

Original Articles

# Use of health information technology (HIT) to improve statin adherence and low-density lipoprotein cholesterol goal attainment in high-risk patients: Proceedings from a workshop

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**KEYWORDS:**

Electronic health record;  
Electronic prescribing;

**Abstract:** The workshop discussions focused on how low-density lipoprotein cholesterol (LDL-C) goal attainment can be enhanced with the use of health information technology (HIT) in different clinical settings. A gap is acknowledged in LDL-C goal attainment, but because of the passage of the

The organizers are grateful to Merck & Co, Inc. (Whitehouse Station, NJ) for providing the support without which this program would not have been possible. The workshop was organized by the National Lipid Association and the program contents are consistent with its mission "to enhance the practice of lipid management in clinical medicine." The workshop planning committee had complete autonomy in developing the program and in the selection of the invited faculty.

A list of all workshop participants is included in the [Appendix](#).  
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Submitted October 1, 2013. Accepted for publication October 7, 2013.

Low-density lipoprotein cholesterol;  
Health information technology;  
Statin;  
Adherence

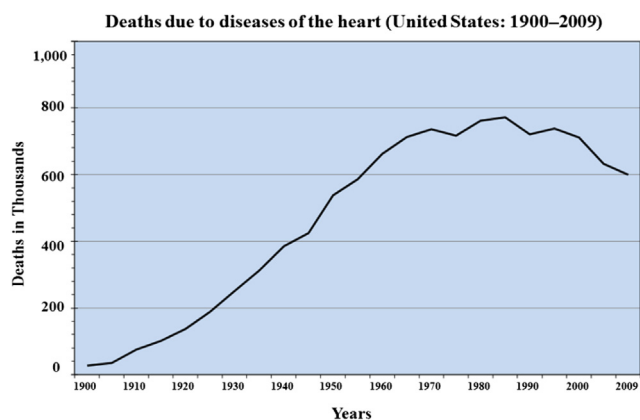
American Recovery & Reinvestment Act and the Health Information Technology for Economic and Clinical Health Acts there is now reason for optimism that this gap can be narrowed. For HIT to be effectively used to achieve treatment goals, it must be implemented in a setting in which the health care team is fully committed to achieving these goals. Implementation of HIT alone has not resulted in reducing the gap. It is critical to build an effective management strategy into the HIT platform without increasing the overall work/time burden on staff. By enhancing communication between the health care team and the patient, more timely adjustments to treatment plans can be made with greater opportunity for LDL-C goal attainment and improved efficiency in the long run. Patients would be encouraged to take a more active role. Support tools are available. The National Lipid Association has developed a toolkit designed to improve patient compliance and could be modified for use in an HIT system. The importance of a collaborative approach between nongovernmental organizations such as the National Lipid Association, National Quality Forum, HIT partners, and other members of the health care industry offers the best opportunity for long-term success and the real possibility that such efforts could be applied to other chronic conditions, for example, diabetes and hypertension. © 2013 National Lipid Association. All rights reserved.

Jerome D. Cohen, MD, Workshop Chairman, gave an introduction to the workshop.

The history of 20th century medicine in the United States is one of great achievements, and, in particular, the chapter on coronary heart disease (CHD) stands out. During the first 70 to 80 years, heart disease deaths rose sharply, reaching a peak in the 1980s, and it was, by far, the number 1 cause of death (Fig. 1).<sup>1</sup> The story continues into the second half of the century with the observations from the landmark Framingham Heart Study.<sup>2</sup> Coronary risk factors were described and defined, with special emphasis on the modifiable risk factors such as hypertension, hypercholesterolemia, and cigarette smoking. In the 1970s, national campaigns were undertaken to curb smoking and to detect and treat hypertension. These were relatively noncontroversial issues. However, debate has been heated about the role of hypercholesterolemia in atherosclerosis and whether dietary and other guidelines for lowering cholesterol were appropriate. This controversy is well reviewed by Daniel Steinberg in his book, *Cholesterol Wars*.<sup>3</sup> One of the most important events in this history was the discovery of the 3-hydroxy-3-methylglutaryl coenzyme A reductase inhibitors, statins, and the Food and Drug Administration approval of the statin drugs, beginning in 1987. Subsequently, it was repeatedly found in randomized placebo-controlled clinical trials that statins reduced recurrent coronary events and mortality rates in high-risk patients. In the National Cholesterol Education Program (NCEP) Adult Treatment Panel (ATP) III Guidelines, a low-density lipoprotein cholesterol (LDL-C) goal <100 mg/dL was extended to all high-risk patients, with or without overt coronary artery disease (CAD).<sup>4</sup> The guidelines were updated in 2004 to suggest an even lower LDL-C target (<70 mg/dL) as optional in the highest risk patients, based on evidence from randomized trials.<sup>5</sup> However, it soon became apparent that many patients were not achieving their LDL-C goals and that compliance with statin therapy over time was far from ideal.<sup>6-8</sup> It was recognized that there are potential problems at every step of the goal achievement process,

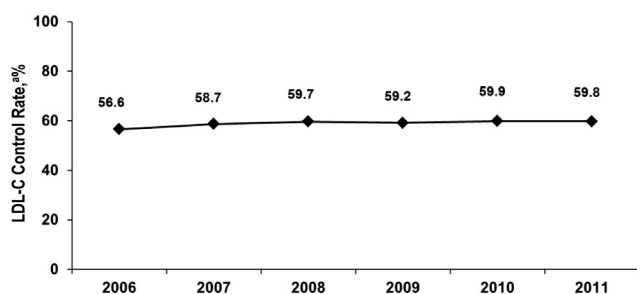
including point of care (prescription not given), prescription not filled, and prescription not taken in accordance with directions or discontinued with or without physician awareness. Multiple potential barriers exist at each of these steps, including at the provider, patient, and system levels (Fig. 2).<sup>9</sup> The ensuing result of these problems is that LDL-C control rates (<100 mg/dL) have improved little over the 5 years from 2006 to 2011 and remain <60% (Fig. 3).<sup>10</sup> An even more startling estimate was that only 22% of high-risk patients with CAD achieved a lower target of <70 mg/dL, and 30% were not even on lipid-lowering therapy (Fig. 4; D. Neff, Merck & Co, Inc, unpublished data). The enormity of underachieving the LDL-C goals and of statin nonadherence can be assessed in other ways. It has been estimated that 11% to 20% of hospital admissions may result from nonadherence, and overall cost estimates are as much as \$290 billion per year (13% of US health care expenditures).<sup>11</sup> Even if future guidelines eliminate LDL-C as a requirement for treatment, or as a target of treatment, the indications for statin therapy, and statin adherence, are expected to remain broad.

No single solution exists to the complex problems of nonachievement of LDL-C goal and statin nonadherence. Consequently, it will take a multifaceted effort that involves the provider, the patient, and the health care system itself to improve the situation. There is, however, some cause for optimism. Of great interest and emerging importance as a potential significant solution to this problem is that the past few years have witnessed the rapid growth and spread of health information technology (HIT) (Fig. 5), in part mandated by the American Recovery & Reinvestment Act (ARRA) and the Health Information Technology for Economic and Clinical Health (HITECH) Act<sup>12</sup> under which Medicare and Medicaid incentive payment programs have been created for hospital and eligible professionals who meet "meaningful use" requirements that pertain to electronic health records (EHRs). To be a meaningful user, providers must use EHRs to report defined objectives, including in the area of patient and family engagement.



**Figure 1** Deaths due to diseases of the heart (United States: 1900–2009). Figure is re-used with permission from the American Heart Association, Inc.

Despite this legislation and the subsequent impressive growth of technology, or, perhaps, because of it, it is estimated that as much as 80% of data contained in EHRs are unstructured and thereby difficult to incorporate into useful clinical information. However, with the emergence of HIT there is now an opportunity to turn information into clinically useful knowledge and move toward developing systems that can intrinsically support better clinical decision-making, improve health care quality, and, perhaps, ultimately have a favorable effect on health care costs. It is an exciting and challenging time to focus on the incorporation of HIT into a system whereby better patient care, enhanced value of services, and improved outcomes can be demonstrated. Thus, a panel of experts from various disciplines was convened to examine how HIT can be used to this end, specifically focusing on the potential for improving LDL-C goal attainment.



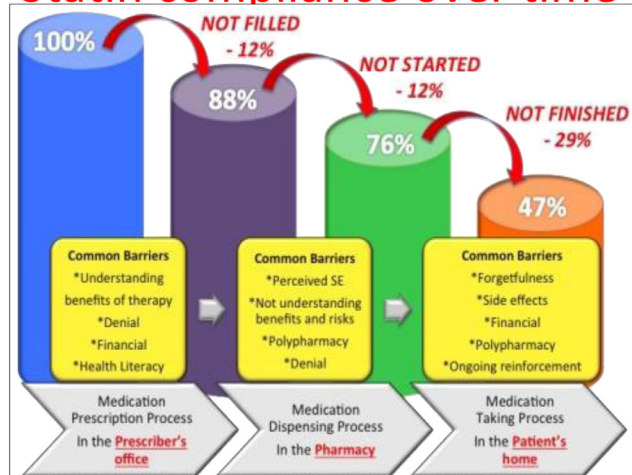
**Figure 3** LDL-C control rate (<100 mg/dL) for US patients with cardiovascular conditions have not improved in recent years.<sup>10</sup> Based on commercial Health Management Organization data from the National Committee for Quality Assurance for adult patients with cardiovascular conditions. Patients were considered to have cardiovascular conditions if they had been discharged for acute myocardial infarction, coronary artery bypass, or percutaneous transluminal coronary angioplasty, or had a diagnosis of ischemic vascular disease. LDL-C, low-density lipoprotein cholesterol.

The workshop had the following 5 major objectives:

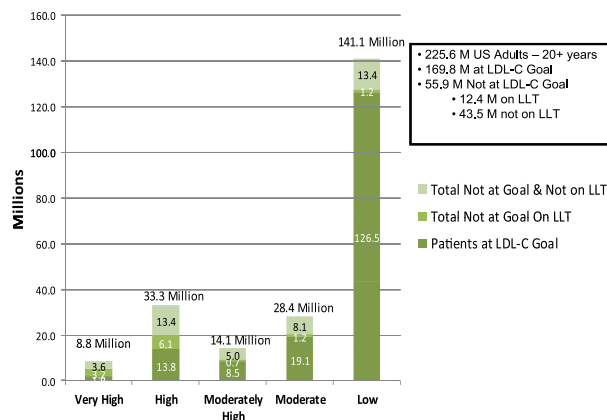
1. Characterize current EHR practices and determine the nature of the current barriers to achieving LDL-C goals.
2. Understand how HIT can facilitate LDL-C goal attainment in high-risk patients.
3. Identify potential HIT-based interventions that can be objectively evaluated and subsequently used in various practice settings to improve LDL-C goal attainment.
4. Make recommendations for quality improvement (QI) projects to improve LDL-C goal attainment.
5. Publish workshop proceedings and literature review findings.

To achieve these objectives, an outstanding faculty was assembled along with the workshop committee of experts that represented various disciplines and backgrounds, including participants from academic medical centers, health

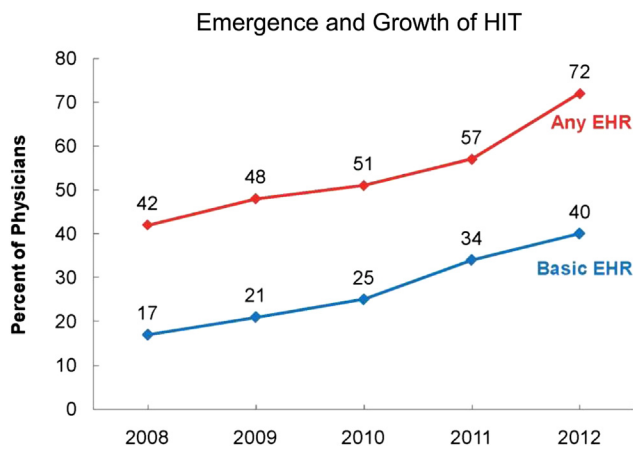
### Statin compliance over time



**Figure 2** Barriers to statin compliance.<sup>9</sup> This figure is part of the National Lipid Association Toolkit and is also included in a supplement in the Fall 2013 issue of the National Lipid Association's Lipid Spin. SE, side effects.



**Figure 4** Estimated number of US adults at LDL-C goal, stratified by degree of risk for a coronary heart disease event. Estimate is based on National Health and Nutrition Examination Survey 2007–2010, extrapolated to 2010 US Census data. Risk stratification was based on the Adult Treatment Panel III update, 2004. LDL-C, low-density lipoprotein cholesterol; LLT, lipid-lowering therapy. Courtesy of D. Neff (Merck & Co, Inc; unpublished data).



**Figure 5** Emergence and growth of HIT.<sup>85</sup> EHR, electronic health record HIT, health information technology.

care policy organizations, large health care systems, as well as the HIT and pharmaceutical industries. The workshop consisted of formal presentations by the faculty and experts, followed by extensive discussions by all attendees.

The workshop began with a keynote address by Tom Valuck, MD, JD, from National Quality Forum (NQF) on how current policy and market trends are driving progress and change in HIT.

### Health care in evolution

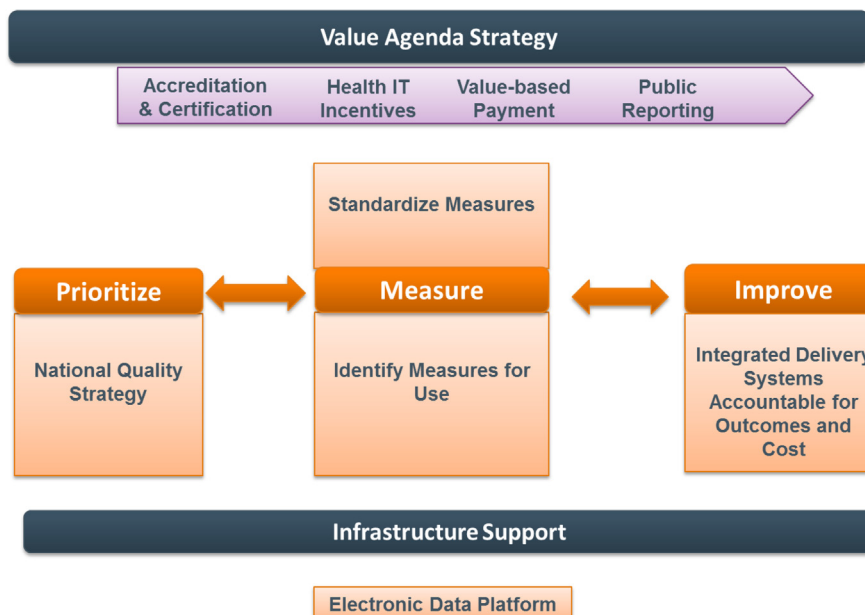
Health care is changing in response to intense pressure to control costs while increasing quality, that is, to increase the value of health care services. Clinically integrated delivery systems, such as accountable care organizations and medical homes, are emerging with the goal of achieving patient-centered, coordinated care. Health care

policymakers and payers are increasingly using incentives, including performance-based payment and public reporting, to reward achievement and to engage consumers and other stakeholders in decision making. All of these changes require a robust electronic data infrastructure to supply the information needed for improvement.

A framework for understanding how the essential pieces of the health care Value Agenda fit together is presented in Figure 6. The Value Agenda strategy focuses on 3 functions: prioritize, measure, and improve. Prioritization determines what to improve. Standardized measurement determines status relative to priorities and progress over time. Improvement of clinical quality and cost of care is supported by integrated delivery models, and an electronic data platform underpins the strategy, while overarching policy approaches use measurement information to drive desired change.

### Priorities for improvement: The starting place

Having clear and consistent priorities help focus efforts to achieve common goals more rapidly. The Affordable Care Act called for a National Quality Strategy to establish aims and priorities for the American health care system. In 2010, the Department of Health and Human Services published the initial National Quality Strategy, depicted in Figure 7. The National Quality Strategy consists of 3 aims and 6 priorities. The aims balance better care, the traditional focus of health care, with better health and affordability. The priorities correspond to the aims: better care is achieved through patient-centeredness, safety, care coordination, and effective treatment; better health is achieved



**Figure 6** Value agenda strategy. The authors thank the National Quality Forum for supplying this figure. IT, information technology.



**Figure 7** National Quality Strategy aims and priorities. The authors thank the National Quality Forum for supplying this figure.

through prevention and well-being; and affordability is a priority unto itself.

**Measurement: Evolving to meet emerging needs**

Measurement is a necessary condition for targeted and sustained improvement, but measurement is insufficient to achieve higher quality without effective improvement strategies. Besides providing essential information to support improvement of care processes and outcomes, measurement also provides information about the performance of physicians and other providers that purchasers and consumers of health care need for selecting the highest performing providers.

The best quality measures address topics that the evidence shows are important opportunities for improvement; are statistically valid and reliable and appropriately adjusted for comparability; provide information that is useful for the intended purpose, such as for QI or performance incentives; are able to be implemented without undue burden on providers; do not produce unintended, undesirable effects; and are harmonized with other measures already in use. These measure properties are the basis for the NQF’s endorsement criteria.

As the needs for quality measures change, the measures themselves are changing. New delivery and payment models demand additional outcome measures, composite measures of processes and outcomes, cost of care measures, and measures that are specified for electronic reporting. Patient-reported measures, such as health-related quality of life, functional status, symptoms, healthy behaviors, and

patient experience, are extremely valuable indicators of the outcomes most important to patients and to keeping populations healthy. Patient-reported information is increasingly available through new data collection methods, such as computer-assisted surveys, biomonitoring devices, and social media. The next frontier of measuring value is efficiency measurement, which links clinical quality outcomes and cost of care. Figure 8 provides a graphic representation of the components of efficiency measures and shows that value is a function of efficiency in the context of preferences.

