Report of the AMIA EHR-2020 Task Force on the status and future direction of EHRs

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AMIA POSITION PAPER

Over the last 5 years, stimulated by the changing healthcare environment and the Health Information Technology for Economic and Clinical Health (HITECH) Meaningful Use (MU) Electronic Health Record (EHR) Incentive program, EHR adoption has increased remarkably, and there is early evidence that such adoption has resulted in healthcare safety and quality benefits.[1,2] However, with this broad adoption, many clinicians are voicing concerns that EHR use has had unintended clinical consequences, including reduced time for patient-clinician interaction,[3] new and burdensome data entry tasks being transferred to front-line clinicians,[4,5] and lengthened clinician workdays.[6–8] Additionally, interoperability between different EHR systems has languished despite large efforts towards that goal.[9,10] These challenges are contributing to physicians' decreased satisfaction with their work lives.[11–13] In professional journals,[14] press reports,[15–17] on wards, and in clinics, we have heard of the difficulties that the transition from paper records to EHRs has created.[18] As a result, clinicians are seeking help to get through their work days, which often extend into evenings devoted to writing notes. Examples of comments we have received from clinicians and patients include: "Computers always make things faster and cheaper. Not this time," and "My doctor pays more attention to the computer than to me."

Ultimately the healthcare system's goal is to create a robust, integrated, and interoperable healthcare system that includes patients, physician practices, public health, population management, and support for clinical and basic sciences research. This ecosystem has been referred to as the "learning health system."[19] EHRs are an important part of the learning health system, along with many other clinical systems, but future ways in which information is transformed into knowledge will likely require all parts of the system working together. Potentially every patient encounter could present an opportunity for patients and clinicians alike to contribute to our understanding of healthcare and participate in research and clinical trials.

As part of the learning health system, EHRs have long been touted as beneficial to the safety and quality of healthcare, and studies have shown potential benefits related to information accessibility, decision support, medication safety, test result management, and many other areas.[20,21] However, implementation of any new technology leads to new risks and unintended consequences; these too have been well-documented.[22–24]

Much of the focus of MU and other incentives over the past decade has been to encourage providers and other health professionals to implement EHRs and use them to capture and share important quality and cost data. The work now ahead involves ensuring that these systems are designed and implemented in a way that yields the promised benefits to efficiency, quality, and safety with fewer side effects.[25] Although cost, usability, and other considerations are important, patient safety and quality of care need to guide how we optimize EHR systems.

There can be tension between efficiency and safety. Medication reconciliation is a good example – medication errors at transitions of care are a significant safety concern and support the idea of adding safeguards despite their impact on time and the care process.[26] EHRs now include detailed processes to reconcile medications, which some providers feel add to their workload and slow them down. Informed by careful studies,[27–29] compromises need to be made to strike the right balance between efficient and safe patient care. However, there are many ways to optimize both safety and efficiency, and this is the goal of the recommendations of the American Medical Informatics Association (AMIA) EHR-2020 Task Force.

As the professional home of health informatics professionals, AMIA is well-qualified to address many health information technology (IT) challenges from a wide range of perspectives. AMIA members include informaticians, clinicians, scientists, vendors, innovation and implementation scientists, change agents, and people who cross all these boundaries; our members study, develop, and implement ways to manage information for patients, for professionals in their clinical practices, for public health, and for clinical research. Within EHR activities, AMIA members have studied, developed, refine\d, and implemented EHRs and have also advocated for their broader use for nearly 40 years. AMIA has recently addressed electronic documentation[30] and usability[31] because of how crucial these areas are to EHR success. The AMIA Board of Directors chartered the multidisciplinary EHR-2020 Task Force to develop recommendations for how to resolve the EHR issues that have been raised.

Although EHRs are a critical part of the learning health system, this report focuses only on near-term strategies to address current EHR challenges and does not address other areas of the learning health system. The future of EHRs will very likely involve many changes as healthcare itself changes through the greater incorporation of genomic information into care,[32] the rising involvement of patients in their own care,[33] and evolving reimbursement models,[34] among other ways. Our report focuses on some but not all of this future; herein, we concentrate on issues that are of the greatest concern to physicians using EHRs today and on directions for the next 5 years of EHR development and implementation, as well as setting the stage for future innovation.

When, where, and how do we start addressing EHR problems? We start now, with 10 recommendations that span five areas.

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AREA ONE: SIMPLIFY AND SPEED DOCUMENTATION

Recommendation 1: Decrease data entry burden for the clinician. Although medicine requires an entire team to care for patients and to document the care patients receive, Center for Medicare & Medicaid Services (CMS) requirements have placed the primary burden of office visit documentation on physicians. Information entered by other care team members and patients should be as valued as information entered by the physician. Much of the information that is relevant to the diagnosis and treatment of patients could more effectively be entered by other members of the care team, captured automatically by devices or other information systems, or captured and entered by patients themselves.[35–37]

Physicians' time investment in patient care documentation has doubled in the last 20 years, by some measures, possibly consuming up to half of a physician's day.[38,39] Time requirements for nursing documentation have also changed, as has documentation workflow.[40] The growth in documentation burden is associated with changes in Medicare reimbursement rules,[41] potentially overly strict interpretations of those rules by compliance officers,[42] concerns about malpractice litigation, and other factors. The introduction of EHRs has magnified these problems and the amount of time providers spend on documentation. In one large survey, staff internists reported that EHRs take an extra 48 minutes of their time per day compared to manual systems.[6] The strongest complaints from the most survey respondents were regarding entry of visit notes.[6] Another large survey conducted by the RAND Corporation documented analogous complaints.[43] To reduce the time cost of using EHRs, some providers use "copy and paste" options to insert information from past notes, system reviews, and laboratory results into the current note. This practice has caused its own set of problems,[44–48] including bloated visit notes, which can obscure the provider's thinking as well as key facts about the patient, and inaccurate editing that yields incorrect or nonsense text,[49] both of which raise concerns about patient safety. Sample comments from providers include: "The notes are all cookie-cutter, unreadable," and "Everyone's notes are 5-8 pages long and who has the time to read them?"[50]

Clinicians remain uncertain regarding who can and cannot enter data into each patient's record, placing a tremendous data entry burden on providers, the most expensive members of the care team. Clinician time is better spent diagnosing and treating patients. Regulatory guidance that stipulates that data may be populated by others on the care team, including patients, would reduce this burden.

