves checking on the status of these multiple measures. The varying periodicity with which each of these tasks should be performed, e.g. within the last 3 months, within the last year, adds to the complexity of this task. The chronic disease management model was developed is evidence-based and is set forth in Figure 1. In this example, the first step is dynamically highlighted because the patient is currently taking metformin.

[1] College of Healthcare Information Management Executives Collaboration award for 2008, http://www.cio-chime.org/chime/PressReleases/pr10_31_2008_10_17_17.asp

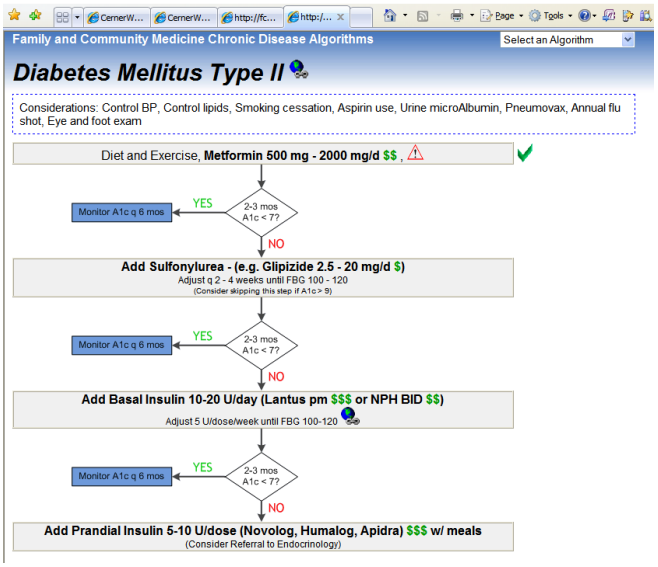

Fig. 1. Screen-shot of the Diabetes Mellitus Algorithm (Evidence-based).

C. *Analysis*

We have collected survey information about physician expectations for the diabetes condition summary and performance reports. We have also evaluated the efficiency and accuracy of the diabetes condition summary in comparison to conventional looking through the EMR. To perform this work we collaborated with the MU Information Experience Laboratory. We used a mixed methods approach, including a quantitative time study and a qualitative analysis of physician information-seeking behaviors. Ten family medicine and internal medicine physicians searched for data in the EHR on simulated patients – first using the conventional method, then the condition summary screen. They were recorded with Morae software and asked to describe their activities with "thinkaloud" interview methods. We measured amount of time needed to access the following data for diabetes care according to recognized guidelines: glycohemoglobin, LDL cholesterol, microalbumin to creatinine ratio, blood pressure, last foot exam, last eye exam, smoking status, and aspirin use. Using qualitative methods, we assessed information-seeking strategies. The mean time to access all data elements using the conventional method was 401 seconds (s.d. 128) compared to 121 seconds (s.d. 40), $p< 0.001$ using the condition summary screen, with date of last eye and foot exam being the most difficult to extract. Considering time on task (that is subtracting time needed to record results for the purposes of this study), time decreased from 5.4 to 1.3 minutes. "Time on Task," Figure 2 below, shows performance by the individual physicians. Physicians did not find all data when using the conventional method. Accuracy increased from 94% to 100% when using the condition summary. A common theme for physicians was, in everyday practice, if they spent too much time searching for a piece of data, they would proceed without it, ask the patient, or order that test again. In summary, a diabetes condition summary screen has the potential to improve both the efficiency and quality of diabetes care. We expect condition summaries for other conditions to be similarly effective.