Many gaps exist in the measures currently available. These need to be filled to provide meaningful clinical quality and cost information to assess value and to support performance improvement. Filling the gaps will require concerted efforts of many stakeholders across the system. Researchers supply the evidence of an opportunity for improvement under the National Quality Strategy, measure developers provide specifications and test measures, NQF endorses measures, and public policymakers and private program implementers use measures for various purposes. The federal government, primarily the Centers for Medicare & Medicaid Services (CMS) and the Agency for Healthcare Research and Quality, sponsors many of these stages of the measurement lifecycle.

**Data infrastructure for improvement: No silver bullet**

The ability to measure quality is limited by the available data sources. When adequate data are available, they should be leveraged for as many appropriate uses as possible. For example, the same data that are needed for quality measurement can also be used for clinical decision support (CDS). Currently available data sources include diagnosis codes and limited pharmacy information from administrative claims, clinical laboratory results, clinical data registries, and EHRs. Unfortunately, these data systems typically lack interoperability; that is, they cannot communicate with one another. Lack of interoperability limits ability to track patient care across settings and to assess the health status of



**Figure 8** Measuring cost, efficiency, and value of care. The authors thank the National Quality Forum for supplying this figure.

populations, leading to higher potential for medical errors and suboptimal disease management. EHR certification and Health Information Exchanges are efforts to enable efficient information exchange and to minimize the chances of such problems.

Quality measurement is in a transition phase from low value data elements contained in claims and paper-based chart abstraction to electronic measures that capture the essential elements of quality care in a structured way from electronic sources. Electronic measures cannot be derived from simply translating paper-based measures because electronic systems are intended to capture information during workflow. De novo measure development is required. Electronic measure development is resource and time intensive, but it presents an important opportunity to align interoperable data elements for all sources and uses, including EHRs, clinical data registries, patient portals, and CDS.

### Incentives for improvement: Using measurement information to drive change

Performance measurement information can be used in many ways to encourage change, with all uses sharing the ultimate goal of improving health outcomes. One way of organizing the array of potential uses of information is on a spectrum of accountability and transparency, as portrayed in Figure 9. Physicians and other health care providers use performance information for QI; medical boards, the National Committee for Quality Assurance, and The Joint Commission use information for certification and accreditation; CMS, the Office of the National Coordinator, and private-sector payers and purchasers use information for payment incentives; and CMS, consumers, purchasers, and regional alliances use information for public reporting.

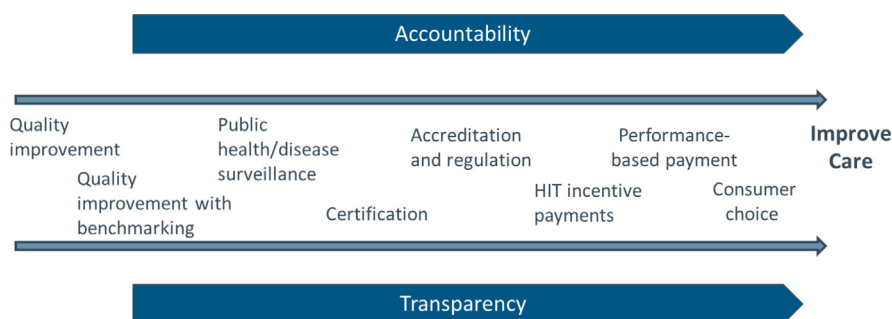
Performance-based payment and public reporting reward achievement and provide strong incentives for performance improvement; however, using performance measurement information for incentive programs can also cause unintended, undesirable effects. Incentive programs may shift resources away from providers who care for the most vulnerable and difficult patients, which could lead physicians and other health care providers to avoid

accepting those patients. What is measured gets attention and resources, sometimes unduly distracting from other improvement priorities. Providers often complain that they do not fully control the outcomes of what is being measured because patients are not adherent to their treatment plans, or other health care providers are not doing their part. Others argue that performance incentives in the form of “carrots and sticks” suppress professionals’ intrinsic motivation. Policymakers and program implementers must have feedback loops to ensure that programs are having desired effects, as well as effective monitoring systems to detect and mitigate potential unintended consequences.

The plethora of incentive programs, mostly using different performance measures, has created a heavy burden of data collection for physicians and other health care providers. Physicians are collecting data for Medicare, Medicaid, regional collaboratives, private sector payers, board certification, QI projects, and other purposes. Efforts are under way to align the performance measures being used across these programs. The federal government has committed to health care providers reporting once for multiple purposes, such that a physician reporting to a clinical data registry or maintenance of certification program could request that same performance measurement information be used to satisfy reporting requirements for the Physician Quality Reporting System, Physician Compare, and meaningful use programs.

### Implications for NLA’s LDL-C goal attainment initiative

Dramatic changes in health care are creating unprecedented opportunities for improving quality of care. Stronger evidence, better quality measures, enhanced modes of gathering and sharing information, and new models for delivery and financing are converging to support efforts such as the initiative of the National Lipid Association (NLA) to improve LDL-C goal attainment through use of HIT. The initiative is focused on intervention, LDL-C management and control, that were found to dramatically reduce death from heart disease<sup>1</sup>; however, LDL-C control has not improved for US patients with cardiovascular conditions in recent years.<sup>10</sup> This evidence strongly supports



**Figure 9** Applying performance measurement information. The authors thank the National Quality Forum for supplying this figure.

the need for physicians to intensify their focus on LDL-C goal attainment; however, physicians need the right information to support their efforts. NQF has endorsed the 19 measures related to lipid management listed in Table 1. These measures can be used to provide physicians who participate in the initiative with information about their performance, as well as to track the aggregate effect of the initiative over time. Furthermore, advances in HIT are making data available for multiple purposes beyond measurement, including CDS. This initiative presents the opportunity to test the effectiveness of various approaches to providing real-time information to physicians at the point of care.

## Discussion

Dr Brown asked if a health care practice was achieving the reported NQF outcomes measures, whether it was necessary to document the associated process measures. Dr Valuck responded that the NQF was focusing on outcomes measures and that, to reduce reporting burden, it was not necessary to report process measures. Dr Brown followed up asking why payment reform has resulted in a 30% payment reduction to cardiologists for achieving a 30% reduction in death from cardiovascular disease (CVD). Dr Valuck said it was an unresolved question whether

payment that reprioritizes health over care will be an improvement.

Dr Cohen asked what are the incentives to use NQF measures, and Dr Underberg asked about measure validation. Dr Valuck said that using measures for high-stakes purposes, such as public reporting, require that the measures be scientific, standardized, valid, and reliable to allow comparison across persons and organizations. Measurement testing for validation is an expensive, time-consuming process that involves population selection, patient exclusions, and risk adjustments to ensure scientific soundness.

Another attendee asked who has clinical ownership of a patient outcome measure when multiple, independent health care providers co-manage a patient. Dr Valuck replied that, although this is a problem for individual physician reporting, the NQF's National Quality Strategy is promoting a systems-oriented, integrated team-based care approach that aligns and coordinates all health care providers around a patient. Medicare Accountable Care Organizations and Patient-Centered Medical Homes are moving health care in a direction that focuses on systems organizations and population health rather than individual health care transactions.

The presentation by Ronald Scott, MD, of the Kaiser Permanente (KP) Group (Oakland, CA) focused on the KP experience in developing CDS systems.

**Table 1** National Quality Forum-endorsed lipid measures

### Process

1. Chronic stable coronary artery disease: lipid control (0074)
2. Anti-lipid treatment discharge (0118)
3. STK-06: discharged on statin medication (0439)
4. Adherence to statin therapy for individuals with coronary artery disease (0543)
5. Adherence to statins (0569)
6. Dyslipidemia new med 12-week lipid test (0583)
7. Hyperlipidemia (primary prevention) – lifestyle changes and/or lipid-lowering therapy (0611)
8. Atherosclerotic disease – lipid panel monitoring (0616)
9. Diabetes with LDL-C greater than 100 – use of a lipid-lowering agent (0618)
10. Atherosclerotic disease and LDL-C greater than 100 – use of lipid-lowering agent (0636)
11. Statin prescribed at discharge (0639)
12. Statin therapy at discharge after lower extremity bypass [LEB] (1519)
13. Laboratory testing [lipid profile] (1668)
14. Cardiovascular health screening for people with schizophrenia or bipolar disorder who are prescribed antipsychotic medications (1927)
15. Cardiovascular monitoring for people with cardiovascular disease and schizophrenia [SMC] (1933)

### Intermediate outcome

16. Chronic stable coronary artery disease: lipid control (0074)
17. Ischemic vascular disease (IVD): complete lipid profile and LDL-C control <100 mg/dL (0075)

### Composite

18. Optimal vascular care (0076)
19. The STS CABG composite score (0696)
20. Therapy with aspirin, P2Y12 inhibitor, and statin at discharge after PCI in eligible patients (0964)

LDL-C, low-density lipoprotein cholesterol; PCI, percutaneous coronary intervention; STS CABG, Society of Thoracic Surgeons coronary artery bypass grafting.

Numbers in parentheses are NQF measurement codes.

The authors thank the NQF for supplying this table.

## HIT implementation

KP uses evidence-based Healthcare Effectiveness Data and Information Set (HEDIS) measures for lipid screening and control in its EHR-based tools. The primary goal of enlisting providers and other staff in the task of improving lipid control is to deliver easy, actionable, point-of-care tools into the EHR and to ensure that these are integrated into the delivery system, workflows, and operational infrastructure.

To succeed, standard workflow integration must be streamlined, efficient, and integrated at the lowest permissible, desired practice scope. For instance, receptionists and medical assistants are trained and prompted to refer patients to the laboratory for LDL-C testing, if appropriate. This process is supported by implementation tools, training, and monthly feedback to individual receptionists and medical assistants of how well they are referring patients to the laboratory.

KP Southern California (SC) manages >55 quality metrics programs that are prioritized by high-level leadership and managed by quality champions who are responsible for engaging front-line providers and for getting decision support implemented and quality goals achieved.

## Point-of-care tools

Permanente Online Interactive Network of Tools (POINT) is a separate, interactive database or registry developed by KPSC that nightly exchanges information with the EHR, laboratory and pharmacy systems, and claims data to identify care gaps across a wide range of conditions, including diabetes, hypertension, CVD, and chronic kidney disease. Selecting “Cardiovascular Conditions” presents a report for 120,000 patients in the Southern California region with histories of CHD, stroke, peripheral arterial disease, and others in which the KP guidelines recommend lipid control. Patients can be categorized by region, medical center, office building, department, provider, and care gaps. Lipid care gaps include missing information for LDL-C, LDL-C being greater than goal, low adherence to statins, or missing information about statin adherence. Selecting each care gap category displays a list of affected patients for provider outreach efforts.

In addition to the POINT registry, point-of-care tools include those by Epic Systems (Verona, WI) of Best Practice Alert, Smart Set, and Smart Rx with Web links. Accepting the Epic pop-up alert of “Patient is a member of the diabetes or CVC registry with LDL-C above goal” takes the provider to the Smart Set orders for atorvastatin 40 mg per day, lipid panel in 6 weeks, and patient instructions on statins. Alternatively, a provider can enter “DYS” for dyslipidemia into Smart Rx to bring clinical guidance into the EHR with Web links for statin drug interactions, guideline postings, and medicine recommendations. Clicking atorvastatin 40 mg places the order and

labels it for the patient with “take 1 tablet daily to lower cholesterol and keep arteries open.”

The POINT-enhanced decision support for CVD is “STAY CV protected”, where “S” stands for statin starts, “T” for titration, “A” for adherence, and “Y” for Yes, positive feedback and member engagement. Activating POINT checks occurs if a patient has a qualifying diagnosis in the registry and is not on a statin. If so, POINT recommends starting with atorvastatin 40 mg and displays the last lipid panel, the date, and the medication list. POINT also checks for listed statin allergies as well as muscle or liver disease to advise lower doses in these patients.

For clinician acceptance, CDS must exhibit the right alert on the right patient. All diagnostic codes are reviewed for sensitivity and specificity before incorporation into POINT as an inclusion criterion. For instance, the code for transient ischemic attack is not specific enough because emergency room physicians often select this diagnosis for vague neurologic symptoms.

For patients who do not have a known cardiovascular condition or diabetes, POINT also calculates a Framingham risk score as another inclusion criterion for risk reduction treatment. The display shows before statin and current Framingham risk score values for patient education to encourage statin adherence.

For patients who potentially require statin titration, POINT determines whether a patient is adherent by calculating “days of supply remaining” and “medicine refill adherence ratio,” which is how often a patient has refilled his or her medicine during 18 months. For adherent patients, POINT recommends an uptitration dose. For nonadherent patients, POINT alerts providers to “explore statin adherence.” Organizationally, KP trains and encourages providers to explore statin adherence barriers with patients, to partner with patients, and to try to overcome those barriers.

To give positive feedback if patients are adherent to their statins with LDL-C at goal and to encourage continued medication adherence, the KPSC encourages providers to use letters that state “Congratulations, your cholesterol is much improved! Continue your cholesterol medicine to help keep your arteries open.”

KPSC also uses secure messaging on their Web site to allow patients to interact with their providers. Approximately 55% of patients use this feature, and, in a study, these patients were more likely to reach targets on multiple quality metrics, including LDL-C screening and control. Within the past year, the Web site introduced the Personal Action Plan whereby members can see their own LDL-C as well as decision support similar to what providers see. For example, patients with CVD may see messages that their LDL-C is too high, that they are due for another test, or that they need to refill or improve adherence to their statin. For primary prevention, the Personal Action Plan presents the patient’s Framingham risk score by using data from the health record and gives patient-friendly, appropriate advice similar to what providers see.



## Inreach and outreach

Whenever a patient is at a KP medical facility, the health care team is trained and encouraged to close care gaps through “inreach.” Medical assistants, licensed practical nurses, and pharmacists follow computerized, integrated, customized lists of care gaps while interacting with patients. For example, a nurse in any department checking a patient may see a message, “lipid panel due.” The nurse will alert the patient and encourage the patient to go to the laboratory for lipid screening. For lipid screening, POINT will check if the patient goes to the laboratory within 30 days of interacting with the nurse. Nurses and support staff members are monitored for closing care gaps, are provided feedback if they do not consistently close gaps, and are monetarily rewarded for how well they close care gaps.

KPSC uses visit-independent regional and local coordination of “outreach” by using mass outreach calls, letters, and e-mails to advise patients to take action as well as providing an EHR for health care providers of all outreach attempts to reinforce the message. Examples for lipids include a refill reminder call or laboratory testing reminder if patients are due for a lipid panel.

## Adherence

KPSC has a sophisticated medicine adherence program. Typically, approximately 12% of statin prescriptions are never filled (primary nonadherence), whereas another 12% fill the prescription but never take the medicine.<sup>13</sup> Of the remaining 76% of patients, 29% never refill the prescription (secondary nonadherence), leaving only 47% of patients adherent after a year.

To reduce primary nonadherence rates, Derose et al<sup>14</sup> in the KPSC region performed a randomized trial that used automated telephone outreach with speech recognition and showed improved fill rates for statin prescriptions. Spanish-language outreach to Spanish-speaking patients resulted in a higher adherence rate than did English-language outreach to English-speaking patients, suggesting language or communication barriers probably play a significant role in primary nonadherence. A similar program of automated reminders for overdue refills exists for secondary nonadherence. For inreach in some KPSC pharmacies, outpatient pharmacists are trained and prompted to explore and address nonadherence and barriers to statins during patient encounters, including if the patient is picking up non-statin medicines.

KP Northern California published a study showing that patients who received refills by mail are more likely to remain adherent; therefore, patients are provided free shipping for refills throughout the system. In addition, medication adherence messages are incorporated into health education classes and patient educational materials.

## Team care and systems level tools

At KPSC, care teams are organized around a primary care physician (PCP), a care manager, and a support coordinator. The care manager is either a clinical pharmacist or specially trained registered nurse who partners with approximately 10 PCPs and their patients. The care manager uses telephone and e-mail to reach out to patients and to help them get to goals. The support coordinator provides logistical and clerical support for the care manager. Support coordinators check on whether patients undergo scheduled laboratory testing, fill initial prescriptions and pick up refills, and gather feedback and adherence data from patients. The support coordinators are trained to provide self-management support and to help patients overcome barriers.

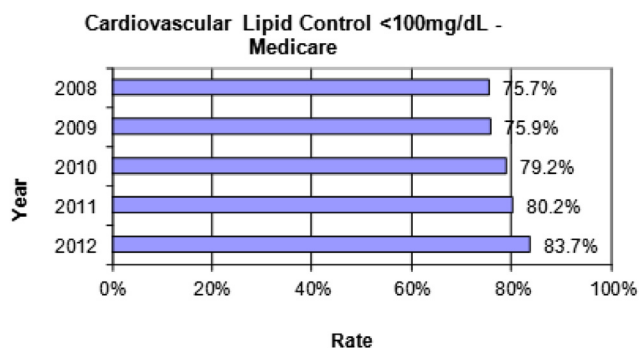
At monthly intervals, PCPs meet with their team to review an actionable list of patients with care gaps. For example, the care manager will ask the PCP to authorize a patient who needs statin up-titration, and the care manager will adjust the dosage, contact the patient, and arrange for follow-up testing. The support coordinators will follow up with the patient if they are nonadherent with the treatment change.

PCPs also receive periodic performance feedback on LDL-C control among their panel of patients. Provider reports are benchmarked unblinded against their peers. Quality lead peers (who often are high performing) and care managers in the module work with lower-performing PCPs to help them improve their quality metrics. New PCPs commonly struggle with performance metrics because they inherit patients without a physician, but, with feedback, quality coaching, and support, performance quickly improves.