Recommendation 2: Separate data entry from data reporting. Data can be entered by the patient, the patient's family members, and the care team, then used in multiple ways to generate customized reports, including formal visit notes, letters to referring providers, billing records, and quality assessment programs.

Templates are often used to capture data as discrete observations, in place of free-text narratives. The resulting documentation sometimes has limited relevance to the visit being documented, and important aspects of patients' stories can only be effectively captured by narratives. Compared to human narrative, purely coded templates neither distinguish informational wheat from chaff, nor capture the subtle details of each patient's unique circumstances. Further, coded templates impede effective clinician communication.[51] With natural language processing we might have accurate and human-digestible narrative as the primary input with computer-understandable discrete data as a by-product. Progress in the realm of real-time natural language processing can reduce physicians' reliance on templates[52] and

should be bolstered. Vendors should enhance the patient portals they develop to support data collection from the patient as well as multiple modes of data entry to accommodate provider preferences, including voice, typing, clicking, and handwriting recognition.

Documentation requirements go beyond writing notes. Manual entry of encoded data needed to track preventive and chronic illness care requires time, and this task often falls to providers at the point of care. Policymakers should encourage fully standardized interfaces between IT systems, as opposed to requiring users to manually transfer clinical data between separate medical devices or other external sources. Laboratory interfaces are widely available, but the standardization of test codes – ie, Logical Observation Identifiers Names and Codes (LOINC) – needed for automatic filing has only begun. Radiology, electrocardiography, cardiac echocardiography, and other diagnostic systems also have interfaces, but policy has not yet required the standardization needed to deliver these results automatically to EHRs. MU now allows for medications, allergies, and problems to be discretely imported into EHRs, but much of what could be encoded is still delivered as text. Expanding bidirectional immunization registries will allow for populating patients' immunization records automatically (with clinical validation where appropriate), obviating the need to manually re-enter this information.

We applaud the efforts to move to value-based purchasing. Less prescriptive and more flexible requirements for documentation will focus attention on outcomes and clinical relevance and will speed the adoption of better ways of capturing and documenting clinical care.

Recommendation 3: EHRs should enable systematic learning and research at the point of care during routine practice, including a better understanding of the costs (in time) and benefits (to care delivery, research, and billing) of different approaches to capturing and reporting clinical data. The Agency for Healthcare Research and Quality, the National Institutes of Health, the Patient-Centered Outcomes Research Institute, the National Institute of Standards and Technology and other organizations should support studies of the usage and unit-time cost of each additional required data collection item and the effect of different collection mechanisms, such as typing, menu selection, drawing, voice understanding, natural language processing, handwriting, and handwriting recognition, on the time to enter such information and its usability. These federal entities should also encourage and support the study of alternative approaches and media that could help providers use their time more efficiently, such as by sound recording patients' history, the physical, and the patient advice portion of the visit, instead of writing it all down.[53,54]

Health services researchers often investigate cost-effective strategies for improving patient care and evaluating proposed therapies. As a result, they have developed sophisticated ways of assessing whether an intervention meets a cost effectiveness threshold and should be recommended for broader use. We need similar studies to understand the cost and benefits of proposed data items to be recorded in the EHR. We should build on studies of the time and effort required to enter documentation and its relation to clinical team efficiency.[53,55,56]

In addition to enabling the incorporation of research knowledge into practice, to support evidence-based medicine, EHRs can enable evidence-generating medicine,[57] thereby creating a virtuous cycle of rapid evidence generation and evidence-based care delivery, an essential element needed to create a learning health system and advance precision medicine.[58] Examples of such activities at the point of care might include: (1) facilitating the identification and recruitment of

potential research subjects during practice (eg, through clinical trial alerts directed at clinicians or patients); (2) enabling adherence to research protocols during clinical practice; and (3) enabling easy and customizable data collection approaches during patient encounters that are unique to research and serve both research and clinical needs. These activities should be accomplished without adding further complexity to physician/clinician interactions.

AREA TWO: REFOCUS REGULATION

Recommendation 4: Regulation should focus on (1) clarifying and simplifying certification procedures and MU regulations, (2) improving data exchange and interoperability, (3) reducing the need for re-entering data, and (4) prioritizing patient outcomes over new functional measures. Regulatory guidance should be provided to local carriers,[59] so that vendors and providers can work together to streamline workflows, relieve data entry burdens, promote innovation, and, thereby, enhance the usability of EHRs.

Clarifying and Simplifying Certification and MU Regulations

The first 3 years of the EHR MU Incentive Program stimulated dramatic increases in EHR adoption and use. More than 3800 ambulatory and 1200 inpatient developers and vendors brought products to market under the Office of the National Coordinator for Health Information Technology's (ONC's) 2011 Edition program for Certified EHR Technology (CEHRT). Despite significant cost and effort to implement EHRs, the majority of Eligible Providers, Eligible Hospitals, and Critical Access Hospitals were able to successfully achieve Stage 1 of MU. Additional requirements have been added to the 2014 certification program. Fewer vendors are providing certified products, and some eligible providers have dropped out of the program. This outcome has led to a flurry of regulatory responses, with exceptions, flexibility, and extended attestation periods among them. It has also led to proposed legislation to increase the program's flexibility. These changes suggest that EHR incentive programs should leverage the gains already made and prevent further erosion of the program.