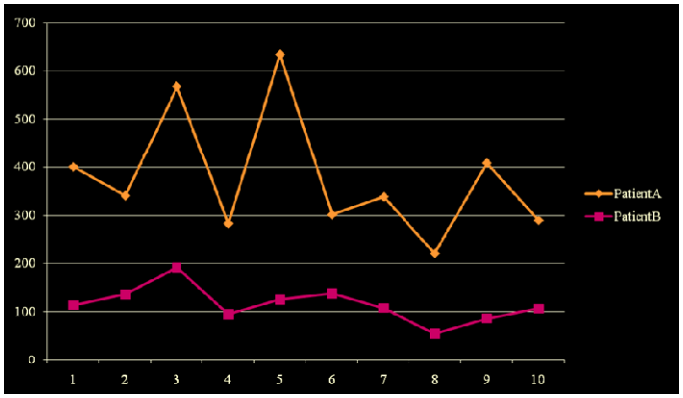

Fig. 2. Summary Condition shows enhanced usability: Time on Task.

V. NEXT STEPS

This project will track the patterns of practice and interrelationships that exist between medical homes, other physicians and hospitals. The nature and magnitude of these relationships must be managed in order to align the goals and incentives of the greater delivery system with those of the medical home. Alternative approaches for managing access to and the utilization of specialty and hospital services will be considered. We will consider the implications physician participation (both primary care and specialists) from a knowledge-base standpoint and the impact on patient satisfaction and the utilization of services as an essential part of coordinating care.

A simulation model will be developed and performance measures will be used to analyze the impact of medical homes on hospitals and health systems. This analysis will measure the impact of the operation of medical homes and of the implementation on access and utilization of hospital(s) and other physicians within the integrated health system.

The study will track these 2,451 patients through a six-month time period of their history in terms of access, utilization of primary care, coordination aspects and their access and utilization of specialists and the hospital. Since the entire system of hospitals and clinics is on an integrated information system, it is easier to track data on these patients across different entities. The degree of level of medical home development within the clinics provides us with two test groups to compare – the first group with a low level medical home capability and only minimal clinical information system capability and, the second with all medical home capabilities. Two patient groups are part of this study in various clinics where the medical home capability has been developed and the composition of patients are listed in Table 1 below:

TABLE I
STUDY SAMPLE SIZE

	Group A	Group B
Medical home capability	Low level	Higher level
Organizational aspects	-	Care coordination Personal physician Evidence-based care
Information technology aspects	Summary reporting	Summary reporting Additional detailed reporting Performance measurement
Clinic (number of patients)	Smiley (238) Keene (353) Blue Team (231) Fulton (389) Fairview (549)	Fayette (19) Green Team (364) Gold Team (308)
Total number of patients	**1760**	**691**

VI. CONCLUSION AND IMPLICATIONS

Hospital and health system executives need to understand the strategic implications of a medical home and its impact on other services within the makeup of the primary care market. The impact of the medical home on the overall functioning and performance of the integrated delivery system should be analyzed. Only then, can they determine the extent to which development of medical homes are effective in achieving their quality of care outcomes and efficiency of their operations. Do improvements in such quality justify the costs? Hospitals and health systems need to know the capital investment, time, and resources required to determine their involvement in the development and sustaining of the operations of an effective medical home.

Our preliminary work involved the development of a clinical decision support system for type-2 diabetes. Next steps involve a comprehensive evaluation of the decision support system for its effectiveness and its impact on the overall care delivery process through a simulation model. The parameters for the simulation model and the evaluation will be built based on data discovery from one hospital system. However, the model can be translated to other systems by changing the parameters suitably and using it in alternate systems. Similarly, our focus is on diabetes mellitus management, to ensure necessary depth and robustness of our study. The study can be extended to include other chronic diseases with the medical home setting.

The method to determine the parameters of the model can be generalized and used to evaluate the feasibility and impact of medical homes within other health systems. These measures of quality and efficiency of medical homes based on inter-organizational and intra-organizational characteristics can be used to evaluate the performance of medical homes and determine where they lie on the continuum of medical home capability.

REFERENCES

[1] Bodenheimer, T., Wagner, E. H., & Grumbach, K. (2002). Improving Primary Care for Patients with Chronic Illnesses. *JAMA* , 288(7): 889-893.