KPSC also produces monthly quality reports for all physicians in a module compared with other modules at a medical center. The module quality leader will meet with all members in the module to compare and discuss performance-run charts, looking to identify modules with best practices that can be taught and disseminated to the members in other modules. KPSC also extends this quality reporting and feedback across all 13 medical centers that cover 3.6 million patients to identify best practices for sharing among medical centers and to find solutions to barriers at low-performing medical centers.

Similarly, KP also has quality meetings across the different regions to improve performance. Most of the regions have achieved greater than the HEDIS 90th percentile on LDL-C <100 mg/dL control. For 2012, the KPSC HEDIS rate was 83.7% LDL-C control among Medicare members with cardiovascular conditions (Fig. 10). In both Medicare and commercial insurance plans, KPSC was number 1 in California and number 3 nationally with HEDIS LDL-C control.

Lipid quality improvement efforts at KP are having a beneficial effect on outcomes. Yeh et al<sup>15</sup> reported a 24% relative decrease in myocardial infarction (MI) from 1999 to 2008.



**Figure 10** Kaiser Permanente Southern California LDL-C <100 mg/dL among Medicare members with cardiovascular conditions, Healthcare Effectiveness Data and Information Set. LDL-C, low-density lipoprotein cholesterol.

KPSC is pursuing many quality metrics besides LDL-C control by using the same multispecialty, multidisciplinary quality reporting and feedback meetings to share best practices and to find solutions for barriers previously described for LDL-C control. For lipid control in cardiovascular conditions, KPSC improved 34.5% from 2004 to September 2012 (Table 2). For blood pressure control, the improvement was 43.5%. Similar substantive QI was seen in many other areas as shown in Table 2. Current initiatives for primary prevention lipid treatment have a 30% to 50% improvement potential over the next 5 years, which would have important ramifications for reducing MI rates in KPSC because of the huge target population.

**Discussion**

The workshop attendees asked Dr Scott about which components of the KPSC system might have the biggest effect when implemented in other health care settings. Dr Scott emphasized that leveraging staff and directly engaging patients electronically were high yield for QI as well as workflow changes that save physicians’ time. In addition, other settings should take maximum advantage of existing tools to improve quality.

**Table 2** Improvements by Kaiser Permanente Southern California in a variety of metrics associated with CVCs from 2004 to 2012

	Increase, %
Lipid control (CVC and DM)	34.5
Blood pressure control	43.5
HbA <sub>1c</sub> < 9.0	13.5
Smoking cessation	17.0
Breast cancer screening	11.1
Colon cancer screening	35.8
AAA screening 2011–2013	28.2

AAA, abdominal aortic aneurysm; CVC, cardiovascular condition; DM, diabetes mellitus; HbA<sub>1c</sub>, glycosylated hemoglobin.

Attendees were also interested in what processes KPSC had in place for behavioral and lifestyle changes. Dr Scott described the registered dietitians that run behavioral change and diet programs for both weight and cholesterol management. In addition, KPSC has extensive flyers, letters, and educational materials at the point of care for providers to educate patients, as well as online programs through the KPSC Web site. Amount of exercise is treated as a vital sign that the staff collects and enters into the EHR.

Karen Aspry, MD, MS, presented the results of a literature review of the effect of HIT interventions on lipid outcomes, undertaken by a subcommittee that also included Ron Furman, MD, PhD, Terry Jacobson, MD, Dean Karalis, MD, and Audrey Zhang, BS.

**Literature review of the effect of HIT on lipid outcomes**

The committee was charged with conducting a qualitative literature review on the effect of HIT tools on lipid treatment process and outcomes measures in ambulatory patients with CHD, diabetes, or at high risk (Table 3). Process measures included changes in lipid screening, medication prescribing, dose titration, medication adherence, and treatment referrals. Clinical outcomes included changes in lipid goal attainment, lipid levels, 10-year CHD risk score, or hospitalizations for cardiovascular events. After a search of Medline and Google scholar databases by using Medical Subject Headings terms related to “medical informatics” and “cholesterol,” and a hand search of the bibliographies of relevant review articles, a total of 34 randomized controlled trials, conducted mostly in community or academic primary care settings between 1999 and 2013, met study inclusion criteria. All studies were rated for quality by using the US Preventive Services Task Force scale and for strength of evidence by using the National Heart, Lung, and Blood Institute scale. Interventions were classified by the committee according to the principal HIT user: provider (12 studies), patient (10 studies), provider and patient equally (4 studies), or health care system (8 studies), although overlap existed within these categories.

**Provider-level HIT interventions**

Twelve studies evaluated a range of provider-level HIT tools for improving lipid process or clinical outcomes or both.<sup>16–27</sup> All tested some form of CDS delivered via a personal digital assistant, Web-based tool, or EHR, including guideline support in all 12 studies, medication support in 8 studies,<sup>17–19,21–23,25,27</sup> and use of a risk calculator in 2 studies.<sup>20,25</sup> CDS was linked to an alert in 7 studies<sup>18,20–24,27</sup> and to computerized provider order entry (CPOE) or electronic prescribing (e-prescribing) in 2 studies.<sup>18,21</sup> Six of the 12 provider-level studies reported positive process outcomes.<sup>17,20–22,24,25</sup> Only 3 studies reported

**Table 3** Characteristics and outcomes of studies included in literature review

First author or source of study, year, country	Setting	Design, duration, mo	Eligibility; No. of participants	Interventions	Lipid outcomes vs control
<b>Provider HIT interventions</b>					
Bertoni, 2009, USA <sup>25</sup>	Community primary care	Cluster RCT, 24	Primary prevention not on lipid therapy; 5057	CDS (via PDA): risk calculator, guidelines, medication support	Increased appropriate treatment
Smith, 2008, USA <sup>23</sup>	Academic primary care	Cluster RCT, 30	T2DM, high CVD risk; 635	CDS (non-EHR): guidelines, medication advice, alerts, virtual consults	No effect
Cleveringa, 2008, Netherlands <sup>22</sup>	Community primary care	Cluster RCT, 12	T2DM; 3291	CDS (non-EHR): guidelines, medication advice, reporting	Decreased LDL-C at 1 y
Mehler, 2005, USA <sup>19</sup>	Community primary care	Cluster RCT, 15	T2DM, >40 y; 884	CDS (non-EHR): e-academic detailing, guidelines, medication advice	Increased screening
Meigs, 2003, USA <sup>17</sup>	Academic primary care	Cluster RCT, 12	T2DM; 598	CDS (non-EHR): guidelines, medication support	Increased screening; increased percentage at goal
Hetlevik, 1999, Norway <sup>16</sup>	Community primary care	Cluster RCT, 18	HTN; 2239	CDS (non-EHR): guidelines	No effect
O'Connor, 2011, USA <sup>27</sup>	Community primary care	Cluster RCT, 12	T2DM; 2556	CDS (via EHR): alerts, guidelines, medication support	No effect
O'Connor, 2009, USA <sup>26</sup>	Community multispecialty	Cluster RCT, 12	T2DM; 2020	CDS (via simulated EHR): virtual patients ± KOL feedback	No effect
van Wyk, 2008, Netherlands <sup>24</sup>	Community primary care	Cluster RCT, 12	Primary prevention not on lipid therapy; 6163	CDS (via EHR): alerts, guidelines	Increased screening; increased treatment
Lester, 2006, USA <sup>21</sup>	Academic primary care	RCT, Single site, 12	CHD or equivalent, LDL-C > goal for >6 mo; 235	CDS (via EHR-e-mail interface): guideline, medication advice, CPOE, eRx, letter	Increased treatment; increased titration; decreased LDL-C if baseline was >130 mg/dL
Sequist, 2005, USA <sup>20</sup>	Academic and community primary care	Cluster RCT, 6	T2DM and CAD; 6243	CDS (via EHR): reminders	T2DM: increased screening; CAD: increased treatment
Tierney, 2003, USA <sup>18</sup>	Academic primary care	Cluster RCT, 12	Ischemic heart disease or CHF; 706	CDS (via EHR): guidelines, medication advice, CPOE, eRx	No effect
<b>Patient HIT interventions</b>					
Vernooij, 2012, Netherlands <sup>37</sup>	Academic primary care	RCT, 12	ASVD, LDL-C > goal; 330	Web portal; tailored education; e-mail to NP	Decreased risk score
Glasgow, 2012, USA <sup>36</sup>	Primary care, Kaiser Permanente Colorado	RCT, 12	T2DM, BMI ≥ 25, ≥1 risk factor; 463	Web portal ± phone contact ± group visit	Decreased TC-to-HDL-C ratio

*(continued on next page)*

**Table 3** (continued)

First author or source of study, year, country	Setting	Design, duration, mo	Eligibility; No. of participants	Interventions	Lipid outcomes vs control
Sheridan, 2011, USA <sup>35</sup>	Academic primary care	RCT, 3	Primary prevention at risk; 165	Web portal at POC; risk calculator; tailored education	Decreased 10-y risk score
Webster, 2010, Australia <sup>34</sup>	Any adult	RCT, 21	Population-wide; 2099	Consumer Web site treatment algorithm	Increased referrals
Grant, 2008, USA <sup>33</sup>	Academic and community primary care	Cluster RCT, 12	T2DM, HbA <sub>1c</sub> > 7 or on Rx; 244	PHR linked to EHR	Increased treatment
Bond, 2007, USA <sup>31</sup>	Academic specialty care	RCT, 6	DM >1 y, age ≥ 60 y; 124	Web portal; e-messaging or online chat with nurse	Decreased TC; increased HDL-C
Grover, 2007, Canada <sup>32</sup>	Community primary care	RCT, 12	CVD, DM, or at risk; 3053	Risk calculator; vascular age	Decreased LDL-C, TC; Increased percentage at lipid goals
Shea, 2006, USA <sup>30</sup>	Community and urban primary care	Cluster RCT, 12	T2DM, ≥55 y; 1665	Telemedicine unit monitoring; web education; messaging to NP; SMS to patients	Decreased LDL-C and TC
Harno, 2006, Finland <sup>29</sup>	Community and academic primary care	RCT, 12	T2DM; 175	SMS to patients	Decreased LDL-C
Verheijden, 2004, Canada <sup>28</sup>	Academic primary care	RCT, 8	T2DM or HTN dyslipidemia; 146	Web Portal; nutrition counseling; messaging	No effect
Provider + patient HIT interventions					
Benner, 2008, Europe <sup>38</sup>	Community primary care	Cluster RCT, 6	HBP and FHRS > 10%; 1103	CDS (PDA-based): risk calculator, heart health report	Improved LDL-C goal attainment; decrease in calculated 10-y CHD risk
Holbrook, 2009, Canada <sup>39</sup>	Community primary care	Cluster RCT, 12	T2DM; 511	CDS (Web): risk tracker, alerts, guidelines, medication advice	No effect on LDL-C, decreased BP
Holbrook, 2011, Canada <sup>40</sup>	Community primary care	Cluster RCT, 12	Primary prevention at risk; 4105	CDS (PDA-based): risk calculator; heart age tool	Significant in subgroups only
Eaton, 2011, USA <sup>41</sup>	Community and academic primary care	Cluster RCT, 12	Primary prevention; 4105	CDS (PDA-based): risk calculator; heart age tool	Subgroup: improved lipid goal attainment; improved screening rate
System-level HIT interventions					
Derose, 2013, USA <sup>14</sup>	Kaiser Healthcare System, Southern California	RCT, 12	Primary statin nonadherence; 5216	Pharmacy database monitoring and automated phone messaging	Improved statin adherence at 2 wk and 1 y

Pape, 2011, USA <sup>45</sup>	Network primary care	Cluster RCT, 24	T2DM; 6963	Pharmacist outreach approved by PCP	Increased screening and treatment; decreased LDL-C; increased percentage at goals
Persell, 2013, USA <sup>48</sup>	Academic primary care	Cluster RCT, 9	Primary prevention at risk; 435	EHR database monitoring; automated mail from PCP	Increased treatment at 9 mo and decreased LDL-C at 18 mo
Peterson, 2008, USA <sup>42</sup>	Community primary care	Cluster RCT, 24	T2DM; 7101	Non-EHR database monitoring; provider alerts; patient outreach	Improved process measures and all-or-none (HbA <sub>1c</sub> , SBP, LDL-C)
Selby, 2012, USA <sup>46</sup>	Kaiser Permanente Northern California	Cluster RCT, 6	T2DM with CVD ± CKD; 12,582	Non-EHR database monitoring; phone outreach by non-PCPs	Decreased LDL-C at 3 mo; no effect at 6 mo
Kooy, 2013, Netherlands <sup>47</sup>	Community pharmacies	RCT, 12	Secondary statin nonadherence; 1017	Pharmacy database monitoring; personal electronic reminder device	Improved statin adherence in women only
Simon, 2010, USA <sup>44</sup>	Harvard Pilgrim Health Plan	Cluster RCT	T2DM; 1200	Healthplan database monitoring; automated phone outreach	No effect
Gilutz, 2009, Israel <sup>43</sup>	Community primary care	Cluster RCT, 6–36	CAD; 7448	Hospital database monitoring; written provider reminders	Decreased LDL-C if > 120 mg/dL; decreased hospital admissions

ASVD, arteriosclerotic vascular disease; BMI, body mass index; BP, blood pressure; CAD, coronary artery disease; CDS, clinical decision support; CHD, coronary heart disease; CHF, congestive heart failure; CKD, chronic kidney disease; CPOE, computerized provider order entry; CVD, cardiovascular disease; DM, diabetes mellitus; EHR, electronic health record; e-, electronic; FHRS, Framingham risk score; HbA<sub>1c</sub>, glycosylated hemoglobin; HBP, high blood pressure; HDL-C, high-density lipoprotein cholesterol; HIT, health information technology; HTN, hypertension; KOL, key opinion leader; LDL-C, low-density lipoprotein cholesterol; NP, nurse practitioner; PCP, primary care provider; PDA, personal digital assistant; PHR, personal health record; POC, point of care; RCT, randomized controlled trial; Rx, prescription; SBP, systolic blood pressure; SMS, short message system; T2DM, type 2 diabetes mellitus; TC, total cholesterol.

positive clinical outcomes, with effects that were considered moderate to large.<sup>19,21,24</sup> In 2 of these 3 studies, CDS was embedded in or linked to the EHR with a non-bypassable active alert,<sup>21,24</sup> and in 1 of these studies the alert was linked to CPOE and e-prescribing.<sup>21</sup> The committee noted that only 3 of the 12 studies to evaluate provider tools were rated as good quality, possibly influencing outcomes. Overall, the data suggested that HIT interventions that rely principally on the health care provider may be insufficient to improve clinical measures of lipid control.

### Patient-level HIT interventions

Ten studies evaluated patient-level HIT tools for improving lipid process or clinical outcomes.<sup>28–37</sup> Most tested some form of general or tailored risk factor education or tracking delivered via a Web site, Web portal, or telemedicine program, and 6 of these provided connectivity to a health care provider (via e-mail, live chat, or other messaging).<sup>28,31–33,36,37</sup> Two studies tested the utility of a patient risk calculator or vascular age tool,<sup>32,35</sup> and 2 evaluated the utility of text messaging reminders to patients.<sup>29,36</sup> Six of the 10 patient-level HIT studies yielded positive clinical outcomes that were graded as small to moderate,<sup>29–32,36,37</sup> and another study yielded a positive process outcome that was graded as large.<sup>33</sup> There appeared to be an association between patient-level HIT tools with connectivity to the health care system and positive outcomes. Two of 2 studies that tested the utility of text reminders yielded positive clinical outcomes,<sup>29,36</sup> as did 1 of 2 studies that tested the effects of patient risk communication.<sup>32</sup> Taken together, the data suggest that patient-level HIT tools may provide practices with significant leverage for improving lipid control.

### Combined patient- and provider-level HIT interventions

Of the 4 studies that evaluated provider- and patient-level HIT tools used together,<sup>38–41</sup> all tested a combination of provider-level CDS (with a risk calculator, guideline support, or medication support) and patient-level tools (2 used a vascular age calculator,<sup>38,41</sup> 1 used Web support with connectivity to health care providers,<sup>40</sup> and 1 used text messaging of reminders).<sup>39</sup> Three of the 4 studies showed either a positive clinical or process outcome,<sup>38–40</sup> and 1 study showed a positive relationship between HIT and outcomes in post hoc analysis only.<sup>41</sup> Little association was found between the mix of health care provider- and patient-level tools, or study quality, and outcomes.

### System-level HIT interventions

Eight studies evaluated system-level HIT interventions for improving lipid process or clinical outcomes,<sup>14,42–48</sup> 2 within KP regional networks,<sup>14,46</sup> 1 each in a non-US

hospital or pharmacy network,<sup>43,47</sup> 1 by a US health insurer,<sup>44</sup> and 3 by large US primary care networks.<sup>42,45,48</sup> All involved monitoring an EHR-based registry or other clinical database for gaps in lipid process or clinical outcomes, followed by patient or provider outreach. In 4 of the 8 studies, outreach was to patients only, via phone calls by nonphysician providers or automated messaging, and in the other 4 studies there was some physician involvement.<sup>42,43,45,48</sup> Six of the 8 system-level interventions reported a positive process outcome,<sup>42,43,45,46,48</sup> and 4 of these reported a positive clinical outcome that was graded as moderate to large.<sup>14,42,43,45,48</sup> System-level patient outreach that involved some messaging by a health care provider was associated with better outcomes. Overall, the data suggest that health care system database monitoring combined with patient outreach via any method can improve lipid process and clinical outcomes, and health care provider involvement may add value.