To comply with MU requirements, vendors have diverted resources away from client-requested enhancements, efforts to streamline workflows and enhance usability and also away from innovation in general. We believe that the 2014 Edition CEHRT has the foundation of EHR functionality necessary to set the stage for better data exchange and interoperability as well as simplified workflows and data entry, which will support quality- and patient outcomes-focused EHRs. Future CEHRT editions should focus on simplifying the certification process and supporting improvements in interoperability, clinical quality measures, safety, and security. Holding fast to existing attestation requirements will allow Eligible Providers, Eligible Hospitals, and Critical Access Hospitals to meet MU requirements while they upgrade their EHR systems in a timely fashion, with adequate testing and training prior to taking the upgraded products live. It will allow time for EHR users and vendors to stabilize their products and improve those products' workflows and usability.

Improving Data Exchange and Interoperability

New certification requirements should focus on technical requirements that will improve interoperability and data exchange, support better quality measures, and provide for safer and more secure patient care. Additional regulations should focus on reducing barriers to interoperability and efficient data flow. For example, the use of the standard code sets that exist for laboratory and radiology test orders could save time and money in their respective information system interfaces.[60] Data registries for quality, immunizations, research data, or syndromic surveillance could benefit from EHR standards for data and for code sets and could reduce the cost of interfaces between different systems. Reducing the costs of interfaces may lead to new business models funded by business interests or the public sector.

Reduce Data Entry and Focus on Patient Outcomes

Quality measurement and reporting should focus on outcomes that are consistent with national priorities and also relevant to clinicians' specialties, patients, and communities. Data collected should only include those data that are necessary to diagnose and treat a patient's condition and do not add to the documentation burden. EHR users should not have to implement functionalities or document findings that will not ultimately benefit the patient or the clinician's practice but, rather, will benefit payers or other secondary data users. Changes in regulation that make it much easier to report accurate and meaningful quality measures are important, given the prospect that outcomes attributed to providers and hospitals will be made publicly available.[61,62] Working with payers and other stakeholders to develop payment alternatives that depend less on documentation and more on quality and value is likely to promote EHR innovation and uses that support these goals.[63,64]

Recommendation 5: Changes in reimbursement regulations should support novel changes to and innovation in EHR systems. We applaud changes to payment models as well as federal guidance designed to accommodate innovation in health IT.

MU incentives have accelerated the use of health IT and have increased documentation to track individual clinical outcomes, including electronic clinical quality measures. The CEHRT program has supported the standardization of this documentation, helping ensure that there is the potential for future semantic interoperability between various health IT systems. EHRs have evolved to facilitate documentation to support billing requirements in addition to documentation needed for care. The current evaluation and management (E/M) coding requirement of capturing bullet points has led to constrained notes that target billing requirements. Generally, vendors have used check boxes and radio buttons to facilitate the calculation of coding points. This format optimizes support for billing, but does not result in a note that easily conveys the essence of the visit. In addition, the patient's voice (the informant) is rarely captured in the documentation, except through the patient's healthcare team.

Reimbursement requirements influence and are integrally intertwined with EHR design. Moving away from the current E/M billing structure would free EHR developers to support more novel methods of data collection. The 2014 MU requirements for a secure patient portal provide new opportunities to collect patient-completed data in advance of the visit, saving documentation time and, more importantly, allowing the provider to focus on the patient's priorities for the visit, rather than following a prescribed pathway for the patient's conditions.

Reimbursement regulations are changing along with healthcare reform. Pilot programs have put a greater emphasis on outcomes, which includes reducing disparities in access to healthcare for the individual patient as well as for patient populations as a whole. These goals necessitate new EHR documentation and reimbursement models. They focus on team-based care, which requires changes in order entry to facilitate guideline- and protocol-based order sets. Proposed new rules from CMS may dramatically change the nature of financial incentives in Shared Savings Programs. New reimbursement models can help facilitate and support the integration of novel technological ways to deliver and document care for patients and patient populations.

There is a natural tension between using EHR systems to guide and document care and using EHR systems to provide adequate documentation to ensure appropriate reimbursement. Continued requirements to support E/M codes in EHRs will slow progress toward new ways of defining the medical record, acquiring and integrating data, and supporting clinical documentation as well as the decision-making process. Working together with CMS and other payers is essential to ensure that the EHR of the future can fulfill the need for comprehensive, usable documentation as well as reimbursement.

AREA THREE: INCREASE TRANSPARENCY AND STREAMLINE CERTIFICATION

Recommendation 6: In order to improve the usability of EHRs and patient safety, to foster innovation, and to empower providers and EHR purchasers, how an EHR vendor satisfies certification criteria, such as for the CEHRT program, should be flexible and transparent. To inform the market and to enhance competition among vendors, additional data about the certification process should be made available to the public. This could include video recordings of the certification processes, demonstrating how each vendor satisfies each certification criteria, detailed data and information models for application programming interfaces (APIs), and information on how data are entered and extracted from the EHR as part of the certification process. These resources should be made available to the public on the certification body's website.

In order to clarify for vendors how to meet the MU certification criteria, ONC provides precise instructions for each MU functional objective. The advantage of this approach is that vendors know with certainty how they can qualify for MU certification. An unintended consequence of this approach is that vendors believe their customers must follow the workflow programmed into each certified function and built into the automated calculation of the MU threshold determination. This predetermined workflow built into EHR products significantly affects the usability of these products, often in a negative way.

We recommend that ONC provide less prescriptive instructions for meeting MU certification and work with vendors, informatics professionals, and the industry in general to develop clear, flexible, and transparent methods for testing whether EHR product meets MU functional objectives. Clearly stating the goals of the testing method, creating flexible methods of reaching those goals, and then making sure that the testing approach can be reviewed by customers would provide testing solutions that meet the needs of both vendors and customers. For example, a testing body could record the process of demonstrating that a product meets an MU functional objective, then post the recording on the certification body's public website. Additional resources that would help a customer make informed decisions could include posting of public APIs, information models, and the steps taken to input data to the system or to extract data from the system. This would ensure the integrity of the process and also inform the market about the usability of the vendor's implementation of MU functional objectives.

