

# Improving Cardiovascular Outcomes Using Electronic Health Records

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**Abstract** Improving quality of care through the enhanced use of digital technologies is becoming an increasingly primary focus of the health care industry in general and cardiovascular (CV) medicine in particular. The recent rapid adoption of electronic health records (EHR) has the potential to improve the management of CV disease by removing variability and assuring at least consideration of guideline-recommended care and appropriate use criteria. This can lead to improved cardiac outcomes at all phases of care; beginning with the automated identification of patients who are at increased risk, implementing evidence based medicine for primary CV prevention, using online decision support tools for acute management, and, possibly most importantly, by connecting the health care provider and the patient through open accessibility to their EHR. The widespread use of EHR is the dawn of a new era where evidence based guidelines can be seamlessly translated to patient care and where patients are actively involved in their own health. As transformative as this will be, it is important to recognize that we are currently experiencing only the very earliest potential of the EHR in improving CV outcomes.

**Keywords** Electronic health records · Health information technology · Cardiovascular outcomes · Cardiovascular risk · Quality of care

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## Introduction

Information Technology remodeling our Health Care

The use of health information technology (HIT) has revolutionized the way we practice medicine and many people within and outside health care see it as a key component to improving the efficacy, quality, and safety of health care delivery. In fact a large majority of recent studies have shown measurable benefits emerging from the adoption of health information technology in one or more aspects of care [1••]. Among the many types of information technology being adopted into the healthcare system in the past decade, electronic health records (EHR) are arguably the most important because they are the one technological advance that can have the most profound effect on the daily work of health care providers, while at the same time impacting the care of individual patients as well as populations of patients as a rich resource for research and learning. Less recognized, but possibly most importantly, it offers the potential to increase the involvement of patients in the active management of their own health [2]. Studies showing an early benefit of EHR in improving outcomes have focused primarily on improving patient safety by using automatic alerts and reminders in the computerized physician order entry, which provided a mechanism to help identify and eliminate errors such as potential interactions with a patient's other drugs [3]. Beyond safety, the full utilization of the EHR's potential can also improve the efficacy of therapeutic interventions in all phases of treatment; primary and secondary disease prevention, acute treatment and chronic disease management.

Our health care system has entered a new phase where the focus on quality improvement is universal. The American College of Cardiology (ACC) and the American Heart Association (AHA) have been committed to improving the quality of cardiovascular care through the creation of guidelines that

carefully review and synthesize the available evidence to better guide patient care [4]. Adherence to these guidelines is the foundation to improving health care quality. Health information technology can enhance that adherence by integrating evidence-based medicine into our daily practice and in so doing can improve our ability to prevent disease, better treat our patients, and to do so in a more efficient and cost-effective manner.

We examined the published literature and closely looked at the experience of using EHR to improve quality of care at multiple health care institutions. Our findings suggest that the use of EHR has several advantages that can potentially improve cardiovascular outcomes (Table 1), but it is not a panacea and there is much refinement to be done.

### Role of EHR in Cardiovascular Disease Prevention

Cardiovascular disease is not only the leading cause of death, but it is also the most costly disease in the United States, accounting for 17 % of all US health care expenditure [5•]. Therefore, the prevention of cardiovascular disease is critical. Being successful at prevention is a key element to improving our patients' quality of life, to lower the cost of care, and to improve the future of our health care system [6].

In order to optimize prevention strategies a major challenge is first identifying patients who are at risk. Predicting risk has been a major focus of cardiovascular research over the past 50 years. The current risk prediction tools that are being used in the United States are based on cohort studies that use chart

review and patient interviews to obtain data [7••]. These measures require time, are based on a particular patient populations with limited sample sizes, and are difficult and expensive to update [7••]. The increasingly available EHR provides an opportunity to replace the old risk assessment measures by new computerized tools that are more accurate and timely [2, 8].