### Summary

The subcommittee concluded that randomized controlled trials to test the utility of HIT interventions for improving lipid control and processes of care are limited in number, quality, generalizability, and efficacy at this time, with only 14 of 34 studies finding improvements in clinical outcomes. On the basis of the existing data, there is suggestion of a benefit from (1) provider HIT tools that contained CDS and linked to alerts and CPOE or e-prescribing; (2) patient tools that provide connectivity to the health care system and communicate risk or vascular age; and (3) health care system interventions that use database monitoring with patient outreach by any method, preferably with some PCP involvement. In aggregate, the data suggest that health care provider tools alone may have little effect, and multifaceted interventions that include patient and system approaches may be required. However, the subcommittee also noted that the inability to find between-group differences in many provider-level studies may have been because of a high degree of baseline lipid treatment, temporal shifts toward more intensive treatment in both groups, underutilization of interventions by large proportions of active arm providers, and short study durations.

### Future research needs

The subcommittee suggested that future research in this area may be improved by developing more uniform HIT terminology and taxonomy, widening the scope of HIT studies to include those performed in more varied practice settings, using commercially available EHRs, using less rigorous study designs (including practical QI demonstration projects), and focusing on human and organizational factors that affect the adoption of HIT.

## Discussion

The panel discussion focused principally on the suitability of randomized controlled trials for showing QI. Several members of the panel noted that prospective before and after studies, or practical demonstration projects that identify barriers, are more suitable and applicable to real-world practices that attempt to improve lipid outcomes with HIT tools. Others noted that randomized controlled trials in this area have provided significant value by reporting how difficult it can be for even well-designed trials to improve lipid control in practice. Collectively, the trials inform us that it takes more than computer alerts to change outcomes and that interventions are more likely to succeed if they are multifaceted and involve patients, team-based care, and systems approaches.

Kaye-Eileen Willard, MD, presented an overview of the survey methodology subcommittee (including Roy Furman, MD, PhD, Ralph Laforge, MSc, and Penny Kris-Etherton, PhD, RD) which had been tasked with the development of a detailed, first-generation landscape survey tool to assess current status of LDL-C monitoring ([Appendix](#)).

### Survey methodology subcommittee overview and discussion

The survey responses were to be used to assess the diversity and capacity of various current, clinical practices in the real world. The practices chosen for this phase included physicians who were members of the NLA and were already using some form of EHR to address the identification and stepwise management of high-risk secondary prevention patients. Furthermore, the practices were lipid focused. The information from the responses was intended to identify best-practice guidelines that would facilitate the design of an electronic aid to improve treatment goal attainment in longitudinal management and risk reduction for patients at high CVD risk and for secondary prevention. We acknowledge that a survey of only 3 clinical programs can provide limited analysis and generalization, but it can provide a general idea of the diversity of NLA-member EHR capabilities.

The subcommittee submitted this survey to 3 model practices, representative of a cross-section of clinic types and patient populations as follows: (1) James Underberg, MD, MS, presented informative data about the system in use at a multispecialty internal medicine practice, affiliated with New York University (NYU); (2) Paul Ziajka, MD, PhD, directs a private lipid specialty referral clinic in central Florida and he discussed his clinic's interventions for risk reduction and LDL-C goal attainment in high-risk referral patients; and (3) Alan Brown, MD, from Midwest Heart Specialists – Advocate Medical Group, a multi-specialty cardiology practice in urban Chicago, Illinois, presented the efforts of their group over a period of several

years to first analyze and then optimize risk reduction in the high-risk patient.

The survey was designed to understand the effect of the introduction of an EHR lipid-monitoring tool into these practices and to delineate the challenges faced during that implementation, as well as the lessons learned and benefits achieved, if any. It was noted that the findings of the survey indicated, as expected, substantial diversity in the ability to identify, track, and report on patients and provider in these various systems. The action plan to be developed would be founded on the gap analysis identified from this survey tool, moving from current capacity toward a best-practice electronic aid for promoting not only good patient management but also setting a standard for electronic tools that would alert practitioners of the need for either initiating or intensifying lipid management.

The steps taken to construct the survey included definition of the following:

- The variable readiness for implementation of prototype clinical practices in terms of electronic tool use
- The current capacity to query, report, and trend lipid-centric outcomes
- The mechanism by which quality measurements for patients, physicians, and systems could be enhanced by studying the barriers to success as they currently exist

The survey design focused on the following:

- Demographics of the practice setting
- Pre-EHR state of readiness for implementation and where the impetus to change to electronic tools originated
- How this population of high-risk patients currently is being identified in the electronic record, and how attention is drawn to whether LDL-C targets have been attained
- Assessing the effect on resources, workflow, and practice efficiency, before and after implementation of the intervention
- Describing the effect (presumably positive) on clinical decision making, patient outcomes, and, ideally, disease end points afforded by present EHR systems, and whether pharmaceutical and lifestyle interventions could be correlated with laboratory data and risk reduction
- Understanding how specific mechanisms such as alerts, flags, and hard stops would affect patient and physician compliance and adherence
- Determining the current ability to provide outcome measurements, such as percentage of patients achieving goals for LDL-C control, and also to deliver reliable feedback to patients, physicians, and systems on these outcomes
- Assessing the capability of measuring and reporting therapeutic lifestyle compliance

These parameters were used to create the gap analysis of existing real-world systems and the definition of a best-practice standardized EHR tool.

The experience of the three lipid clinics that used HIT in different clinical settings to better manage high-risk patients was then presented.

## Model clinic: NYU-affiliated multispecialty internal medicine practice

James A. Underberg, MD, began his presentation on the NYU-affiliated practice with a story about the Great Fire in 17th century London, which stimulated a need for innovation in the construction of safe buildings. This disaster resulted in the development of fire and casualty insurance businesses, which ultimately worked collaboratively to also develop safety standards for building in London and elsewhere. The analogy centered on the current well-defined need to achieve uniform, systematic control of risk factors pertinent to the CHD epidemic. His presentation emphasized the importance of an entire system being jointly invested in the same outcomes of improved quality and adherence. He discussed the diversity within the NYU system and how a diverse institution with some private practitioners, as well as some who are university employed, can have major inherent barriers to success. The model is not unique and is widespread among health care practices.

The Murray Hill medical group in which Dr Underberg practices is a private multispecialty academic group practice affiliated with NYU and was described as a general internal medicine-focused practice run by 40 generalists and supported by 20 specialists in cardiology, infectious disease, endocrinology, rheumatology, gastroenterology, and rheumatology. All physicians have faculty positions, but with a mix of salaried and voluntary participation. The practice is staffed by medical students, residents, and fellows as part of a teaching institution. The practice has used Centricity EMR (GE Healthcare IT, Barrington, IL) since 1999. The demographics of the practice are 30% Medicare patients, 50% managed care, and 20% self pay, with an age of  $\geq 18$  years. The electronic record in this clinic has evolved into including not only clinic documentation but also e-prescribing and scheduling features, as well as the recent addition of direct e-messaging between patients and practitioners.

Dr Underberg identified several issues.

- Consistent integration of all laboratory data is absent from the 3 laboratory systems that support the clinics; therefore, currently approximately 25% of patients' laboratory work does not flow directly to the EHR.
- Cardiac risk factors, family history, and smoking history, as well as anthropometric indicators such as waist circumference and body mass index (BMI), must be entered as text and are therefore not searchable data points.
- Diagnostic codes can be searched alongside drugs, or classes of drugs, type of medication, laboratory values, when available, age, and sex, but diagnostic codes are often imprecise and inaccurate.
- The identification of percentage of patients at goal must be done manually to search for diagnostic codes consistent with secondary prevention patients, such as atherosclerosis and CAD.

- Framingham risk score must be actively calculated by the practitioner, and many of the criteria contributing to this score are not inputted automatically. In addition many practitioners do not have a clear understanding of the appropriate use of the Framingham risk score, to be reserved for patients with 2 or more cardiac risk factors.
- Often the EHR systems in hospitals and medical groups, although clinically integrated, do not communicate with each other or transfer information.

## Model clinic: The Florida Lipid Institute

Paul E. Ziajka, MD, PhD, then discussed The Florida Lipid Institute, a private clinic entirely focused on lipid referral patients. It is staffed by Dr Ziajka as the only physician, a dietitian, a study coordinator, needed because of participation in many pharmaceutical company-sponsored clinical research trials, as well as support staff. His practice uses Practice Fusion (San Francisco, CA), which is a free Web-based business model with which he recently has been able to achieve reimbursement for meeting meaningful use criteria.

Dr Ziajka described his system in the following manner:

- Easily created templates are available that are customizable for a lipid practice with the option to cut and paste information into subsequent office notes.
- A patient database with search capabilities is in place, but only with 1 selection criteria, such as medications.
- Scheduling modules are user friendly.
- Laboratory data can be imported.
- Alerts are in place, but are not lipid centric at this time.
- Lipid results and goals cannot be captured separately, because results of panels are stored as documents rather than individual results. Therefore, a percentage of patients at goal must be obtained manually.
- Medication lists are searchable, but there is no ability to track compliance with refills.
- Baseline LDL-C at the initial visit is recorded, and current and target LDL-C can be pasted into each visit subsequently.
- Patients receive a copy of their laboratory results at each visit, with clearly marked LDL-C goals, and each visit report is faxed to the referring physician.

Dr Ziajka concluded that the level of compliance among his patients is consistent with a motivated subpopulation, as opposed to the patients typically seen in urban practices such as those of Dr Underberg or Dr Brown.

## Model clinic: Midwest Heart Specialists Lipid Clinic

Alan S. Brown, MD, related the story of how his group became motivated to introduce a system for tracking patients to LDL-C goals. Dr Brown began his lipid clinic within the cardiology practice in 1985, in the era before



electronics. At the time, he recognized the need for LDL-C control in the setting of complex ATP guidelines, which frequently were not well understood. He also recognized with the help of Quality Assurance Program data, that no LDL-C data existed for almost all of the patients with CAD in the practice, and that little information was available about whether these patients were achieving their targets. Within his lipid clinic practice of 4000 patients, each patient received intensive one-on-one teaching, dietary counseling, and follow-up with nursing staff; other risk factors, such as hypertension and weight control, were integrated into the prevention program.

The national Quality Assurance Program (Merck, Whitehouse Station, NJ) data were compared with Dr Brown's cardiology practice and, although with 22% of patients at goal, they had achieved twice the national benchmark of 11% of patients at goal, the practice did not deem this to be an acceptable performance. The initial solution was thought to be lipid clinic referrals, but the volume of patients with CAD in the practice was not commensurate with the resources of the lipid clinic, so another solution was required.

Michael O'Toole, MD, an electrophysiologist within the practice, was then charged with developing the EHR and the suggestion was made to simply put an alert into the record if either no LDL-C was on the record or LDL-C was not at goal of <100 mg/dL. This was in recognition of the point above, that it would not be feasible to provide a lipid clinic level service to 80,000 patients in the practice with CAD, and a minimal basic intervention was all that might be needed. The EHR chosen by the groups of Drs. Brown and O'Toole was an open architecture system that was based on MedInformatix (Los, Angeles, CA), which allowed the importing of custom alerts, and all elements could be uploaded as data points. This has evolved into the groups' own system, now called *Cardioworks* (Lombard, IL). For every patient with CAD, the system provides documentation of whether LDL-C was on the chart, and, if it is, whether it achieves target. All data, including the earliest recorded lipid profile, liver function tests, and current lipids, may be entered, saved, and become part of the office note.

The doctors engaged with this system enthusiastically because it saved time, and because the note was largely created for them. Only the decision-making portion needed to be dictated. Dr Brown noted that a consultant observed their practice during this process and advised creation of a team that comprised a registered nurse and a medical assistant for each physician to standardize the patient interactions for greater consistency. Dr Brown added that the group motivation for adopting these changes and attention to this alert system was pride and prayer. He stated that "...We were proud of what we wanted to do ... (and) wanted to be able to demonstrate (it), and the prayer was that someday we would get paid for quality." It was also emphasized that this effort represented the convergence of EHR, team development, ability to make changes

quickly when data were returned which appeared less than satisfactory, the efficiency factor, and the sense of opportunity to negotiate contracts someday, based on the quality of work. Nonrandomized data collected after introduction of this system have been published from Dr O'Toole's practice.<sup>49,50</sup> Dr Brown stated that the lessons learned focused on creation of a simple tool that did not interfere with workflow. Ultimately use of this electronic tool allowed an increase of 4 to 6 patients daily in office volume. The alert generated was unavoidable in the sense that it had to be addressed in real time.

Dr Brown indicated that within the first year of using alerts in their EHR, the percentage of patients at goal increased from 22% to 53%. This effect was because of the alert system and no other intervention. These data also indicated that a secondary observed goal of non-high-density lipoprotein cholesterol target achievement rose to 89% for the same group of patients.

The Quality Assurance Program alerts in their practice have now expanded to include LDL-C alerts, hypertension, abdominal aortic aneurysm screening, atrial fibrillation rates, BMI, smoking cessation, heart failure indicators such as use of angiotensin-converting enzyme inhibitors, and depression screening. In addition, when erroneous claims-based data were presented to the practice by an insurer with whom they were negotiating a contract, the group was able to effectively respond with accurate data to achieve better reimbursement. Dr Brown also mentioned that the way in which the message is delivered to the patient is important for addressing adherence to statin therapy. The patient needs to hear "take this medicine because it will save your life.... (not) because it will lower your cholesterol."

Discussion ensued after the presentation of the survey methodology overview, and the model clinic data. Mr. Laforge and Dr Kris-Etherton both strongly advocated that measures of lifestyle intervention, including dietary changes and physical activity, be included as correlates in the process of LDL-C reduction and goal attainment. In addition, the need was emphasized for easy accessibility to anthropometric data points such as waist circumference and BMI.

## Survey methodology conclusions from the model clinic presentations and workshop

The important take-home conclusions from the workshop were as follows:

- An electronic tool must be simple and nonintrusive in the workflow of the office and the physician.
- Teamwork is essential for appropriate monitoring and management of patients and for overall success.
- One must be able to query the data within the practice to identify the percentage of patients at goal. This includes provision of feedback to practitioner, patient, and system for performance and achievement of targets.

- Ideally, the system should have the capacity for integration of what the HIT partners have identified as the medical neighborhood in which laboratory and prescription refill data are easily uploaded into the EHR.
- Lifestyle interventions must be collated with the pharmaceutical interventions.
- Patient adherence factors must be effectively addressed for the understanding of the importance of the lipid-lowering intervention and the ability to obtain prescriptions.
- Provider adherence to therapeutic recommendations should be linked to patient adherence measures.
- An effective tool needs to be legacy agnostic, a phrase coined by the HIT partners, in other words, easily superimposable on an existing EHR.
- The tool should be generalizable for use in future projects to include broader populations and possibly disease entities, along with perhaps simple anthropometric measures (BMI, waist circumference), additional lipid parameters (non-high-density lipoprotein cholesterol), and a measure of therapeutic lifestyle compliance.

A panel of experts who represented 4 HIT providers then discussed how the use of this technology can enable solutions to sustain LDL-C goal attainment. Dr O'Toole introduced the panel experts by first describing that the Midwest Heart Specialists practice was started in 1973, has grown to >50 cardiologists, and was recently acquired by Advocate Healthcare. Since 1997, the practice has used an EHR that is a hybrid of commercially available components supplemented by the group's internal development to make it cardiology specific. Dr O'Toole indicated that the group started examining their data after the Quality Assurance Program study when they realized that their performance with lipid, blood pressure, heart failure, and CAD management was not nearly as good as the informal impression of their care. What they thought was performance in the 80th to 90th percentiles was, in actuality, 30% to 40%. In 2004 the Midwest Heart Specialists started working with the American Medical Association and the Physician Consortium for Performance Improvement, which is the primary measure developer for CMS and the NQF.

Data have continuously improved on a quarterly basis during the past 10 years. Performance in all measures has improved from as low as 14% (smoking cessation documentation) to consistently in the upper 80th and lower 90th percentiles for the management of CAD, heart failure, and hypertension. This has provided superior patient care, but at what cost? A recent examination of the money received from the various incentive programs (meaningful use, Physician Consortium for Performance Improvement, Physician Quality Reporting System, e-prescribing, Advocate Physician Partners' Clinical Integration) since 2007 (approximately \$6.5 million) is approximately the same as the costs for HIT infrastructure purchase, support, and personnel. Thus, Dr O'Toole stated, "We believe that we are practicing better medicine, it's more enjoyable, and the

incentives over the past 5 years have covered most of the HIT costs.... It is a break even proposition." It is expected to be even more interesting going forward because the shift is from just seeing 1 patient at a time into population health. This is going to require even more innovative use of HIT, personnel, and reimbursement strategies.

## HIT providers

### Allscripts

In the first of the presentations by HIT providers, Thomas F. Stout, MD, presented the Allscripts (Chicago, IL) perspective of working with large and small practices in integrating EHR into their clinical practices. Dr Stout started his discussion, pointing out that EHR tools, like all tools, depend on the skill and experience of their users. Only by addressing ergonomic, psychological, perspective, and incentive factors of both providers and patients do users obtain the full benefits of tools.

EHR tools can provide CDS, clinician alerts, e-prescribing, task management, patient education, and outcomes analytics. CDS tools can be categorized as learning CDS, workflow CDS, and cognitive CDS. Learning CDS includes clinician support for drug-drug interactions or sepsis alerts. Workflow CDS covers documentation requirements for specific medical conditions. Cognitive CDS, which probably has the least effect currently, has the greatest potential to drive best practices in clinical care. In Allscripts, cognitive CDSs are called CareGuides, which are configurable, evidence-based order sets to simplify clinician efforts to deliver best practices at the point of care. These CareGuides can be further configured to include subcategories of specific guideline recommendations.