Currently, purchasers of EHRs often do not have insight into how applications work. This lack of transparency inhibits an effective, competitive marketplace. Those in charge of purchasing EHRs need clear knowledge of what each commercial EHR system offers and, importantly, what workflows are incorporated into their use for common, frequently performed tasks such as creating notes, entering data, reconciling medications, responding to decision support, and extracting data for reports or research, so they can make more informed choices. Protecting intellectual property must be balanced with encouraging competition and an open marketplace, but greater transparency will ultimately help everyone. An informed market would enhance competition, empower consumers, and stimulate innovation.

Recommendation 7: In order to improve usability and safety and to foster innovation, healthcare organizations, providers, and vendors should be fully transparent about unintended consequences and new safety risks introduced by health IT systems, including EHRs, as well as best practices for mitigating these risks.

There is much evidence that health IT systems can improve patient safety, but there is also evidence that these systems can introduce safety risks and other unintended consequences,[65] such as "wrong patient" errors, copy and paste errors, and alert fatigue. These issues can arise anywhere in the sociotechnical model,[66] from inadequate software to inadequate policies to poor implementation. Appropriately, many vendors, hospital systems, and ambulatory practices have developed ways to mitigate these kinds of issues. However, this information is not frequently shared, so organizations are constantly reinventing the wheel to address EHR issues and improve functionality.

Vendors, healthcare organizations, and providers should not be competing on safety. Instead, they should share problems they have identified as well as ways to prevent or mitigate those problems. To facilitate information sharing, vendors and healthcare organizations should work with patient safety organizations to share information about safety issues and best practices. All data that are relevant to patient safety risks (workflows, screenshots, data definitions, code sets, etc.) should be shared with these organizations, so that all the parties involved can better understand and address safety risks.[67] We support the recent Food and Drug Administration Safety and Innovation Act report's recommendation that a public-private partnership work together to create a national health IT safety center that would promote health IT as an integral part of patient safety, with the ultimate goal of assisting in the creation of a sustainable, integrated health IT learning system.[68]

AREA FOUR: FOSTER INNOVATION

Recommendation 8: EHR vendors should use public, standards-based APIs and data standards that enable EHRs to become more open to innovators, researchers, and patients. These standards should support extensions and innovations from both the academic informatics community as well as from innovators inside and outside traditional health IT communities. Access to EHR data and functionality will drive innovation and research on better systems and empower patients to engage in their own care. These public APIs and data standards should be consensus-based, transparent, well-documented, and openly available in a fair and nondiscriminatory way.

Pioneering advances in clinical informatics have historically come from academic medical centers with associated informatics programs as well as from vendors and other sources. Today's EHRs have benefitted from 30 years of innovations, from academic centers and elsewhere, including functionality, data standards, and operating systems. However, nearly all academic centers are now switching to commercial EHR products, most of which are closed-source products, potentially restricting informatics research and innovative pilot studies based on commercial EHRs and the data they contain.

Similarly, the comprehensive, longitudinal information needed for precision medicine or other national priorities is difficult and expensive to extract from EHRs. This problem is not limited to research: patients

do not have the ability to transfer their comprehensive longitudinal record (which includes clinic visits, laboratory and pathology reports, operative and radiology information, as well as patient-generated information) from one EHR system to another or to use this information for their own purposes.

New methods must be developed that can continue to tap the research capacity of academic informatics centers and encourage the creativity of researchers and innovators who wish to participate in and advance the health IT ecosystem. This is particularly important in light of the US government's Precision Medicine Initiative, which will require the ability to capture, store, and present increasingly meaningful molecular information specific to patients and to leverage that data for decision support and other uses. We need a broader ecosystem of innovators to help address workflow and functionality gaps faced by current EHR users, with opportunities that are attractive to venture capitalists, academicians, private equity firms, and entrepreneurs who have creative ideas and the willingness to take risks in the marketplace. In short, we believe that EHR vendors should become more open to both extracting data from the EHR and in creating novel ways to interact with externally defined applications. To get there, we need APIs, data element standards, and other ways to efficiently extract data and interact with commercial EHRs. Recent projects using the Health Level 7 Fast Healthcare Interoperability Resources standard have demonstrated the promise of such open, standards-based approaches that leverage existing web-based technology.[69–71]

To that end, we strongly endorse the recent recommendation of the JASON report[72] and the JASON Task Force[73] that the health IT community should advocate for public APIs as core functionality to support data access. We agree with the JASON Task Force that these public APIs must be based on open, consensus-based standards (eg, Health Level 7 Fast Healthcare Interoperability Resources)[74,75] but must also be widely deployed and exposed to a wide variety of independent innovators in a fair, reasonable, and nondiscriminatory way, such that new innovations can arise. We believe that, in order for these public APIs to be widely implemented, they should eventually become a component of the CEHRT program as the standards mature.

As the learning healthcare system evolves, we will want data to be accessible to more than just providers. Patients can be empowered to interact with data either through APIs or through data standards that support patients' extraction of their own longitudinal record from EHRs. Experience with the Blue Button initiative suggests that standardized access to patient data will drive and facilitate the development of mobile health applications that can help bridge gaps, enhance communications, and facilitate greater interaction between providers and their patients. We foresee the day when prescribing an "app" as part of a care plan and incorporating app-generated data into a treatment record and subsequent care plans will be a routine occurrence. Patient access to these data will empower consumers to support national initiatives such as precision medicine.

The academic research community will also benefit from the standardization of public APIs and their accompanying data standards. Interoperable data element definitions or common data elements used by public APIs will reduce the data mapping burdens that complicate current data aggregation for research use. We believe that widespread availability of public APIs will lead to the creation of new data-sharing networks focused on research uses.