Multiple studies have evaluated the use of EHR to create cardiovascular risk assessment tools. One observational study compared automated risk stratification assessment to physician manual chart review and found high correlation between the two methods [9]. Automated methods accurately identified candidates for antiplatelet therapy and lipid lowering therapy in this study. Therefore, routine EHR data can be integrated into automated clinical decision support for the recommendation of specific, individualized preventive interventions as a physician reminder during routine, primary care visits [10]. Individualized risk can also be further refined beyond routine Framingham-like criteria to identify risk factors for risk factors. The EHR can successfully identify younger patients at increased risk for developing diabetes or hypertension, and therefore eventually at higher risk for developing cardiac disease [11, 12].

Therefore, the EHR has the potential to automatically identify patients at increased risk for future cardiovascular disease, whom physicians might not otherwise be aware, and then provide guidance as to the most appropriate intervention for that individual patient's unique characteristics. In addition, the large amount of longitudinal data provided through the EHR can allow for a more refined risk assessment that is specific to the regional population. It has been shown that, once these data exist, developing reliable and accurate risk scores is within the scope of most large health systems [7••].

### Role of EHR in the Continuous Management of Cardiovascular Disease

#### *Outpatient Setting*

Suboptimal management of cardiovascular disease in the United States is well documented [13]. Despite the large amount of clinical evidence supporting the benefit of achieving treatment targets, modifiable risk factors such as hyperlipidemia and hypertension are poorly controlled [13, 14]. The advances in clinical informatics provide opportunities to improve the management of these risk factors. In a randomized, controlled, physician-blinded trial, the outcome of computer-assisted, physician-directed intervention to improve secondary prevention of hyperlipidemia was assessed [14]. Two hundred and thirty-five patients, who had coronary artery disease (CAD) or risk equivalent and with LDL cholesterol levels above National Cholesterol Education Program-

**Table 1** Advantages of using EHR to improve quality in cardiac care

Features of EHR that can potentially improve cardiovascular outcomes
Improving patient safety via identifying potential medical errors (drug interactions, etc)
Automated, passive identification of patients at risk for atherosclerotic disease
Offering risk stratification assessment tools for therapeutic guidance; e.g., thromboembolic risk in atrial fibrillation, bleeding risk with antithrombotic therapies
Triaging and treatment guidance for patients with active symptoms: clinical decision support system incorporating guidelines and appropriate use criteria
Computer assisted physician directed intervention programs for primary prevention; e.g., automated reminders for physicians to prescribe treatment when lipids are not at goal.
Eliminating unnecessary cost through better individualizing evaluations and treatments and minimizing variations in care.
Offering patient's access to their health information, leading to greater patient activation
Offering a rich data repository for quality improvement and quality measures; building learning healthcare system
Facilitates communications and handoffs between health care providers decreasing errors during transitions of care.

recommended levels for greater than 6 months, were randomized into two groups: the control group who received usual care and the intervention group in which physicians received a single e-mail per intervention patient. Emails were visit independent, provided decision support and facilitated 'one click' order writing. A greater proportion of intervention patients had prescription changes at 1 month and 1 year. The study showed that a visit-independent online disease management tool resulted in a significant improvement in the treatment of hyperlipidemia. Similar results were found in regards to hypertension management. A study that examined retrospective data from the National Center of Health Statistics compared blood pressure control in practices where physicians reported using EHR only, EHR with clinical decision support system, or neither. The study showed that physicians' use of electronic health record and a clinical decision support system was associated with improved blood pressure control in those practices [15].

As opposed to suboptimal management, overtreatment leading to unnecessary tests and higher costs is a tremendous challenge in the current health care system. Annually, 6 million Americans present to the emergency department for evaluation of chest pain, in whom only 20 % are found to have an acute coronary syndrome [16]. Implementing an online decision support system can help risk-stratify patients reporting possible cardiovascular symptoms and triage those patients to the emergency department, urgent care clinic or the outpatient clinic. This online decision support tool has been evaluated and found to be both technically feasible and clinically reliable [17]. Utilizing these tools could improve efficiency, reduce unnecessary patient visits to the emergency department and decrease cost.