In 2011, e-prescribing accounted for >190 million prescriptions, and now it improves best practices by providing selection lists of all available dosages, patient education materials, information to pharmacists, and drug utilization reviews. Peer review through outcomes analytics can be a potent driver for health care change. Allscripts has a cloud-based solution that populates a clinician's EHR with an outcomes dashboard at the point of care. Beta-test programs of outcomes analytics found that physicians are often unaware of areas in which their outcomes are below guidelines.

Emerging areas for EHR tools are moving onto mobile platforms for both clinicians and patients and finding solutions for interoperability, which is currently the biggest hurdle for EHR systems. The general barriers to effective use of EHRs include the following: EHRs represent simply another tool, albeit a potentially powerful tool; decision making in EHRs is commonly boiled down to simplistic yes/no algorithms, whereas health care is quite a complicated process; human egos and vanities are involved; perspectives and biases need to be entertained; and all

involved are potentially affected by incentives or disincentives. However, when designed and used effectively, EHRs can overcome these barriers through the use of Health Management Plans, CDS, e-prescribing, educational resources, and patient engagement portals and personal health records. The immediate future also holds great promise through better use of mobile devices, interoperability, and, ultimately, thorough analytics that will drive better outcomes.

## Practice Fusion

Chris Hogg presented the HIT features of Practice Fusion, a free EHR for providers and a free patient portal where any patient can see his or her personal health record and laboratory values and can schedule visits. Practice Fusion was founded in 2005 and focuses on small ambulatory practices (generally <10 physicians).

Practice Fusion is an integrated health platform; that is, a network of physicians and patients all centered on 1 unified database. Real-time data come from the physician and external data sources in the form of prescriptions, diagnoses, chart notes, laboratory values, images, billing data, and so forth. In the near future, Practice Fusion will begin integrating data from personal health devices, apps, trackers, and patient-reported outcomes measures via surveys. There is significant value, currently untapped, in overlaying patient-reported outcomes data on top of clinical data for the same person.

Practice Fusion has approximately 4 million visits on the platform per month, which translates to approximately 600,000 visits for patients with known high cholesterol, according to diagnosis by International Classification of Disease-9 code, approximately 15% of all visits. Approximately 175,000 patients were seen on the platform in July 2013, who were not at LDL-C goal, according to NCEP ATP III Guidelines.

One of the great promises of EHR systems is the ability to manage populations at scale. First, clinicians need to determine solutions that work to improve population outcomes, and then HIT partners need to deploy these solutions at scale. Successful technology-based population management strategies will combine the best clinical research with user-centric design, iteration, and testing. Practice Fusion is historically a technology company, and it has an approach to solving these types of problems with design and technology. Typically, when solving a user experience or process problem, the group that is able to test more approaches and to iterate the fastest will find the best solution faster. Toward that end, Practice Fusion is in the process of creating a platform to rapidly test interventions before the visit, during the visit, and after the visit, using real-time data, and then deploy interventions that work at scale.

To explain this process, Practice Fusion, in collaboration with Merck, has a sample program to improve LDL-C goal

attainment in high-risk patients. The schema for the program is as follows:

- Identify appropriate patients for the program.
- In this case, programmatically identify high-risk patients not at goal by ATP III Guidelines.
- Reach out to appropriate patients.
- In this case, reach out via short message service and e-mail to schedule a visit.
- CDS at point of care.
- In this case, alert doctor at point of care that he or she is seeing a high-risk patient who is not at LDL-C goal according to ATP III, or seeing a patient with high LDL-C not on statin.
- Engage patients after the visit.
- In this case, short message service/e-mail to push prescription fill/refill, reminder to get laboratory tests done, or schedule follow-up visit if not at goal after 6 to 8 weeks.
- Measure short-term and long-term outcomes with the use of real-time data.
- In this case, prescription patterns (add-on, switch, uptitration), laboratory tests ordered, follow-up visit scheduled, percentage of patients at goal (by ATP III Guidelines), average LDL-C, and percentage of appropriate patients with current LDL-C laboratory value.
- Iterate program to optimize key metrics with the use of real-time data.

The goal today should not necessarily be to determine the correct patients, interventions, or alerts. The goal should be to create an environment to test many different interventions and alerts and then measure the effect of each in real time. The goal has to be to reduce the cycle time. Technology can have a significant positive effect on population health by combining the best clinical research with good product design to maximize improvement in outcomes for everyone.

## MDdatacor

David Hanekom, MD, presented MDdatacor's (Alpharetta, GA) population management solution that enables clinicians to deliver better care by using a clinical registry with embedded evidence-based CDS. The solution's interoperability, transparency, and usability is well accepted across multiple practice settings, is effectively integrated into the practice's workflow, and provides an affordable solution to enable success in multi-payer payment and delivery system transformation activities in support of Patient-Centered Medical Home and Accountable Care Organization activities. The registry allows PCPs to identify their practice panel, understand the disease burden distribution within the panel, and identify clinical risk factors within each patient and the practice panel, thereby allowing for identification of clinical care opportunities to deliver better care to individual patients and to plan for

population-based interventions in the form of targeted health improvement activities and outreach to patients.

For technology to act as an enabler to physicians, the technology must allow the care team to perform today's tasks today, identify potential areas for clinical care delivery improvement in each patient, and reliably allow for clinical care improvement both during an office visit and in the interoffice visit period. The technology must not disrupt the practice workflow and must allow for the measurement and reporting of clinical outcomes relevant to an individual patient as well as the practice population. Clinicians are generally working at maximum efficiency in terms of their patient throughput, and they have organized their practice workflow to maximize the use of their local resources. It does not necessarily mean that they are producing maximum clinical outcomes and results from that efficiency, but their desire to maximize outcomes for their patients is a universal and pervasive feature of the practice of medicine.

The predominant interaction with data and information occurs within the EHR. It is therefore imperative that meaningful clinical information from external sources surfaces within the EHR environment to assure timely access at the point of care and to ensure physician adoption. MDdatacor has surveyed their end-users and determined that the following HIT functionality features are important to physicians in delivering patient-centric population health:

- The solution needs to be legacy-system agnostic and supplement current HIT platforms, thereby allowing clinicians to adopt the technology without significant additional cost or human resources, both of which pose significant barriers to adoption.
- The solution must not disrupt their current legacy systems. Solutions that require significant integration and interfacing with existing systems tend to require significant financial and implementation resources, both acting as adoption barriers.
- The solution needs to be able to do cost-efficient data collection across the medical neighborhood, not only on the provider side but also integrating the payer information fully.
- The reporting needs to be patient-centric with a goal of identifying care opportunities by using the most robust evidence-based standards.
- The solution must not disrupt the workflow of the medical practice and should ideally improve efficiency and be fully integrated within each practice's workflow.
- The solution needs to provide timely outcomes reporting with appropriate external benchmarking.

Patient management plans and critical physician decision-making information are most often recorded in nonstructured fields within EHRs, requiring the use of Natural Language Processing to extract process and outcomes data from this information for reporting and benchmarking activities.

In meeting the needs of the provider for actionable clinical information at the point of care, we need to assure that the following barriers in data acquisition, data analytics, and reporting across the medical neighborhood are overcome:

- The population registry functions should be embedded within the EHR user environment to allow for a single-user interface.
- Incomplete patient information, contained within multiple electronic systems, must be reconciled and presented in a patient-centric manner for consumption and use by the care teams.
- Timeliness of the patient-centric information needs to be such that the information can be used to aid the care team in making decisions and executing an evidence-based care plan.

Human resources, both in number and in skill sets, are extremely limited, and there is a need for significant redefinition of roles within practice staffing to meet the needs of population management care programs. HIT solutions need to automate and surface clinical insights for care improvement that minimizes the need for additional staffing to execute population management activities. Much work needs to be done to develop and implement HIT solutions that meet the clinical needs of clinicians in ensuring that better care and better outcomes are delivered to their patients and that both provider satisfaction and revenue generation are positively affected.

MDdatacor currently serves >4000 primary care physicians across 15 states in their population management activities as part of Patient-Centered Medical Home and Accountable Care Organization programs. In terms of the focus of the activities, all PCPs are identifying high-risk patients who have CHD and diabetes mellitus and are using evidence-based interventions to reduce the risk of disease progression and the development of complications related to poor risk factor or disease management.

The summary results indicate that 61% of women and 63% of men with known CHD have an annual LDL-C test performed. This means that approximately 4 of every 10 patients with identified CHD do not have an annual test performed or recorded within the clinical record systems across the medical neighborhood. Seventy-two percent of patients tested have an LDL-C level at or below target, defined as an LDL-C <100 mg/dL. The mean LDL-C within the CHD population is 87 mg/dL. For outcomes in women with CHD, 65% have LDL-C at or below goal, whereas 75% of men with CHD are at or below target. There appear to be no significant differences in the frequency of lipid testing between sexes, yet there is a significant difference in target attainment rates that will need further analysis and investigation. When reviewing the sex differences in LDL-C goal attainment in adult patients with diabetes, a similar difference exists. There is clearly a need to investigate this sex difference to understand the factors that contribute to these results and to design interventions to minimize differences in LDL-C goal attainment in all high-risk populations.<sup>51</sup>

## Medivo

Destry Sulkes, MD, presented Medivo's (New York, NY) solution for laboratory data access and secure electronic laboratory connectivity. In 2010, Medivo acquired a company that had connectivity to the 2 biggest US commercial reference laboratories, serving approximately 80% of all outpatient laboratory tests in a network of 200,000 physicians and 50 million patients. To date, Medivo has added to such connectivity coverage with >150 additional regional laboratories.

For enrolling physicians, Medivo pulls the practice's laboratory data to perform analytics and to deliver practice-wide quality reports at both aggregate and individual patient levels. All data are stored in the cloud for easy access and constant updates. The Medivo service both sends structured laboratory information into EHRs and pulls laboratory information from EHRs. Enrolled practices not only receive a summary report and dashboard but also each patient's longitudinal results are highlighted in red, yellow, and green to draw attention to the patients with the largest gaps between LDL-C goals and actual results. These reports are sent to the doctors once a month, delivered in hard copy through direct mail, online via a secure portal, and available through mobile devices.

Practices also can request that Medivo reach out to their patients to show them their laboratory results with a reminder or education about what to do next. These messages are sent once every 3 months. The laboratory results are delivered to patients formatted in 4 colors, written at a third-grade reading level for health literacy, and presented in a simple, highly understandable fashion.

To assess LDL-C laboratory testing frequency and LDL-C results vs LDL-C goals, from July 2012 to May 2013, Medivo compared approximately 33,000 patients with dyslipidemia in 160 practices using the service with approximately 283,000 patients with dyslipidemia in 1294 control practices not using the service. In practices that used the service and received the laboratory reports, a statistically significant increase was found in LDL-C testing frequency, from 25 tests per month in July 2012 to 29 tests per month in May 2013 ( $P = .01$ ). In addition, the practices' mean LDL-C test results across all the patients with dyslipidemia showed a trending decrease from 105.56 mg/dL to 99.63 mg/dL ( $P = .11$ ). LDL-C testing frequency did not significantly increase in practices not using the service (from 21 to 22 tests per month;  $P = .14$ ), and LDL-C test results showed a trending increase (from 107.56 to 109.57 mg/dL;  $P = .28$ ).

## HIT panel discussion

Dr O'Toole started the panel discussion with the HIT partners and the workshop attendees by asking, what are the time and financial implications for clinicians addressing population health in addition to existing clinical

obligations? Dr Hanekom responded that, for specialists, multiple studies support the economics for hiring staff to handle documentation support. In addition, workflow needs to be better balanced across teams to handle tasks before, after, and between visits. Technology can provide clinicians with encapsulated, patient-centric summaries. Population management, however, is difficult, requiring both the leadership of the physician and a financial arrangement with payers that rewards patient outcomes and not patient volume as health systems are already operating on a narrow 1% to 5% profit margin. Dr Sulkes responded that workflow redesign and task automation could free clinician time for population management. Dr Stout added that increased publication on population health management would provide leadership to engage more clinicians in this area.

About workflow redesign and task automation, 1 attendee cautioned that HIT solutions introduced into his academic medical center have bypassed traditional staff assignments and transferred the workload to physicians. Dr O'Toole responded that, although these are HIT implementation issues, nevertheless, there are other difficult workflow redesign issues: administrators are looking to decrease costs by using HIT to reduce staff, but HIT solutions only add IT staff. Compliance officers often insist that physicians perform tasks that, in actuality, can be assigned to clinical staff with the correct rules and processes in place.

Mr LaForge asked if any HIT solutions had a metric for adherence, such as the "patient readiness" of the Trans-theoretical Model. Both Mr Hogg and Dr Sulkes responded that they had looked at such metrics, but obtaining the necessary data, especially from clinicians, was a challenge that had not yet been solved.

Another attendee asked the HIT partners how physicians respond to the introduction of HIT solutions. Dr Hanekom commented that initially most physicians are extremely skeptical about HIT, which is only re-enforced when they introduce HIT into existing processes and find that HIT adds a layer of complexity, costs, and inefficiencies that they did not have before. The most successful practices to implement HIT first ask the following questions: what are we doing, why are we doing it, how can we make it better, how do we redefine roles, and how can technology support these practice changes? In addition, at any one time, approximately 18% to 20% of practices are transitioning EHR vendors, and that disruption re-enforces negative views of HIT in clinicians. Dr Stout concurred, noting that practices do not want to change long-standing paper-based workflows and assignments, especially when they believe that their workflows achieve good performance outcomes.

Dr Brown raised the provocative issue of how we recreate the human experience in the doctor-patient relationship by using HIT when vendors focus on the data and specialists focus on goal attainment. Dr Sulkes responded that social media technology that fosters stronger relationships between family, friends, colleagues, and so forth could potentially be a solution for better asynchronous provider-patient engagement.

Dr Aspary asked if any EHR systems had the capability of directly providing Physician Quality Reporting System measures to CMS. Dr Stout replied that this was an Allscripts feature and that other vendors have, or soon would have, similar capabilities as payment models transitioned from fee-for-service to quality outcomes payments.

Dr Willard, noting the diversity across EHR implementations, commented that it would be beneficial if HIT developed around minimum shared standards-of-care, or best practices. Mr. Hogg agreed that currently there is very little sharing of information and best practices among HIT vendors and that there should be more discussion among vendors.

Dr Willard noted that training and deployment of EHR systems encounter clinician resistance, because training is often not individualized by specialty with, for instance, cardiologists receiving extensive training to document strep throat. Dr Hanekom noted that individualized training was labor intensive, but it was worthwhile because it led to faster adoption, greater clinician satisfaction, and quicker improvement in quality.

Joanne M. Foody, MD, gave a presentation that addressed how HIT can empower patients to improve adherence.

## Adherence

### Definitions: Adherence, persistence, and compliance

The World Health Organization defines adherence as “the extent to which a person’s behavior, taking medications, following a diet, and/or executing lifestyle changes, corresponds with agreed recommendations from a health care provider.”<sup>52 (p18)</sup> Some publications use the term *compliance*. *Compliance* is defined as the extent to which a person follows doctor’s orders. The World Health Organization favors the term adherence because it better reflects the patient’s involvement in his or her own health care. *Persistence*, on the other hand, is defined as the length of time a patient fills his or her prescriptions. This is another useful term in the field of adherence study, especially in the treatment of chronic conditions.<sup>52,53</sup>

### Magnitude of the nonadherence problem

Lipid lowering with statins has been found to significantly reduce CVD morbidity and mortality in a broad range of patients. Despite these findings, statins are underused in clinical practice, and a significant proportion of patients for whom statins are prescribed discontinue their therapy or take it incorrectly.<sup>54–58</sup> Discontinuation rates at 5 years in clinical trials range from 6% to 30%, but, in clinical practice, the rates are much higher. Studies show that the number of patients who continue therapy falls sharply

in the first few months of treatment, followed by a more gradual decline. In the United States, it is estimated that only approximately 50% of patients continue at 6 months and 30% to 40% at 1 year.<sup>55</sup> Similar rates have been found internationally.<sup>57,58</sup>

Several large-scale studies have assessed adherence and persistence rates in older persons. In an analysis to describe the patterns and predictors of long-term persistence with statin therapy in an elderly US population, Benner et al<sup>55</sup> used data from a retrospective cohort of 34,501 enrollees in the New Jersey Medicaid and Pharmaceutical Assistance to the Aged and Disabled programs who were at least 65 years of age and had initiated statin treatment. In this study, persistence with statin therapy in older patients declined rapidly over time, with the greatest drop occurring in the first 6 months of treatment. Only 1 in 4 patients persisted at 5 years. In a cohort study that used linked population-based administrative data from Ontario, patients aged 66 years or older who received at least 1 statin prescription were followed for 2 years from their first statin prescription.<sup>56</sup> Two-year adherence rates were only 40.1% for patients with acute coronary syndromes, 36.1% for chronic CAD, and 25.4% for primary prevention. These data suggest that many patients who start statin therapy may receive no or limited benefit from statins because of premature discontinuation.

Not surprisingly, many patients prescribed therapy fail to meet lipid-lowering targets.<sup>59</sup> Although this may, in part, be due to the prescribing of insufficient doses of the statin and heterogeneity in individual responses to statins, poor response to treatment seems primarily to be due to patients not taking the drug as prescribed (eg, poor adherence or poor persistence). In a large population study of 6000 patients with diabetes, adherence to LDL-C-lowering statin therapy was associated with lower LDL-C levels.<sup>60</sup> Similarly, the probability of achieving the LDL-C goal (<100 mg/dL) rose progressively with the medication possession ratio, defined as the ratio of medication supplied over a given time period. Although 19% of subjects with the lowest adherence rates were at goal, nearly 80% of patients with the highest adherence achieved the LDL-C goal.