There have been demonstration projects using APIs (and that have involved commercial EHR vendors and academics) in which apps have been able to upload data from a commercial EHR, perform an operation (such as decision support), and return messages to the EHR.[76] We hope these encouraging results will be the first steps toward developing a learning health system that supports healthcare apps that will eventually be able to import data from and export information to multiple EHRs. EHRs should also leverage innovations originating outside the walls of health IT, just as other applications benefit from external resources such as map services and global positioning system (GPS) data.

AREA FIVE: THE EHR IN 2020 MUST SUPPORT PERSON-CENTERED CARE DELIVERY

An EHR is shared by the patient, their care provider teams, and the institutions that pay for and provide that care. As a result, EHR technologies must be able to evolve at the same pace as changes in the culture of care delivery. To accomplish this goal, AMIA has the following recommendations.

Recommendation 9: Promote the integration of EHRs into the full social context of care, moving beyond acute care and clinic settings to include home health, specialist care, laboratory, pharmacy, population health, long-term care, and physical and behavioral therapies. Records of care must provide views that can vary the timeline of data, the level of aggregation and abstraction of data, the scope of data, ranging from the problem to the entire sociocultural context as well as the user's point of view. The ability to incorporate data from different sources into the EHR is essential. Including patient-generated data, population data, and community contexts into EHRs will spur the development of new care delivery models, improve population health, aid in the development of precision medicine, and support other healthcare transformations.

At one end of the precision medicine spectrum are the patient's social, environmental, and functional contexts. Person-centered care must gather, represent, and integrate a patient's social context, functional information, goals, and population-relevant information. Although functional status has been shown to be a key predictor of clinician decision-making in many areas,[77] it is extremely difficult to access. Social data may often be key to accurate decision-making,[78] but these data are often distributed among multiple systems or simply absent.[79,80]

At the other end of the precision medicine spectrum is the patient's molecular profiling data. With ever-decreasing costs of sequencing technology, patients' genomes are likely to be sequenced routinely in the course of clinical care in the not-so-distant future. The Precision Medicine Initiative[58] will initially focus on cancer, but other disease areas will be incorporated into the Initiative as researchers learn more about their underlying molecular dysregulation. Pharmacogenomics (the study of how genes affect a person's response to drugs) and the study of congenital diseases are two other areas that are already reaping the benefits of genetic sequencing. While other "omic" biomarkers – eg, proteomics, metabolomics, and epigenetic signatures – are less mature, these additional types of data may also become important data sources.

Patient-centered medical home (PCMH) models of healthcare delivery are being promoted as crucial to the future of the US healthcare system.[81] The EHR adds substantial capability to any PCMH system.[82] In the immediate future, EHRs need to support the PCMH principles of care – ie, care that: (1) is personal, continuous, and comprehensive; (2) provides teams with a shared awareness of the patient's situation across settings and time; (3) supports a whole-person perspective in which the patient's context and life-story is available and integrated across the record; (4) supports enhanced coordination, so that care can be tracked, monitored, and followed through time; (5) integrates

evidence-based practice deep into the patient's record through decision support and quality improvement tools; and (6) expands access to care through the use of flexible tools that facilitate enhanced patient-provider communication, expanded hours, and the sharing of culturally specific information.

Manifesting this vision requires not only simple interoperable platforms, but also a new conceptualization of the nature of healthcare data. Abstracted and summarized patient data should be available and configurable for different goals across a myriad of views. The principles of person-centered care can be enhanced with the integration of new systems, such as smart phones, biometric sensor information, genomics, and big data. Many of these technologies have improved the way our society travels, purchases goods and services, communicates, educates, and informs. Although there are technologies and services poised to encourage consumers to interact with their own health data (eg, Fitbit, Apple HealthKit, and 23andMe), these lack integration, usability, and ubiquity in the healthcare domain.

A taste of what is possible in healthcare has been presented by the ONC's Blue Button campaign.[83] Supported by data standards, the Blue Button campaign has shown that access to data can drive creativity and involvement between patients, providers, and developers. Today, it is possible for consumers and patients to integrate mobile, video, e-mail, sensor, and other technologies into their personal EHR record. But although this functionality is possible, it is not yet easy nor ubiquitous, due to impediments such as proprietary datasets, unique coding configurations, inaccessible siloed information, data duplication and integrity problems, and a lack of data governance structure. Ultimately, an EHR does not stand alone in the equation of what is necessary to realize the vision of true interoperability between different health IT systems. EHRs' core functions, however, should be focused on the benefits they can provide to patients – both direct benefits, in the case of the acute and ambulatory settings, and indirect benefits, in the case of research and public health. Efforts such as those of the Patient-Centered Outcomes Research Institute need this functionality in order to realize their missions. Without new payment models or research providing the impetus for change, change will not occur. In the near term, because there has been no incentive to change the status quo, there is now a disconnect between the promise of what can be done and the real-world infrastructure required to actually make these efforts operational and scalable.

Recommendation 10: Improve the designs of interfaces so that they support and build upon how people think (ie, cognitive-support design). These designs would include empirical findings from areas such as human factor engineering as well as traditional social sciences (ie, anthropology, psychology, sociology, and economics).

Usability is a real science and goes beyond screen design.[31] Safe and effective EHRs must support person-level customization that addresses such factors as level of expertise, scope of responsibility, and task assignments. These designs must also incorporate institutional guidelines and population-level data into a useful, ergonomic package. Although it is known that experts use automatic cognitive processing, information displays have not been designed to facilitate pattern matching with minimal cognitive effort. Nor have tools been designed that allow clinicians to control their information environment.[84] Current EHRs do not align with patient's situations or clinician's mental models.[85]

EHR systems often use alerts as a blunt instrument to inform and motivate clinicians, creating significant frustration and alert fatigue.[86,87] Designing EHRs to match work processes is difficult but

essential in order to maximize functionality and safety; future work should focus on how to effectively implement decision support systems. Certain aspects of health IT have disrupted communications and workflow and also increased workarounds.[88,89] Maintaining safety requires more than design; it requires participation by the whole institution involved in EHR implementation. Rigorous, independent studies of usability as well as in vivo assessments of ongoing EHR performance necessitate provider and patient input, and would eventually lead to a common set of core features and functions.