#### *Inpatient Setting*

Among patients admitted to the hospital with an acute coronary syndrome, there is a strong, and clinically significant association between the quality of care delivered based on guideline adherence utilization of evidence based medicine [18, 19]. Studies have found that medical records of patients with a non-ST elevation acute coronary syndrome often lack key elements of the history and physical examination, and that patients treated at hospitals with better medical record quality have significantly lower mortality and better outcomes [20]. Medical charting is a central component of the health care process and critical to the appropriate coordination of care among multiple providers. It is plausible that a thorough documentation of all aspects of care is associated with a more reliable and appropriate use of evidence-based therapies that lead to better outcomes.

The growth in EHR use has opened the door for creating new tools for innovation in quality improvement. A study that evaluated the data quality of the Veterans' Administration

(VA) Clinical Assessment, Reporting, and Tracking System for Catheterization Laboratories program (CART) have found that cardiac catheterizations reports generated by CART program demonstrated excellent data validity, superior completeness and a trend toward more timely availability to referring providers relative to cardiac catheterization reports generated prior to the CART program implementations [21].

Electronic health records make transitions of care from one provider to another easier and more accurate. Discharge summaries are immediately available to be viewed by the primary care provider, which can allow for more rapid outpatient follow-up and coordinated care. At Geisinger Health System, the EHR connects several hospitals and multiple clinics that are geographically widespread in a rural setting. This network keeps patients' data up to date and accessible to providers at all locations, allowing a patient's primary care provider to know exactly what occurred, and what the discharge plan is for their patient discharged just a day or two earlier from a hospital that may be a hundred miles away.

#### Limitations of Current EHR Systems

Despite the multiple benefits the EHR has the potential to bring to providers and patients, they are still far from perfect, have significant limitations, and can be overwhelming to both the health care provider and the patient if their capabilities are implemented haphazardly or in a way that doesn't include rigorous evaluation of all pertinent outcomes. In a cross-sectional survey, the perceptions of primary care practitioners (PCPs) in the Veterans' Administration healthcare system of automated EHR-based alerts were examined. The median number of alerts PCPs reported receiving each day was 63. The majority of PCPs (69.6 %) reported receiving more alerts than they could effectively manage. Almost one-third of PCPs reported having personally missed results that led to care delay [22]. These numbers suggest that PCPs using comprehensive EHR are vulnerable to information overload and alert fatigue.

Current data also suggests that the use of EHR-based treatment is not a panacea for improved quality and requires innovative incorporation into the flow of care. The IMPROVE HF study was a prospective cohort study of 15,381 patients with HF or post myocardial infarction and left ventricular ejection fraction  $\leq 35$  % cared for in 167 US outpatient cardiology practices. Quality of care was assessed based on seven quality measures, with practices with and without EHRs compared [23]. The investigators found that the use of angiotensin-converting enzyme inhibitors (ACEI), aldosterone antagonist, and heart failure education were significantly higher at sites using EHR compared to those without. However the care was similar with regards to atrial fibrillation, beta blocker use and anticoagulation and worse in regards to the use of implantable defibrillator.

Another current limitation of the EHR is in the reporting of clinical performance measures, something becoming more important as this information becomes available publicly and influences reimbursement. At least one study has found that the automated measure of quality metrics via discrete EHR data can miss a significant amount of important data [24]. The investigators performed a retrospective review comparing automated measurement of treatment quality metrics of coronary artery disease patients with a combined automated measurement supplemented by a review of free-text notes within a large internal medicine practice using a commercial EHR. They found that misclassification of potential quality failures was common, and that anywhere from 15 to 81 % of 'quality failures' detected in an automated manner were not true quality failures, depending on the criteria being evaluated. Despite the EHR advantages for quality improvement, these results highlight that clinical information that are required to accurately measure quality are currently not being captured in a way that can be used by available algorithms designed to measure quality of care.