Furthermore, nonadherence has a significant effect on subsequent outcomes. Patients who do not take their medication as prescribed are more likely to be hospitalized than are patients who follow prescription instructions.<sup>61,62</sup> Although it is not clear just how adherent a patient needs to be to derive the benefits of lipid lowering, we can gain insights from clinical trials. In the West of Scotland Coronary Prevention Study, for example, patients taking  $\geq 75\%$  of their prescribed dose of pravastatin had significantly lower rates of nonfatal MI, revascularization procedures, death from any cause, and cardiovascular death, compared with patients taking <75% of their prescribed dose.<sup>63</sup> A study of patients’ adherence to statin treatment after an initial MI showed that patients with greater adherence to statin therapy were significantly less likely to experience a second MI.<sup>64</sup> In this study, which included 5590 patients, 7.7%

used statins after the incident MI. Among all patients, 12.8% experienced at least 1 further MI. Compared with patients not taking statins, patients who had 80% or better adherence to statin treatment had an adjusted relative risk of recurrent MI of 0.19. No significant reduction was found in risk among patients who were <80% adherent to statins. These data suggest that nonadherence to medication can affect the occurrence or reoccurrence of cardiovascular events, such as MI. Other studies have shown that withdrawal of statins<sup>65</sup> or sudden reduction of dose<sup>66</sup> can increase the rate of thrombotic events. These findings may also factor into incremental risk with nonadherence and poor persistence.

Patients with low adherence are also responsible for substantially greater health care costs than are patients with good adherence. Even accounting for savings in drug costs, patients who take <20% of their lipid-lowering medications have >\$3000 greater yearly health care costs than do patients with at least 80% adherence.<sup>67</sup> Given the significant burden of CVD, the known benefits of lipid lowering and the poor health consequences of nonadherence, strategies to improve adherence are essential to improving health globally.

### Determinants of adherence and nonadherence

Although patient nonadherence to medication regimens remains 1 of the most important health care concerns, it is surprising that high-quality research in this area has not been extensive. Evidence, however, is available that patient nonadherence to medication is a multicausal phenomenon. A variety of patient characteristics, including age, sex, race, and presence of depression, have been associated with the risk for nonadherence (Table 4). In 1 study, older subjects were significantly more adherent with statin therapy than were younger subjects (odds ratio, 1.03; 95% CI, 1.02–1.03), whereas men were significantly more adherent compared with women (odds ratio, 1.42; 95% CI, 1.33–1.50).<sup>68</sup> In another study, patients with depression were more likely to have suboptimal persistence with statin use than patients who were untreated (odds ratio, 1.19; 95% CI, 1.11–1.28).<sup>55</sup> Patients treated for depression were also less likely to persist in statin use, consistent with the study's observation that depressive symptoms correlate with poor persistence with antihypertensive medications.<sup>55,68,69</sup> The seriousness of the illness, the cost of treatment, and treatment side effects can also affect compliance, as well as the complexity of the recommendation, the duration of the regimen, the type of medical advice, the clarity or unclarity of the written instructions, and the amount of instruction provided. Of note, it has been shown that patients who filled their statin prescriptions via mail order were more likely to have statin medication on hand than patients who used retail pharmacy stores.<sup>70</sup> However, retail pharmacies, with their patient contact, may be a point of action to positively influence patient adherence.

Other studies have provided additional insights about lack of adherence to pharmacotherapy, although this is not specific for lipid-lowering therapy. A retrospective study of 8643 elderly beneficiaries of the New Jersey Medicaid and Medicare programs showed that patients with more visits to a physician were more likely to be adherent to antihypertensive therapy than were patients with fewer visits.<sup>71</sup> This study defined adherence as having antihypertension medication available to cover at least 80% of the days during the study period. In a prospective study of patients filling antihypertensive medication at community pharmacies (n = 821), patients reported that the single most common reason they did not take their medication as prescribed was forgetfulness.<sup>72</sup> Four main themes were reflected in patients' responses: (1) perception of treatment benefits, (2) perception of treatment risks, (3) costs, and (4) convenience.

Patients should be encouraged to indicate to their physicians verbally or in writing that they understand medication requirements. Physicians should be aware that patients are more likely to adhere to medication regimens when they are convinced that the medication they are taking is clearly linked to future health and wellness and when they are made an active participant in the decision-making process about the medications. Most busy physicians fail to allot sufficient time for quality interaction with their patients and, therefore, often fail to consider adherence issues. However, failure to tackle adherence issues early may cost the physician more time and energy later.

Some patients have poor memory and concentration skills, and they seem to quickly forget more than one-half of the physician's instructions.<sup>73</sup> In fact, they are more likely to remember their diagnosis than their prescribed therapy. The provider must speak briefly and clearly, emphasize the information necessary for compliance early in the communication, and then repeat the same information both orally and in writing. We cannot assume that patients understand even simple language. Terms common to the practitioner, such as follow-up and workup, may very well require explanation or substitution.

In a study of patient interpretation of written prescription instructions, researchers found that 25% of subjects interpreted the phrase "every 6 hours" as meaning "3 times a day" (because they sleep at night).<sup>74</sup> "As needed for water retention" was thought to mean that the pills would be used to cause water retention. Full clarification of medical terms is strongly encouraged, and more structured follow-up sessions may be necessary to determine whether patients understood the information and instructions.

A number of studies have found that cultural mores, folkways, and norms are important factors in determining who is and who is not likely to comply with medication regimens. One study found that Hispanic patients were more likely to comply with medication recommendations when their physicians showed some understanding of Hispanic cultural norms and practices.<sup>75</sup>

Patient motivation must be evaluated to determine the likelihood of medication adherence. Although many patients appear motivated, they actually may be in a pre-commitment phase in the decision-making process; that is, although patients may wish to take their medications, they may not be ready to comply with all aspects of the medication regimen.

### Assessing nonadherence

The degree of patient adherence to medication regimens can be determined from information gathered from the patient, physician or pharmacist, family members, and friends. Adherence can also be shown by counting pills or examining biochemical evidence. Asking the physician may, unfortunately, be the poorest of choices. Physicians generally overestimate their patients' compliance rates and, even when their guesses are not overly optimistic, they are usually wrong. One early study reported a correlation of 0.01 between physicians' estimates of compliance and an objective pill count.<sup>60</sup> Asking patients themselves is a more valid procedure, but it is fraught with difficulties. The same study showed that approximately 10% of the patients claimed that they were 100% compliant; however, a pill count of the medications indicated that the patients were using from 2% to as much as 130% of the prescribed pills.<sup>60</sup> Some patients took more medication than recommended, and others took far less.

Self-reports are inaccurate for at least 2 reasons: (1) patients may feel pressure to report more positive use of medications to avoid displeasing their physicians or (2) they may simply not know their rate of compliance. Patients not only underreport poor adherence, but they also overreport good adherence. To improve overall adherence/compliance rates, trained interviewers could help improve the accuracy of self-reports and, at the same time, identify the types of medication errors typically made by patients. Constant observation by family, friends, or

hospital staff may be physically impossible, and the quality of family relationships can affect accuracy. Pill counts, that is, pills gone from the bottle minus pills dispensed, may seem ideal because of the mathematical certainty; however, even if the required number of pills is gone, the patient may not have been compliant. The patient, for many different reasons, may have discarded some of the medications or taken them in a manner other than had been prescribed.

Although methods to assess adherence have limitations, nonetheless, physicians are encouraged to try more than 1 strategy and to implement an adherence plan early in the treatment process.

### Strategies and interventions to improve adherence

A variety of strategies exist that can help promote medication adherence, including raising information and skill levels, altering characteristics of the regimen, including rewards and reinforcement strategies, and improving the relationship between the provider and the patient. One strategy involves linking a medication schedule with other daily activities. Patients can be told, for example, to place their medication schedule next to their toothbrush as a mnemonic strategy in that they would be reminded of their medication schedule every time they brushed their teeth. Patient reminders can be linked to other daily routines that match the medication intervals related to the patient's recommended medication dose and the frequency and duration of the medication schedule.

The patient's family can help ensure medication compliance. Routine automated phone call reminders can also serve to periodically remind the patient of the proper medication regimen. Some health care workers give lectures, which can include audiovisual aids, and distribute educational materials to patients during evening classes held in the physician's office. The classes serve as an opportunity to inform the patient about the disease and how

**Table 4** Determinants of adherence/non-adherence and persistence/poor persistence

#### Determinants of nonadherence and poor persistence

- Female sex
- Age < 45 years
- Age > 75 years
- Low socioeconomic status
- Non-white
- Multiple daily dosing
- Multiple drug regimens
- Primary prevention, asymptomatic, feeling in good health
- Lack of knowledge about disease, need for treatment, and side effects
- Some comorbidity, for example, dementia, depression, myocardial infarction after statin started

#### Determinants of adherence and persistence

- Prior good compliance
- Feeling in bad health
- Good relationship with physician, understanding of need for treatment
- Some comorbidity, for example, diabetes, hypertension, stroke, congestive heart failure



best to handle it, including the importance of medication adherence.

Provider and patient awareness of medication adherence can be enhanced with the creative application of behavioral contracts, issued to the patient at the initiation of treatment. The contract should include a simple and clearly written set of instructions that describe the medications; important facts about the medications, including side effects and interaction with other medications; and information as to the purpose of the medications and the consequences of not taking them as prescribed. The contract needs to include when and how medication readjustments will occur and when and how prescriptions will be refilled. A schedule of medication intake should also be included, that is, time contingency or pain contingency instructions, plus dose frequency and length of time the patient is expected to take the medications. A behavioral contract can include information about frequency of expected office visits, how to contact the physician in an emergency, what to do when an emergency occurs, and, most important, a relapse prevention plan. The patients should also be instructed to never change their medication regimen without the consent of the treating physician.

One of the simplest ways to improve adherence is to simplify drug regimens. A study within a large managed care population ( $n = 8406$ ) showed that patients who initiated therapy with both antihypertensive and lipid-lowering drugs within 30 days of each other were more likely to be adherent to both drugs over time.<sup>76</sup> At 4 months, 15% to 24% more patients were adherent among patients who were prescribed antihypertensive therapy and lipid-lowering therapy together vs patients who were prescribed antihypertensive therapy and lipid-lowering therapy separately. Finally, improvements in adherence have been shown for use of a single pill combination of atorvastatin and amlodipine vs 2 pills taken individually.

It appears that patients weigh the perceived benefits, perceived risks, and costs (in terms of money and convenience). Education from the health care provider can have a large effect in convincing patients that drug therapy is necessary.<sup>72</sup> Cost pressures are a substantial influence on the prescription-taking habits of Medicare beneficiaries. They may simply not fill the prescription, skip doses, or take smaller doses to make the prescription last longer. More than 1 in 10 Medicare beneficiaries report spending less on basic needs to afford their prescription medications. Patients with more outpatient visits for cholesterol during the baseline period also were more adherent than their counterparts with fewer visits. Patients who had undergone a cardiovascular procedure or who had been hospitalized were more adherent, but persons who had at least 1 emergency department visit were less likely to be adherent than patients who had not had an emergency visit. In brief, most interventions have a positive effect in the short term, but to be successful in the long term, a sustained multifactorial approach is required. A combination of patient-focused, physician-focused, and system-focused interventions works best.

Lipid lowering with statins has the potential to substantially reduce cardiovascular events by one-third; however, in view of high rates of nonadherence and poor persistence, these benefits are not being achieved. Given the significant burden of nonadherence to society, strategies are urgently needed to improve medication adherence so that all patients benefit from evidence-based therapies.

## Discussion

Dr O'Toole noted that cardiologists were fortunate to have LDL-C levels as a measure of patient statin adherence. Dr Foody responded that the adherence challenge for cardiologists was how to obtain a current LDL-C level at the time of the visit rather than addressing the problems of ensuring a value after the visit.

Dr Brown wanted to know the effect of popular media medical coverage on adherence. Dr Foody replied that around 2008 national prescription patterns and LDL-C goal attainment decreased after publicity about black box warnings on high-dose simvastatin therapy. Professional organizations have a responsibility to frame these issues in a way that patients understand, but, as Dr Brown noted, the media often fail to cover the professional organizations' recommendations.

Dr Brown asked why patients have no economic disincentives for poor adherence, such as increases in co-payments, whereas health care providers have legal and economic penalties if they do not document and perform compliance efforts with nonadherent patients. Dr Foody replied that, although we do not have alignment of incentives for patients and providers, it is not clear what patient incentives are truly meaningful to them. The Post-Myocardial Infarction Free Rx Event and Economic Evaluation (MI FREEE) trial provided free medications to high-risk patients with CAD, but adherence was still only about 50%.<sup>77</sup> Dr Stout noted that the Affordable Care Act had incentive provisions that allow employers to reduce health benefit premiums up to 50% by requiring clinical outcomes for employees.

Dr Stout also asked about predictive algorithms for determining patient adherence. Dr Foody replied that because of heterogeneity in health care systems, health plans, and patient groups, so far, risk predictors have lacked sensitivity and specificity. Others noted that providers often fail to simply ask if patients are taking their medicines. Dr Neff described Merck's 3-question Adherence Estimator for chronic, asymptomatic conditions, such as high cholesterol.<sup>78</sup>

Dr Jacobson queried if there is an evidence base of proven methods to improve adherence. Dr Foody responded that despite much study there are not proven methods. Conceptually, however, the most important factor for improving adherence is an integrated health care team, and more ideas to improve adherence need to be piloted and tested. Dr Jacobson followed up by asking if there is

anything to learn from medical conditions in which adherence is high. Dr Foody noted that adherence tends to be high in symptomatic conditions, such as human immunodeficiency virus combination therapy with close monitoring by a care team, feedback, reminders, and packaging of medication.

Matthew Ito, PharmD, gave an overview of e-prescribing and presented the potential role of e-prescribing in improving LDL-C goal attainment.

## E-prescribing update and LDL-C goal attainment

E-prescribing is a technology that allows a physician or other medical practitioner to use a computer or handheld device to electronically access information about a patient's drug benefit coverage and medication history, and electronically transmit a prescription to a participating pharmacy of the patient's choice. When the patient runs out of refills, the pharmacy can also electronically send a renewal request to the physician's office for approval.

Before 2008, e-prescribing was not used by most prescribers. In 2003, Blue Cross Blue Shield of Massachusetts (Boston, MA), Tufts Health Plan (Watertown, MA), and Zix Corporation (Dallas, TX) were early pioneers in helping to form an e-prescribing collaborative.<sup>79</sup> The collaborative distributed an e-prescribing system with a formulary decision support (FDS) tool with costs paid by the insurance companies to Massachusetts' high-volume outpatient prescribers. Fischer et al<sup>79</sup> reported the results of this program on the difference in tier 1-prescribed medications for patients whose provider used e-prescribing with FDS compared with patients whose provider did not. After controlling for baseline differences between patient and provider characteristics, e-prescribing correlated with a 3.3% (95% CI, 2.7%–4%) increase in tier 1-prescribed medications and an estimated savings of \$845,000 per 100,000 patients over an 18-month period. In 2010, the National Council for Prescription Drug Programs developed the standards for e-prescribing which have been adopted by various Health Information Exchange networks. Surescripts (Arlington, VA) implemented this standard and has become a major player in e-prescribing and operates the largest Health Information Exchange network in the nation. Surescripts is connected to >58,800 pharmacies via their hub.<sup>80</sup> Approximately 93% of all community pharmacies in the United States are e-prescribing enabled.<sup>80</sup> Growth of e-prescribing has grown from 10% of office-based physicians and 68 million prescriptions per year in 2008 to 69% of office-based physicians and greater than an 11-fold increase (788 million) in prescriptions per year in 2012.<sup>80</sup>

The main driver of e-prescribing has been the escalating health care cost, especially after the passage of the Medicare Modernization Act in 2003. Health care providers have been urged by private insurers, consumers, and public programs to incorporate technology to reduce costs and

improve patient care. The Affordable Care Act as part of the ARRA of 2009, which included the HITECH provision, provides incentives for implementation of qualified e-prescribing as an integral demonstration of meaningful use as well as increasing penalties for noncompliance with these federal directives.<sup>12</sup> Changes in the Anti-Kickback Statute in 2006 establish exceptions and safe harbors to the Anti-Kickback Statute and the Stark Law for the adoption of HIT.<sup>81</sup> This allows hospitals and other organizations to donate HIT to physicians and other health care providers for the implementation of e-prescribing and EHR systems. Other major drivers of e-prescribing, which will be covered below, are related to reduced costs associated with increased efficiency and reduced medication misadventures.

The e-prescribing process links the physician, pharmacy, and payers. An essential component that allows the 2-way electronic exchange of patient-specific prescription information and benefits is the Health Information Exchange network. The Health Information Exchange network allows the prescriber at the point of care to validate personal health information received from the patient; review prescription benefits and select the most cost-effective therapy; review prescription history for drug duplications, potential drug-drug interactions, and allergies; generate an e-prescription; and select a pharmacy that is convenient for the patient. The prescription renewal process is also streamlined by eliminating the need for telephone calls and faxes that require significant coordination of pharmacy and physician staff. The physician's office can approve or deny electronic renewal requests quickly and efficiently. This reduces the time for patients waiting for the pharmacy and physician's office to communicate. The benefits of e-prescribing to the provider is more time taking care of patients as a result of fewer distracting pharmacy callbacks, enhanced staff efficiency, and financial incentives. Patients benefit by increased convenience; lower out-of-pocket expenses with increased use of tier 1 medications; improved medication safety by reducing drug-drug interactions, drug-allergy interactions, and drug class duplications; elimination of opportunities for getting the wrong drug or dose because of illegible handwritten prescriptions; and improved patient adherence and satisfaction. The pharmacy saves time spent communicating with the physician's office on renewals and deciphering illegible handwritten prescriptions. Collectively, these benefits improve medication safety and reduce emergency department visits and overall costs.