SUMMARY

The problems we face today regarding EHR use are complex, and their solutions will not be simple or quick. Solving these problems will require regulatory stability, the development of an acceptable threshold "barrier to entry" into the EHR marketplace, and supportive national policies. We recommend a focus on these five areas during the next 6-12 months, while as a nation we develop a long-term framework for innovation for EHRs.

AMIA has always been at the forefront of the world of EHRs. The EHR-2020 Task Force is the next step in the organization's involvement. We look forward to working with other groups, government agencies, and professional organizations to find creative ways to solve the EHR problems currently faced by clinicians and patients and to further develop a sustainable framework for EHR innovation. We look forward to continuing our work with policymakers on their critical role in moving our nation toward using EHRs to achieve the Triple Aim.[90] AMIA's 2015 annual policy meeting will be devoted entirely to EHRs.[91] Individual AMIA members should also continue to take action to promote EHR improvements by influencing EHR purchase decisions; fulfilling criteria in Requests for Proposals; making comments on proposed regulations and legislation; conducting research on EHR innovation, safety, usability and workflow; and by other means.

We also share the sense of urgency other organizations have expressed about addressing current EHR problems.[92–95] However, these problems can be solved, and the future for EHRs is bright.

CONTRIBUTORS

All authors contributed substantially to the drafting, revising, and final review of this manuscript.

COMPETING INTERESTS

Dr Corley is an employee and stockholder of QSI NextGen Healthcare. Dr Tierney is President and CEO of the Regenstrief Institute, Inc., and serves as Chairman of the Board of Directors of OpenMRS, Inc. Dr Gandhi is the President and CEO of the National Patient Safety Foundation. Dr McCallie is an employee of Cerner Corporation. Dr Zaroukian is a member of the Health Information and Management Systems Society (HIMSS) Board of Managers and Chair-elect, HIMSS North America Board of Directors. Dr Mattison, is Assistant Medical Director and CMIO at Kaiser Permanente, Southern California.

REFERENCES

1. McGinn TG, McCullagh L, Kannry J, et al. Efficacy of an evidence-based clinical decision support in primary care practices: a randomized clinical trial. JAMA Intern Med. 2013;173(17):1584–1591.

2. Jones SS, Rudin RS, Perry T, Shekelle PG. Health information technology: an updated systematic review with a focus on meaningful use. Ann Intern Med. 2014;160(1):48–54.

3. Toll E. A piece of my mind. The cost of technology. JAMA. 2012;307(23):2497–2498.

4. Sinsky CA, Beasley JW. Texting while doctoring: a patient safety hazard. Ann Intern Med. 2013;159(11):782–783.

5. Shipman SA, Sinsky CA. Expanding primary care capacity by reducing waste and improving the efficiency of care. Health Aff. 2013;32(11):1990–1997.

6. McDonald CJ, Callaghan FM, Weissman A, et al. Use of internist's free time by ambulatory care electronic medical record systems. JAMA Intern Med. 2014;174(11):1860–1863.

7. Oxentenko AS, West CP, Popkave C, Weinberger SE, Kolars JC. Time spent on clinical documentation: a survey of internal medicine residents and program directors. Arch Intern Med. 2010;170(4):377–380.

8. Block L, Habicht R, Wu AW, et al. In the wake of the 2003 and 2011 duty hours regulations, how do internal medicine interns spend their time? J Gen Intern Med. 2013;28(8):1042–1047.

9. Abramson EL, McGinnis S, Moore J, Kaushal R; HITEC investigators. A statewide assessment of electronic health record adoption and health information exchange among nursing homes. Health Serv Res. 2014;49(1 Pt 2):361–372.

10. Vest JR, Zhao H, Jasperson J, Gamm LD, Ohsfeldt RL. Factors motivating and affecting health information exchange usage. JAMIA. 2011;18(2):143–149.

11. Friedberg MW, Van Busum KR, Chen PG, et al. Factors affecting physician professional satisfaction. Santa Monica, CA: RAND Corporation, 2013. http://www.rand.org/pubs/research_briefs/RB9740.

12. Verdon DR. Physician outcry on EHR functionality, cost will shake the health information technology sector. Med Econ. February 10, 2014.

13. Babbott S, Manwell LB, Brown R, et al. Electronic medical records and physician stress in primary care: results from the MEMO Study. JAMIA. 2014;21:e100–e106.

14. Sinsky CA, Beasley JW, Simmons GE, Baron RJ. Electronic health records: design, implementation, and policy for higher-value primary care. Ann Intern Med. 2014;160(10):727–728.

15. Creswell J. Doctors find barriers to sharing digital medical records. The New York Times. September 30, 2014.

16. Zuger A. With electronic medical records, doctors read when they should talk. The New York Times. October 13, 2014.

17. Rowland C. Hazards tied to medical records rush: subsidies given for computerizing, but no reporting required when errors cause harm. Boston Globe. Boston, MA; July 20, 2014. http://www.bostonglobe.com/news/nation/2014/07/19/obama-pushed-electronic-health-records-with-huge-taxpayer-subsidies-but-has-rebuffed-calls-for-hazards-monitoring-despite-evidence-harm/OV4njlT6JgLN67Fp1pZ01I/story.html?s_campaign1/4email_BG_TodaysHeadline. Accessed July 20, 2014.

18. Hyman P. The day the EHR died. Ann Intern Med. 2014;160:576–577.

19. Friedman CP, Wong AK, Blumenthal D. Achieving a nationwide learning health system. Sci Transl Med. 2010;2(57):57cm29.

20. Congressional Budget Office. Evidence of the Costs and Benefits of Health Information Technology. May 2008. http://www.cbo.gov/sites/default/files/05-20-healthit.pdf. Accessed January 11, 2015.

21. Bates DW, Leape LL, Cullen DJ, et al. Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. JAMA. 1998;280(15):1311–1316.