#### The Patient and Access to Their EHR

As a new health care model is taking shape, the culture that medical care is being delivered only during doctors' visit is changing, and patients are becoming increasingly engaged in their own health care. EHR has made it easy for patients to access their health information. At a number of healthcare systems patients have had an established online patient portal where they could access discrete components of their health information and are able to communicate with their health care providers electronically. More recently, the next phase in the evolution of patient accessibility is via the "Open Notes" project which invites patients to review their provider's full notes in order to improve their understanding of their health [25].

As an initiative of the Open Note project, primary care practices in three different states conducted a survey to measure doctors and patients' attitude toward potential benefit or harm of open visit notes. A total of 173 primary care physicians and 37,853 patients completed the survey [26•]. The survey showed that physicians were divided in their expectations of the effect that open visit notes would have on their practices and the benefits that it would provide to their patients, but patients expressed great enthusiasm, anticipating both improved understanding and more involvement in care.

Despite being wanted by many patients and physicians, providing patients with an online access to their health information may have undesirable consequences. A retrospective cohort study of the utilization of health services by users and nonusers of online access to health records found that patients who have an online access to their medical records had a subsequent increase in use of both in-person and telephone

clinical services including office visits, emergency department visits and number of hospitalizations [27].

Whether open visit notes will improve the physician-patient relationship and health care delivery remains to be seen, but the widespread use of EHR has ensured the potential for patients' to have greater access to their medical records. As the healthcare community migrates toward greater patient empowerment and with it, improved communication and engagement of patients in their care, identifying how to best share medical care information in an informative and non-anxiety producing manner will be necessary.

#### Innovations in Health Information Technology: Vision of the Future

Significant opportunities for improvement are to be considered in the development of future generations of the EHR including innovative user-interface technologies, special functions for each type (specialty, provider type) of users' specific requirements, easy-to-use functions for research support, and patient-directed functions [28].

Investing in health information technology and learning from other industries' management practices are key factors to consider for the future of our healthcare system. Other industries, like telecommunications, retail and general merchandising, have invested heavily in information technology during the late 1990s and into this century, which was associated with a significant increase in annual productivity growth as well as decreases in cost [10]. Researchers, who looked at the quality of care in cardiac units across the country, have found that the use of management practices adopted from manufacturing sectors was associated with higher quality of care and lower mortality in cardiac units [29].

One example of the future potential for optimizing the EHR is the smart heart failure sheet that integrates all patient data in one automatically uploaded display. This smart tool alerts the provider that the patient should be treated with beta blocker, angiotensin converting enzyme inhibitor, and aldosterone antagonist. It also detects atrial fibrillation when present, calculates CHADS2 score and risk for bleeding, and suggests implantation of a defibrillator when appropriate [30].

#### Conclusion

We believe that the rapidly advancing incorporation of information technology in healthcare is a critical component to the continued improvement in the care of patients with, or at risk for cardiovascular disease. The same technology that led to smart phones and tablets will also lead to even smarter EHR where cardiovascular data, often downloaded automatically from mobile devices worn continuously by patients, gets integrated, processed, and displayed in a format readable and

actionable by both provider and patient. In addition, it can provide decision support tools that are driven by evidence-based guidelines allowing all providers to assure the best quality of care to our patients. There is tremendous potential for the EHR to improve all aspects of care and have a positive impact on patients, providers and the entire healthcare system. This is especially true when considering that the EHR is just in its infancy and over the following years will evolve exponentially to truly achieve its potential for improving cardiovascular outcomes for all.

### Compliance with Ethics Guidelines

**Conflict of Interest** Mazen Roumia and Steven Steinhubl declare that they have no conflict of interest.

**Human and Animal Rights and Informed Consent** This article does not contain any studies with human or animal subjects performed by any of the authors.

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