Michelis et al<sup>82</sup> evaluated the effect of e-prescribing on attainment of LDL-C goals in a retrospective cohort study design. Adult patients with baseline and follow-up LDL-C levels, sufficient information to determine their LDL-C goal, and who had been seen by a PCP, cardiologist, or endocrinologist were included in this analysis. All physicians used EHR and had the option to e-prescribe (included FDS). A hierarchical logistic regression analysis was used to determine if the odds of reaching LDL-C goal were influenced by e-prescribing and retail prescription price while

controlling for provider specialty and characteristics, patient characteristics, insurance type, NCEP ATP III LDL-C goals, and high-use medications. Patients whose health care provider used e-prescribing had a 59% increased odds (odds ratio, 1.59; 95% CI, 1.12–2.25) of goal attainment compared with patients who received a manual prescription. In addition, for every \$10 increase in copayment, patients' likelihood of reaching goal decreased by 5% (odds ratio, 0.95; 95% CI, 0.93–0.98). Generic statins were prescribed significantly more often to patients whose physician used e-prescribing compared with manual prescriptions (30.0% vs 22.9%;  $P < .001$ ). This study was the first to find that e-prescribing with FDS improved LDL-C goal attainment.

In a discussion after the presentation, most comments dealt with problems in obtaining data on adherence. In some e-prescribing networks, the mechanism to query if a patient has picked up his or her prescriptions is difficult or lacking.

In conclusion, e-prescribing is accurate, secure, efficient, and convenient. It improves the quality of health care, patient satisfaction, and adherence and reduces medication delivery mishaps and health care costs. It also appears to improve LDL-C goal attainment.

The program ended with a general discussion, facilitated by Dr Ito, of the potential use of various HIT solutions in demonstration projects and clinical trials.

## Selection and prioritization of HIT solutions to improve LDL-C goal attainment

Workshop attendees were asked to indicate the elements and specifications for an HIT intervention, the possible barriers to implementation, the format and content of the HIT intervention, the feasibility of implementing the intervention, and the relative effect of the intervention on achieving LDL-C goal attainment.

The goals for managing high-risk patients with ischemic vascular disease or type 2 diabetes or both are presented in Table 5, and, as shown in Table 6, the group consensus identified 5 HIT functionality requirements likely to have moderate-to-high impact on LDL-C goal attainment according to these goals/aims. These were (1) risk assessment, (2) goal attainment, (3) CDS, (4) patient communication, and (5) QI monitoring. For these requirements to gain clinician acceptance, the group emphasized that they must minimize effect on provider workflow, as well as facilitate quality metric reporting for receiving incentive payments to providers.

## Risk assessment

Risk assessment is a necessary prerequisite for selecting LDL-C goal target, enabling the clinician and practice to apply resources to patient populations at greatest risk of

adverse clinical events and excess medical care utilization. Risk assessment should stratify individual patient's CVD risk and assess target LDL-C goals on the basis of that risk. Assessing and stratifying CVD risk from the EHR, however, presents numerous challenges related to the accuracy and validity of the data sources. International Classification of Diseases-9 codes in the EHR may not accurately reflect the clinical diagnosis nor reflect meaningful clinical distinctions among CVD risk categories. Calculating risk scores, such as the Framingham risk score, depends on accurate pretreatment data that either may not be available in the EHR or may not technically be able to be queried in all EHR implementations. To address these concerns, the workshop attendees recommended that EHR vendors implement heuristic algorithms that scan a patient's record by using multiple sources of data, such as procedure codes, medication and laboratory histories, clinical descriptions, and so forth, to identify potential high-risk patients. To address false-positive identifications, the attendees recommended that the high-risk CVD designation be provisionally added to the patient's problem list with the clinical option to remove the designation with justification. Finally, it was decided that primary prevention patients would not be targeted for intervention in this initial project, but there was a strong consensus that this lower risk group of patients should be studied after successful QI projects in the higher risk group.

## Goal attainment

Goal attainment plans should ensure both timely documentation of LDL-C values as well as any unresolved LDL-C treatment gaps. Although LDL-C documentation should be a basic EHR feature, some EHR implementations do not store laboratory values as structured, searchable elements that can be used to trigger an alert if an LDL-C value is missing or out of date. Co-management of a patient between a primary health care provider and a specialist also presents LDL-C documentation challenges because laboratories report results only to the provider ordering the tests. Overcoming these interoperability barriers was deemed to be beyond the scope of the workshop, but this is a key issue that needs to be given consideration. The solutions will require full support and cooperation of the HIT vendors.

Opportunities for timely documentation of an LDL-C value are often missed because the patient is not fasting at the time of the visit. The workshop attendees recommended an EHR alert for opportunistic LDL-C screening in the non-fasted patient. Because laboratories do not report calculated LDL-C values when triglycerides are  $>400$  mg/dL, the group also recommended alerting health care providers to order direct LDL-C values in this scenario.

Determining the LDL-C treatment gap also has social and technical challenges. Shared clinical care between primary care provider and specialist can lead to role

confusion between advising and treating that is not amenable to technical solutions but should be considered at other levels. Several attendees advocated always acting in the best interests of the patient by treating and resolving any role and responsibility conflicts, if they arise, on an ad hoc basis. The technical challenge to determine LDL-C treatment gaps arises from distinguishing adherence from titration issues. It was agreed that patient adherence is a challenging problem that cannot yet be attacked with an HIT solution in most health care systems because of problems linking pharmacy data with EHR systems, but could be solved in the near future with the cooperation and support of the HIT vendors. Nevertheless, it was felt that LDL-C is a sufficient proxy for adherence, which would not adversely affect titration decisions. The attendees discussed the target treatment goals of LDL-C <100 mg/dL vs <70 mg/dL. Although the NLA members all advocate <70 mg/dL in high-risk patients, they felt they should conform with the existing ATP III Guidelines of <100 mg/dL, with an optional goal of <70 mg/dL, that have been widely promoted to PCPs. Therefore, it was recommended that health care providers be alerted that if the LDL-C value was  $\geq 100$  mg/dL on no lipid-lowering therapy, a statin should be started, or to intensify the lipid-lowering treatment if the LDL-C was >100 mg/dL and it was not decreasing on current therapy.<sup>4,5</sup>

## Clinical decision support

CDS integrates the algorithms of risk assessment and goal attainment with the clinical guidance recommendations for managing the high-risk patient with CVD. At a minimum, CDS should present a clinical dashboard that summarizes the patient's CVD risk, calculated LDL-C goal, current LDL-C level, goal status, and treatment recommendation(s). A historical list of tried and abandoned lipid therapies would be useful for managing statin-intolerant patients.

Additional desirable features include alerts for overdue, repeat LDL-C testing to both provider and patient, e-prescribing capabilities, guidance on drug-drug interactions, feedback of patient-days covered on current prescriptions, specific medication recommendations that are based on expected LDL-C lowering, referral

recommendations, adherence screening guidance for patients who fail to reach goal, and charts that show LDL-C values over time annotated with treatment interventions. These advanced features, however, require compatibility with other HIT systems that may not be generally available at all sites or that require local customizations. For instance, recommending specific LDL-C-lowering therapies that are based on predicted LDL-C lowering depends on both local formularies as well as patient insurance coverage. Selecting an optimal, but non-covered, therapy converts a goal titration decision into an adherence problem.

## Patient communications

The value of patient communications was endorsed to help patients understand their therapeutic goals and successes, to remind about and communicate laboratory testing, and to educate patients about adherence and their disease. Technology opens many new opportunities to communicate with patients, including personalized Web sites, personal health records, social media, and mobile technologies, as well as facilitating traditional methods of printed materials and telephone calls.

On the basis of both the presented literature review and clinical experiences, the attendees agreed that helping patients understand the personal significance of achieving and maintaining their LDL-C goals by providing online and at the point-of-care personalized vascular age reports was a simple and highly effective patient education tool.<sup>8,3</sup> Supplementing this individualized report with educational information about statins and their benefits and side effects would help counter both statin noncompliance over time and less reputable Internet information.

There was also support, as well as concerns, about using HIT for reporting laboratory values to patients. Concerns about direct reporting of laboratory values to patients were based on worries that patients with normal values would discontinue treatment or miss follow-up appointments. To some extent, this concern could be mitigated by e-reminders to patients for follow-up visits, as well as automated practice reports of missed appointments. The attendees were in agreement that any laboratory values reported to patients would first need to be adjudicated by the provider who ordered them.

**Table 5** Goals for managing high-risk patients with ischemic vascular disease or type 2 diabetes mellitus (T2DM) or both

### Goals/Aims

1. Identify high-risk patients with ischemic vascular disease or T2DM or both
2. Increase percentage of high-risk patients with documented LDL-C in chart
3. Refer high-risk patients with missing or outdated (>12 mo) LDL-C values for laboratory testing
4. For untreated high-risk patients with LDL-C >100 mg/dL, increase percentage of patients on a statin
5. For treated high-risk patients with LDL-C >100 mg/dL, increase percentage of patients being titrated to goal
6. Increase percentage of high-risk patients at LDL-C goal <100 mg/dL

LDL-C, low-density lipoprotein cholesterol.

**Table 6** HIT functionality requirements for managing high-risk patients

HIT functionality requirements	Goals/aims
Risk assessment	1
Goal attainment	2, 3
Clinical decision support	4, 5, 6
Patient communication	3, 4, 5, 6
Quality improvement monitoring	2, 3, 4, 5, 6

HIT, health information technology.

Another area in which HIT could improve patient management and practice efficiency is coordinating automated patient reminders for laboratory tests with laboratory results. With multiple communication options widely available to patients, the group expressed support for allowing patients to select preferred communications from telephone, e-mail, mail, texting, and so forth. The participating HIT partners, however, noted that automated support for all communication methods presented numerous technical challenges that would be hard to generalize to all health care systems.

## QI monitoring

One of the most significant and challenging aspects of HIT interventions is QI monitoring for aggregating data on patients, providers, and populations. At the patient level, QI monitoring identifies specific patients not at goal, not progressing to goal, and not following up with laboratory tests and appointments. At the provider level, QI monitoring reports process and outcome metrics on all the patients cared for by a provider. At the population level, QI monitoring reports process and outcome measures for all patients in a clinical practice.

Patient-level reporting helps a practice identify patients who need extra case management by automated or manual processes or both. Provider-level reports are the foundation for QI initiatives such as Shewhart-Deming improvement cycles of Plan-Do-Study-Act.<sup>84</sup> High-performing health care systems, such as that described previously by Dr Scott of KP, use provider reports to identify QI opportunities, to track progress on improving care processes, and as learning and discovery tools for professional development. Population-level reports are the basis for insurer and governmental reporting requirements, as well as incentive payments to practices. HIT systems that automate reporting NQF, and other practice quality metrics for incentive payments to providers, are seen as critical leverage for providers to adopt HIT tools in clinical care.

Although seen as having high value by the workshop attendees, QI monitoring presents many challenges for near-term generalized implementation. The challenges are technical, involving the variety of strategies that extant EHR systems use to organize and store data for point-

of-care documentation of complex and varied clinical data sets vs the different database organizations required for searching and querying large data sets for reporting. Existing health care systems extensively using QI monitoring, such as KP, have extracted data from EHR systems into stand-alone, custom patient registries.

## Overall HIT solution

Figure 11 is a conceptual flow diagram that summarizes incorporating the first 4 HIT functionality requirements into the EHR and clinic workflow. The panel divided into several groups for more in-depth discussion related to recommendations for future studies and research. A group of the workshop attendees met with the HIT partners to discuss how by working together they might create EHR solutions that could accomplish the workshop objectives for LDL-C goal attainment. It was concluded that it would be reasonable for a QI demonstration project to target practices that are already using 1 or more of the partners' solutions. This would eliminate the implementation, interoperability, and comparability issues of rapidly field-testing HIT solutions for improving LDL-C goal attainment. Working together would provide rich data across different practice types that could be explored, and such collaboration would enhance the chances of achieving the objectives. The HIT partners agreed that working together and sharing their respective resources would be beneficial to all.

As a first step, the HIT partners requested the software requirements be specified. The functional requirements should specify the triggering conditions, behavior, and wording of provider alerts; the tracking and management of laboratory results; the algorithms to analyze LDL-C levels based on the patients' histories; how to identify high-risk patients with CHD based on multiple coding systems, such as International Classification of Diseases-9, Systemized Nomenclature of Medicine, and Current Procedural Terminology, as well as on structured and unstructured EHR data; and the decision guidelines for recording and recommending lipid-lowering therapies on the basis of LDL-C levels.

Although compliance assessment was considered a high priority, it was agreed that obtaining timely and accurate refill data from multiple pharmacies and data systems is not yet possible, in general. Given that LDL-C levels are easy to track and correlate well with statin therapies, LDL-C levels can be surrogates for compliance and could be used to trigger provider adherence alerts that are based on analysis of LDL-C trends in relationship to statin dosing.

In addition, it was recommended that the population data be collected along with patient analytics. Population analytics for both the provider and practice would show status of improvement efforts and motivate the health care team to identify and overcome practice barriers to improving LDL-C goal attainment. Patient analytics would identify patients needing treatment review and optimization and assist the health care team in developing solutions for these patients.

It was agreed that a team-based approach was also a critical requirement for successful demonstration projects because electronic intervention alone will likely not be sufficient. It was further recommended that the NLA develop a training module and survey tools for practice groups to increase the chances for success. The training module would increase the likelihood that all practice members would understand and support a QI project. The survey tool would assess whether a practice is team based, has a culture focused on achieving quality measures, and has an influential quality champion on its staff. In addition, materials that offer an opportunity to participate in a demonstration project should describe the reasons why a practice would want to participate, the potential rewards for participating, and the recognition and awards for participating, such as a certificate of special competency in lowering heart attack rates to place in waiting rooms.

The final recommendation was that LDL-C goal attainment demonstration projects that use EHR tools should initially focus on relatively smaller practices to simplify the training process and to more easily identify the factors underlying the outcomes in the demonstration projects.

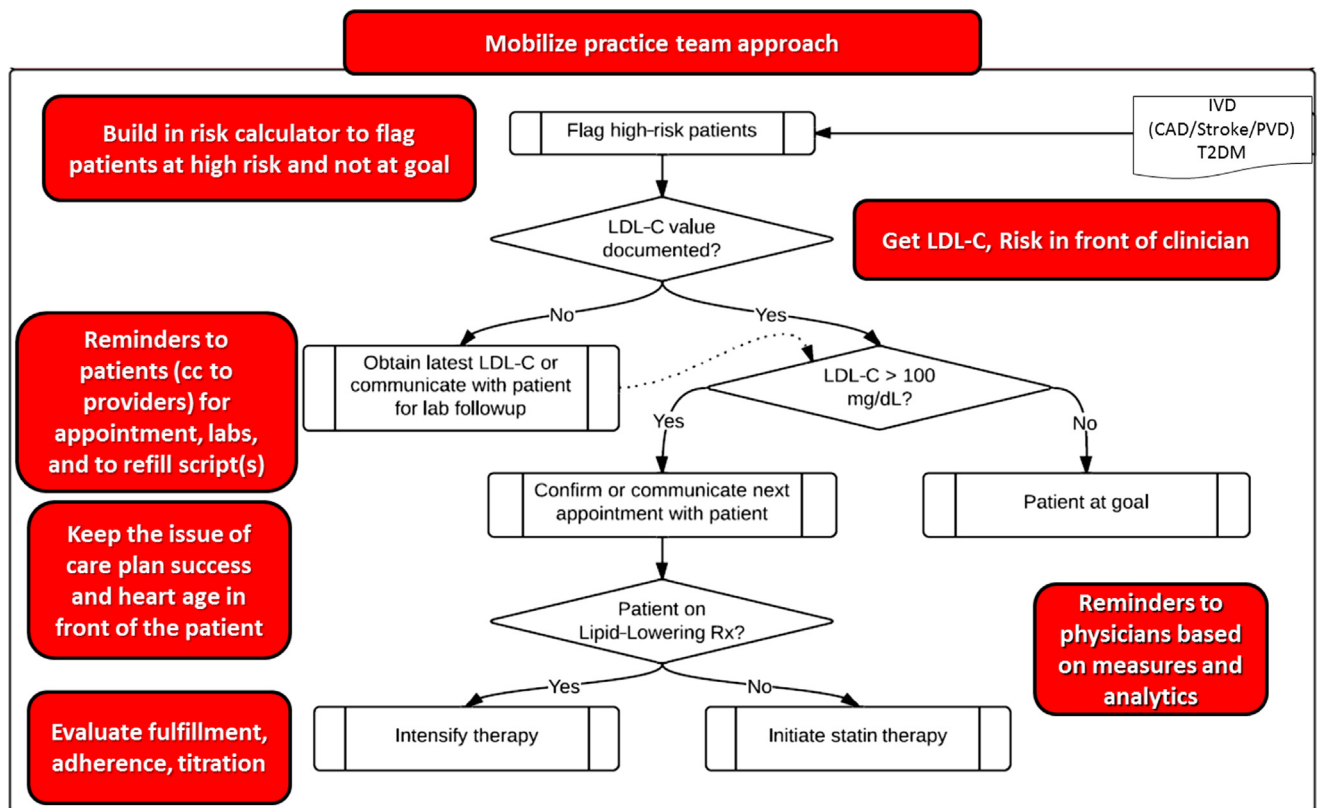
## Considerations for future studies

The final session of the workshop was devoted to discussion of the next appropriate steps for studies in the immediate future. The group discussed the issues involved in designing and implementing a clinical trial in QI. An ideal design would be a randomized trial with an adequate control group to obtain meaningful results and to reduce the possibility of bias. The following is a description of the important points and potential obstacles that should be considered in future research projects:

- **Study design** – inclusion of a usual-care control group to compare with the HIT intervention; choice of the unit of randomization, that is, at the level of the practice vs at the level of the individual provider
- **Clinical outcome measures** – selection of the primary clinical outcome to use for determination of sample size (percentage of high-risk patients with LDL-C <100 mg/dL) and determination of additional outcome variables (comparison of mean LDL-C levels among groups)
- **Defining clinical success** – specification of a level of improvement that, if achieved by the intervention group, would be considered clinically meaningful, for example, a 15% improvement from baseline of 30% to 45% in LDL-C goal achievement
- **Site selection** – selection of a medical group with a lower baseline prevalence of LDL-C goal attainment (eg, 20%–40% of patients at goal) would likely have the best chance of showing benefit; in groups with a higher baseline LDL-C goal achievement rate (eg, 60%–75%) measurable improvement would be more difficult to achieve

- **Provider inclusion and exclusion criteria** – determination of the type of health care providers to target for participation, such as primary care providers, including family practitioners, internists, nurse practitioners, physician assistants, and others who do most of a practice's primary care
- **Patient inclusion and exclusion criteria** – choice of simple entry criteria to increase generalizability of study results, for example, patients who are at high risk of CHD, >18 years of age who had been receiving primary care for at least 6 months to 1 year, who are not pregnant, who have no history of rhabdomyolysis, and who have no terminal illness
- **Intervention design** – determination of whether the intervention should be multifaceted in a 2 × 2 or 3 × 3 design wherein several intervention strategies could be tested simultaneously; decision of whether both clinical and population intervention approaches should be used, that is, giving the intervention health care providers a list in advance of all patients not at LDL-C goal, whereas the control health care providers would receive data on the baseline percentage of patients at LDL-C goal but not a list of individual patient names
- **Provider feedback** – determine the frequency of feedback to the provider, which would depend on the length of the trial, for example, intervals of 3 to 6 months; the method of feedback, for example, standardized written or verbal feedback, or both; and the type of feedback, for example, the number of patients at LDL-C goal, as well as any other metrics deemed important (ordering LDL-C levels, initiating statin therapy, statin titration, and so forth)
- **Patient-level involvement** – determine whether to include direct patient interventions, not just those at point of care, based on EHR literature that reports benefits of combined provider and patient interventions; independent institutional review board may be needed
- **Follow-up time frame** – determination of the time frame to assess the effect of the intervention on improving outcomes would depend on whether point-of-care interventions were supplemented by visit-independent interventions; minimal time frame for assessment may be 6 months to 1 year, with 1 to years of follow-up being optimal

Although it was agreed that a randomized clinical trial would be preferential, surmounting the problems discussed above would be difficult and time-consuming. All things considered, it was recommended that the next step should focus on the design of a successful QI intervention and to assess outcomes in a prestudy and poststudy design or to use other data for comparison such as concurrent or historical controls. Although the study design could affect the generalizability of the results to other practices, the panelists concurred that the time for action was now, given that the percentage of high-risk patients at LDL-C goal has not improved in the past decade.



**Figure 11** High-level conceptual flow diagram that summarizes incorporating the first 4 health information technology functionality requirements into the electronic health record and clinic workflow. CAD, coronary artery disease; IVD, ischemic vascular disease; LDL-C, low-density lipoprotein cholesterol; PVD, peripheral vascular disease; Rx, prescription; T2DM, type 2 diabetes mellitus.

**Overall summary and conclusions from Dr Cohen, Workshop Chairman**

The workshop focused on the fact that the gap in LDL-C goal attainment that has existed for many years is not closing. The passage of the ARRA and HITECH Acts, with their meaningful use incentives, has accelerated the growth of HIT and provides an opportunity to focus on evidence-based patient outcomes. The presentations and discussions described herein indicated that LDL-C goal attainment can be greatly enhanced through the appropriate use of HIT. Table 7 outlines the key principles for successful use of HIT, and Table 8 presents the system elements that were determined to be essential for improving HIT. For HIT to be

effective, it must be implemented in a setting in which the health care team is fully engaged, and the delivery system and culture support performance reporting and QI. It was emphasized that implementation of HIT without the full commitment of the health care team has been ineffective. Both components, HIT and a committed health care team to employ its use, are critical to success. Leveraging the skills set of the health care team and working closely with patients must be accomplished without increasing the overall work/time burden. It was recognized that this may be difficult to achieve initially, but that by enhancing communication between the health care team and the patient more timely adjustments to treatment plans can be made, thereby enhancing the opportunity for LDL-C goal

**Table 7** Summary of the key principles for successful use of HIT

- An electronic monitoring system is necessary to manage patient care at the population level.
- The EHR is a tool to help both health care providers and patients get to guideline-specified goals, but it cannot be expected to drive success alone.
- The EHR needs to help improve practice efficiency with more automated triggers, not add to the burden.
- The ultimate success is driven by the health care provider team/patient relationship to motivate and execute with as few obstacles as possible.
- A team approach is essential, especially in larger or busier practice settings.
- The process path to achieving LDL-C goal can occur before, during, and after the live patient visit.
- Seamless, timely, and efficient communications between health care provider team and patient, without wait periods, is ideal.
- Frequent interactions, based on timing to make a decision about laboratory values and prescriptions, are key.

EHR, electronic health record; HIT, health information technology; LDL-C, low-density lipoprotein cholesterol.

**Table 8** Essential system elements for improving HIT

- Practice population: for participating practices, include all patients with known CVD also having LDL-C laboratory values available to analyze
- Monitoring system: population-level dashboards reflecting percentage of patients with LDL-C >100 mg/dL; patient-level flags that reflect patient's LDL-C goal, actual LDL-C, and distance from goal; batch reports that detail patients not at goal
- Health care provider team notification: send update to health care provider when laboratory results become available, according to their communication preference(s)\*
- Patient communication: send laboratory results to patients when available, according to their communication preference(s)\*
- Routine scheduled LDL-C measurements and follow-up interactions until goal is achieved and properly maintained

CVD, cardiovascular disease; HIT, health information technology; LDL-C, low-density lipoprotein cholesterol.

\*Communication options include e-mail, short message system text, phone call or message, or standard mail.

attainment and creating more efficiency in the long run. One of the challenges in today's environment is the lack of LDL-C values available at the time of the patient visit. Although this has been a longstanding problem, the implementation of HIT alone has not resulted in reducing the gap in documentation, and it is critical to build an effective management strategy into the HIT platform. The workshop discussions explored the advantages of providing information in a timely and useful manner along with additional support, such as reminders for health care providers to encourage better adherence to treatment guidelines and better communication to encourage patients to take a more active role in their care and to better understand the importance of adherence. It is critical that these support tools are evidence based and in accordance with established guidelines and standards of care. It was recognized that the involvement of NQF brings a much needed dimension to this effort. It was also noted that the NLA recently has developed a toolkit to help improve patient adherence and which could be modified for use in an HIT system.<sup>86</sup>

Discussion was robust about the appropriate next steps for evaluating the role of HIT in improving LDL-C goal achievement. The merits of a randomized controlled trial vs a QI demonstration project were debated. The virtue of simplicity of design and implementation of a demonstration project is attractive and, depending on the clinical setting, may be more practical and advantageous than a randomized trial.

In any event, the representatives of the NLA, NQF, HIT partners, and industry sponsor agreed on the importance of a collaborative approach to address the problems of HIT implementation to improve patient outcomes in high-risk patients. Such a collaborative effort will set the groundwork for future expansion of the format into other chronic conditions, for example, diabetes and hypertension, and eventually lower risk persons as well. Recognizing that the failure to achieve LDL-C goals is a complex problem because of many factors, a collaborative approach offers the best opportunity for long-term success. Given the current status of HIT implementation, there is optimism that, by establishing a working relationship between these partners, a meaningful favorable effect on LDL-C goal attainment can be achieved.

## Acknowledgments

The authors would like to thank Mary R. Dicklin, PhD, and Kevin C. Maki, PhD, of Biofortis, Inc (Addison, IL) for their assistance in preparing the manuscript, and Audrey M. Zhang, BS, of Intelligent Medical Decisions, Inc, for assistance in the preparation of the graphical summaries presented for the literature review.

## Financial and support disclosures

Dr Cohen has received consulting fees from Merck & Co, Inc. Dr Aspry has no disclosures to report. Dr Brown has received speaker honoraria from Abbott Laboratories, Forest Pharmaceuticals, and Merck & Co Inc and is on the Advisory Board for Abbott Laboratories, Kowa Pharmaceuticals, Aegerion Pharmaceuticals, Inc, Merck & Co Inc, and Gilead. Dr Foody has received consulting fees from Merck & Co Inc, Pfizer Inc, Genzyme Corporation, and Sanofi. Dr Furman is employed by Intelligent Medical Decisions, Inc. Dr Jacobson has received consulting fees from AbbVie Inc, Amarin Corporation, Merck & Co Inc, Regeneron Pharmaceuticals, Inc, Sanofi, and Amgen, Inc. Dr Karalis has received speaker honorarium from GlaxoSmithKline. Dr Kris-Etherton has received research grants from The Peanut Institute, General Mills Inc, The Almond Board of California, Western Pistachio Association, Hass Avocado Board and has received honoraria from MonaVie LLC and Unilever. Mr LaForge is on the speaker's bureau for AstraZeneca. Dr O'Toole has no disclosures to report. Dr Scott has no disclosures to report. Dr Underberg is on the speaker's bureau for Abbott Laboratories, Forest Pharmaceuticals, GlaxoSmithKline, Daiichi Sankyo, Inc, Kowa Pharmaceuticals, LipoScience, Inc, diaDexus, Inc, Merck and Co, and Eli Lilly & Co and has received consulting fees from Genzyme, News Corporation, Publicis, Inc, Guidepoint Global, Amarin Corporation, and Aegerion Pharmaceuticals, Inc. Dr Valuck has no disclosures to report. Dr Willard has no disclosures to report. Dr Ziajka has received speaker honoraria from Kowa Pharmaceuticals, Abbott Laboratories, Merck & Co, Inc, Hunter Heart Laboratory, Atherotech, Inc, and AstraZeneca. Dr Ziajka has received a research grant from Genzyme Corporation and has received



consulting fees from Hunter Heart Lab. Dr Ito has received speaker honoraria from GlaxoSmithKline, Kowa Pharmaceuticals, and Abbott Laboratories. Overall support for this workshop was provided by Merck & Co, Inc.

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## Appendix

### Workshop participants

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**Appendix Table 1** Survey tool to assess current EHR use in practice to achieve LDL-C goal

## A. Practice setting description/demographics

Identify the following:

- Type of practice (primary care, specialty, multispecialty)
- Clinical specialty if applicable
- Total number of patients
- What percentage of your patient population does your practice
  - Care for as the primary provider of CVD risk management?
  - Co-manage with the referring primary care provider?
  - See in consultation only a limited number of times?
- Referral patterns (also see Section C for additional detail)
  - Percentage of patients referred from outside your practice
    - By self-referral
    - By primary care providers
    - By other specialists
  - Percentage of patients referred from within your practice
    - By self-referral
    - By primary care providers
    - By other specialists
- Staff composition (number of providers, including mid-levels, clinical support staff)
- Does your clinic group belong to an ACO?
- Does your group participate in NCQA's Patient-Centered Specialty Practice (PCSP) Recognition Program or would your group be interested in such participation in the future?

## B. EHR readiness (status before establishing an EHR)

- What were the factors that initiated the development of EHR tools for CVD risk reduction in your practice?
- Who initiated, or first championed, the effort in your practice?
- If professional staff initiated, what approach was required to engage administrative support? (eg, return on investment, cost avoidance, reduction of readmission, etc)
- If initiated by the administration, what approach was required to gain professional staff support? (eg, payer-related penalties, quality reporting initiatives, etc)
- What obstacles to instituting change for either the administrative or professional staff were encountered? How did you manage their concerns?
- What was the effort in both time and costs to institute the changes?
- How many major iterations were required to achieve your current process?
- What quality/performance metrics, if any, were in place before the change? If so, what was your performance level?

## C. Patient population and clinical target identification

1. Who are the patients to be targeted and how were they culled from the generalized patient database?
  - Do you differentiate high-risk patients (ATP III criteria) in your EHR? If not, do you include all patients not at ATP III LDL-C goal?
  - Does your EHR calculate Framingham risk scores or lifetime CVD risk scores for each patient at baseline?
  - If you use other patient risk identification criteria (eg, ADA, VA, NCQA, or your own), please identify.
  - Do you include high-risk (ATP III) primary prevention patients (eg, patients with 2 or more traditional risk factors and a calculated Framingham score of >20%)?
  - Are any patient demographics used to identify specific patient populations who have higher prevalence of not achieving LDL-C target goals (eg, ethnicity, age, income level, etc.)? (data from 2012 BRFSS, BCNC, etc)
  - Are any special populations (chronic kidney disease, patients with HIV) specifically evaluated?
2. How are "not at target" patients electronically identified?
  - If you use an alert trigger system, how are the alerts chosen?
    - Framingham risk score
    - Individual risk factors, including LDL-C
    - History as entered in the EHR document
    - Laboratory results and imaging
    - Other
  - In what form is the alert (eg, flags, e-reminders, color codes)?
  - How are alerts designed to inform the practitioner of potential concerns? Are hard stops put into place with certain alerts?
  - What does your system do to address the issue of "alert fatigue" that is common to many EHR implementations?
  - Is an algorithm used by which practitioners can be alerted that a lipid clinic or lipidologist referral should be generated?
  - With what frequency are the alerts generated if a patient has not achieved target?
  - Do you have an integrated clinical decision support feature? If so, briefly describe the protocol.
  - Are the alerts combined with any interventional targets for lifestyle modification?

## 3. EHR-related work flow

- How are the data extracted and downloaded from prior paper records with emphasis on accuracy?
- Is this preloading done when the patient registers for an appointment with the lipid clinic or at another time?
- What is the mechanism for maintenance of the record/flowsheet, including prescription and laboratory monitoring? (personnel vs automated)
- How did the introduction of EHR tools affect the workflow of your team?
- Did it change your clinical care processes for other team members?
- Did team members have any resistance or issues with the changes? If so, how were these issues resolved?

## 4. Clinical decision making and interventions

- Are interventions for lifestyle modification and medication used in this patient population? If so, are these needs and decisions made electronically?
- What elements are included in the flowsheet for longitudinal documentation of interventions?
- Does this include trials of medications correlated with the dates of administration, and associated laboratory results?
- How is patient adherence tracked in terms of medication use, that is, filling prescriptions, potential drug interactions, appropriate medication choices for degree of LDL-C lowering necessary, medication intolerances?
- Do you use a metric to identify or score prescription refill compliance vs original prescription fill?
- Do you have a metric for identifying, at least in a general sense, statin compliance and, if necessary, intolerance responsiveness (myalgia, fatigue, etc)?
- Do you have a metric for scoring lifestyle (dietary, physical activity, and weight loss) compliance?
- Is the first lipid panel on record downloaded manually or extracted from the record?
- Are lipid panels interpreted and qualified with any interpretative guidelines? If so, please describe the guidelines.

## 5. Outcomes measurement and communications

- Do you perform periodic trend/outcome reporting from data collected from your EHR?
- If so, please list those outcome reporting measures.
- How frequently are your reporting measures and outcomes measured?
- Are they released as a percentage of patients in the overall clinic population who have achieved goal?
- Are they linked to readmission rates for all cause, or event rates for cardiac pathology?
- Is the lipid clinic visit reported back to the referring physician on a visit-by-visit basis?
- Have you demonstrated improvements in LDL-C goal attainment specifically correlated to the EHR identification and intervention tools? Are these outcomes published or readily available for review or both?

## 6. Features and issues related to the development and implementation of your EHR

- Does your system user interface have features that you found challenging or helpful?
- Does your system exchange data externally with health information exchanges, pharmacies, or payers?
- Does your system provide computerized patient order entry or e-prescribing?
- Does your system interface with or provide any type of personal health record for patients?
- Does your system provide any mobile health features, such as patient messaging?
- Does your system provide any Web-based tracking or education initiatives for patients?
- Regarding Quality Improvement (QI)
  - How have you used EHR data for internal QI initiatives?
  - What barriers have you encountered in improvement efforts?
  - What successes have you had?
- Do you participate in the CMS Electronic Health Record Incentive Program?

## 7. Recommended revisions to your current model

- What have you learned from experience and could anything be improved in the development and subsequent use of these lipid management techniques?

## Open questions for Health Quality and Research Committee Appraisal

- How do these initial 3 practice sites differ in the responses to the above questions?
  - Private referral lipid clinic
  - Academic center
  - Cardiology practice
- How do or would these initially chosen practice sites responses contrast with ACO, PCMH, and other Collaborative Care Model sites with regard to EHR tools to improve LDL-C goal attainment?

ACO, Accountable Care Organization; ADA, American Diabetes Association; ATP, Adult Treatment Panel; BCNC, Boston Chinatown Neighborhood Center; BRFSS, Behavioral Risk Factor Surveillance System; CMS, Centers for Medicare and Medicaid Services; CVD, cardiovascular disease; EHR, electronic health record; HIV, human immunodeficiency virus; LDL-C, low-density lipoprotein cholesterol; NCQA, National Committee for Quality Assurance; PCMH, Patient-Centered Medical Home; QI, quality improvement; Rx, prescription; VA, Veterans Affairs.