22. Campbell EM, Sittig DF, Ash JS, et al. Types of unintended consequences related to computerized provider order entry. JAMIA. 2006;13:547e56.

23. Ash JS, Sittig DF, Poon EG, et al. The extent and importance of unintended consequences related to computerized provider order entry. JAMIA. 2007;14:415e23.

24. Meeks DW, Smith MW, Taylor L, et al. An analysis of electronic health record-related patient safety concerns. JAMIA. 2014;21(6):1053–1059.

25. The Joint Commission. Safe use of health information technology. Sentinel Event Alert. Issue 54, March 31, 2015. http://www.jointcommission.org/assets/1/18/SEA_54.pdf. Accessed April 11, 2015.

26. Schnipper JL, Hamann C, Ndumele CD, et al. Effect of an electronic medication reconciliation application and process redesign on potential adverse drug events: a cluster-randomized trial. Arch Intern Med. 2009;169(8):771–780.

27. Schnipper JL, Liang CL, Hamann C, et al. Development of a tool within the electronic medical record to facilitate medication reconciliation after hospital discharge. JAMIA. 2011;18(3):309–313.

28. Plaisant C, Chao T, Wu J, et al. Twinlist: novel user interface designs for medication reconciliation. AMIA Annu Symp Proc. 2013;2013:1150–1159.

29. Heyworth L, Paquin AM, Clark J, et al. Engaging patients in medication reconciliation via a patient portal following hospital discharge. JAMIA. 2014;21(e1):e157–e162.

30. Cusack CM, Hripcsak G, Bloomrosen M, et al. The future state of clinical data capture and documentation: a report from AMIA's 2011 Policy Meeting. JAMIA. 2013;20(1):134–140.

31. Middleton B, Bloomrosen M, Dente MA, et al. Enhancing patient safety and quality of care by improving the usability of electronic health record systems: recommendations from AMIA. JAMIA. 2013;20(e1):e2–e8.

32. Masys DR, Jarvik GP, Abernethy NF, et al. Technical desiderata for the integration of genomic data into electronic health records. J Biomed Inform. 2012;45:419–422.

33. Mandl KD, Kohane IS. Tectonic shifts in the health information economy. N Engl J Med. 2008;358(16):1732–1737.

34. Fisher ES, McClellan MB, Safran DG. Building the path to accountable care. N Engl J Med. 2011;365(26):2445–2447.

35. Murray MF, Giovanni MA, Klinger E, et al. Comparing electronic health record portals to obtain patient-entered family health history in primary care. J Gen Intern Med. 2013;28:1558–1564.

36. Dixon BE, Jabour AM, Phillips EO, et al. An informatics approach to medication adherence assessment and improvement using clinical, billing, and patient-entered data. JAMIA. 2014;21:517–521.

37. Kaelber DC, Jha AK, Johnston D, et al. A research agenda for personal health records (PHRs). JAMIA. 2008;15:729–736.

38. Oxentenko AS, West CP, Popkave C, Weinberger SE, Kolars JC. Time spent on clinical documentation: a survey of internal medicine residents and program directors. Arch In Med. 2010;170:377–380.

39. Block L, Habicht R, Wu AW, et al. In the wake of the 2003 and 2011 duty hours regulations, how do internal medicine interns spend their time? J Gen Intern Med. 2013;28(8):1042–1047.

40. Kelley TF, Brandon DH, Docherty SL. Electronic nursing documentation as a strategy to improve quality of patient care. J Nurs Scholarsh. 2011;43(2):154–162.

41. Medicare Learning Network, US Department of Health and Human Services Centers for Medicare and Medicaid Services. Evaluation and Management Services Guide. ICN: 006764. November 2014. http://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/downloads/eval_mgmt_serv_guide-ICN006764.pdf. Accessed January 11, 2015.

42. Moore KJ. Documenting history in compliance with Medicare's guidelines. Fam Pract Manag. 2010;17(2):22–27.

43. Friedberg MW, Chen PG, Van Busum KR, et al. RAND Research Report: Factors Affecting Physician Professional Satisfaction and Their Implications for Patient Care, Health Systems, and Health Policy. 2013. http://www.rand.org/pdfrd/pubs/research_reports/RR439.html. Accessed October 30, 2013.

44. Turchin A, Goldberg SI, Breydo E, Shubina M, Einbinder JS. Copy/paste documentation of lifestyle counseling and glycemic control in patients with diabetes: true to form? Arch Intern Med. 2011;171(15):1393–1394.

45. Hammond KW, Helbig ST, Benson CC, Brathwaite-Sketoe BM. Are electronic medical records trustworthy? Observations on copying, pasting and duplication. AMIA Annu Symp Proc. 2003:269–273.

46. Siegler EL, Adelman R. Copy and paste: a remediable hazard of electronic health records. *Am J Med.* 2009;122(6):495–496.

47. Wrenn JO, Stein DM, Bakken S, Stetson PD. Quantifying clinical narrative redundancy in an electronic health record. *JAMIA.* 2010;17(1):49–53.

48. Hirschtick R. Cases & Commentaries. Sloppy and Paste. *AHRQ WebM&M.* July 2012. http://webmm.ahrq.gov/case.aspx?caseID=274. Accessed July 15, 2015.

49. Vogel L. Cut-and-paste clinical notes confuse care, say US internists. *CMAJ.* 109–4656; published ahead of print November 11, 2013, doi:10.1503/cmaj.109-4656

50. Unpublished comment from respondents in reference 6 (McDonald C, et al.).

51. Weir CR, Hammond KW, Embi PJ, Efthimiadis EN, Thielke SM, Hedeen AN. An exploration of the impact of computerized patient documentation on clinical collaboration. *Int J Med Inform.* 2011;80(8):e62–e71.

52. Nadkarni PM, Ohno-Machado L, Chapman WW. Natural language processing: an introduction. *JAMIA.* 2011;18(5):544–551.

53. Mamykina L, Vawdrey DK, Stetson PD, Zheng K, Hripcsak G. Clinical documentation: composition or synthesis? *JAMIA. 2012;*19(6):1025–1031.