[2] Chen, A., Brown, R., Archibald, N., Alliota, S., & Fox, P. (2000). *Best Practices in Coordinated Care.* Princeton, NJ: Mathematics Policy Research.

[3] Snyderman, R., & Williams, R. S. (2003). Prospective Medicine: The Next Health Care Transformation. *Academic Medicine* , 78(11): 1079-1084.

[4] Cohen, J. W., & Krauss, N. A. (2003). Spending and Service Use Among People with the Fifteen Most Costly Medical Conditions. *Health Affairs* , 22(2): 129-138.

[5] Rogers, J. C. (2008). The Patient-Centered Medical Home Movement-Promise and Perilof Family Medicine. *The Journal of the American Board of Family Medicine* , 21(5): 370-374.

[6] ACP. (2006). *The Advanced Medical Home: A Patient-centered, Physician-guided Model of Health Care.* American College of Physicians.

[7] NCQA. (2008). *Standards and Guidelines for Physician Practice Connections - Patient-centered Medical Home.* Washington, DC: National Committee for Quality Assurance.

[8] Paulus, R. A., Davis, K., & Steele, G. D. (2008). Continuous Innovation in Health Care: Implications of the Geisinger Experience. *Health Affairs* , 27(5): 1235-1245.

[9] Adams, J., Grundy, P., Kohn, M. S., & Mounib, E. L. (2009). *Patient-centered Medical Home: What, Why and How?* Somers, NY: IBM.

[10] Berenson, R. A., Hammons, T., Gans, D. N., Zuckerman, S., Merrell, K., Underwood, W. S., et al. (2008). A House is not a Home: Keeping Patients at the Center of Practice Redesign. *Health Affairs* , 27(5): 1219-1230.

[11] Thorpe, K. E., & Howard, D. H. (2006). The Rise in Spending Among Medicare Beneficiaries: The Role of Chronic Disease Prevelance and Changes in Treatment Intensity. *Health Affairs* , 25(5): w378-w388.

[12] Grumbach, K., & Bodenheimer, T. (2002). A Primary Care Home for Americans: Putting the House in Order. *JAMA* , 288(7): 889-893.

[13] McGlynn, E. A., Asch, S. M., Adams, J., Keesey, J., Hicks, J., DeCristofaro, A., et al. (2003). The Quality of Health Care Delivered to Adults in the United States. *N Engl J Med* , 348(26): 2635-2645.

[14] Wagner, E. H., Austin, B. T., Davis, C., Hindmarsh, M., Schaefer, J., & Bonomi, A. (2001). Improving Chronic Illness Care: Translating Evidence into Action. *Health Affairs* , 20: 64-78.

[15] Rittenhouse, D. R., Casalino, L. P., Gillies, R. R., Shortell, S. M., & Lau, B. (2008). Measuring the Medical Home Infrastructure in Large Medical Groups. *Health Affairs* , 27(5): 1246-1258.

[16] Rosenthal, T. C. (2008). The Medical Home: Growing Evidence to Support a New Approach to primary Care. *The Journal of the American Board of Family Medicine* , 21(5): 427-440.

[17] Fisher, E. H. (2008). Building a Medical Neighborhood for the Medical Home. *N Engl J Med* , 359(12): 1202-1205.

[18] O'Malley, A. S., Peikes, D., & Ginsburg, P. B. (2008). Qualifying a Physician Practice as a Medical Home. *Policy Perspective* , 1: 1-7.

[19] Pham, H. H., Peikes, D., & Ginsburg, P. B. (2008). Pating for Medical Homes: A Calculated Risk. *Policy Perspective* , 1: 15-17.

[20] Spann, S. J., Nutting, P. A., Galliher, J. M., Peterson, K. A., Pavlik, V. N., Dickinson, L. M., et al. (2006). Management of Type 2 Diabetes in the Primary Care Setting: A Practice-based Research Network Study. *Annals of Family Medicine* , 4(1): 23-31.

[21] ACEP. (2008). *The Patient-centered Medical Home Model.*