54. Poissant L, Pereira J, Tamblyn R, Kawasumi Y. The impact of electronic health records on time efficiency of physicians and nurses: a systematic review. *JAMIA.* 2005;12(5):505–516.

55. Hripcsak G, Vawdrey DK, Fred MR, Bostwick SB. Use of electronic clinical documentation: time spent and team interactions. *JAMIA.* 2011;18(2):112–117.

56. Poissant L, Pereira J, Tamblyn R, Kawasumi Y. The impact of electronic health records on time efficiency of physicians and nurses: a systematic review. *JAMIA.* 2005;12(5):505–516.

57. Embi PJ, Payne PR. Evidence generating medicine: redefining the research-practice relationship to complete the evidence cycle. *Med Care.* 2013;51(8 Suppl 3):S87–S91.

58. Collins FS, Varmus H. A new initiative on precision medicine. *N Engl J Med.* 2015;372(9):793–795.

59. Centers for Medicare and Medicaid Services. *Medicare Program Integrity Manual.* http://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/downloads/pim83c13.pdf. Accessed January 30, 2015.

60. Vreeman DJ, McDonald CJ. Automated mapping of local radiology terms to LOINC. *AMIA Annu Symp Proc.* 2005:769–773.

61. Physician Compare. Medicare.gov. http://www.medicare.gov/physiciancompare/search.html. Accessed January 11, 2015.

62. Hospital Compare. Medicare.gov. http://www.medicare.gov/hospitalcompare/search.html, Accessed January 11, 2015.

63. HealthIT.gov. May 2014 HITPC Certification Hearing. http://www.healthit.gov/facas/calendar/2014/05/07/policy-certification-hearing. Accessed January 11, 2015.

64. Versel N. Bill would cut 2015 meaningful use reporting period to 90 days. *Forbes.* September 16, 2014. http://www.forbes.com/sites/neilversel/2014/09/16/bill-would-cut-2015-meaningful-use-reporting-period-to-90-days. Accessed January 11, 2015.

65. Koppel R, Metlay JP, Cohen A, *et al.* Role of computerized physician order entry systems in facilitating medication errors. *JAMA.* 2005;293:1197–1203.

66. Sittig DF, Singh H. A new sociotechnical model for studying health information technology in complex adaptive healthcare systems. *Qual Saf Health Care.* 2010;19 (Suppl 3):i68–i74.

67. Sittig DF, Murphy DR, Smith MW, *et al.* Graphical display of diagnostic test results in electronic health records: a comparison of 8 systems. *JAMIA.* 2015;pii: ocv013.

68. US Food and Drug Administration. FDASIA Reports. http://www.fda.gov/RegulatoryInformation/Legislation/FederalFoodDrugandCosmeticActFDCAct/SignificantAmendmentstotheFDCAct/FDASIA/ucm356316.htm. Accessed January 11, 2015.

69. Mandl KD, Mandel JC, Murphy SN, *et al.* The SMART Platform: early experience enabling substitutable applications for electronic health records. *JAMIA.* 2012;19(4):597–603.

70. Healthcare Services Platform Consortium. http://healthcaresoa.org. Accessed January 11, 2015.

71. The Argonaut Project. http://hl7.org/implement/standards/FHIR-Develop/argonauts.html. Accessed March 15, 2015.

72. JASON, The MITRE Corporation. A Robust Health Data Infrastructure. AHRQ Publication No. 14-0041-EF. http://healthit.gov/sites/default/files/ptp13-700hhs_white.pdf. Accessed January 11, 2015.

73. Health IT Policy Committee. JASON Report Task Force Final Report. http://www.healthit.gov/facas/sites/faca/files/Joint_HIT_JTF_JTF%20HITPC%20Final%20Report%20Presentation%20v3_2014-10-15.pdf. Accessed January 11, 2015.

74. Health Level 7 International. Introducing HL7 FHIR. http://www.hl7.org/implement/standards/fhir/summary.html. Accessed January 11, 2015.

75. Hollott P. Project Yosemite, SMART on FHIR, and the Argonauts. http://piersholott.blogspot.com/2014/12/project-yosemite-smart-on-fhir-and.html. Accessed April 3, 2015.

76. Dixon BE, Paterno MD, Simonaitis L, *et al.* Demonstrating cloud-based clinical decision support at scale: the Clinical Decision Support Consortium. MEDINFO 2013. *Stud Health Technol Inform.* 2013;192:1268.

77. Rodríguez-Molinero A, López-Diéguez M, Tabuenca AI, *et al.* Physicians' impression on the elders' functionality influences decision making for emergency care. *Am J Emerg Med.* 2010;28(7):757–765.

78. Weiner SJ, Schwartz A, Weaver F, *et al.* Evaluating physician performance at individualizing care: a pilot study tracking contextual errors in medical decision making. *Med Decis Mak.* 2007;27:726–734.

79. Thraen I, Bair B, Mullin S, Weir CR. Characterizing "information transfer" by using a Joint Cognitive Systems model to improve continuity of care in the aged. *Int J Med Inform.* 2012;81(7):435–441.

80. Wilhelmson, K., Rubenowitz Lundin E, Andersson C, *et al.* Interviews or medical records, which type of data yields the best information on elderly people's health status. *Aging Clin Exp Res.* 2006;18(1):25–33.

81. Backer LA. The medical home: an idea whose time has come . . . again. *Fam Pract Manag.* 2007;14(8):38–41.

82. Kern LM, Edwards A, Kaushal R. The patient-centered medical home, electronic health records, and quality of care. *Ann Intern Med.* 2014;160 (11):741–749.

83. HealthIT.gov. Blue Button. http://healthit.gov/patients-families/your-health-data. Accessed March 28, 2015.

84. Senathirajah Y, Kaufman D, Bakken S. The clinician in the driver's seat: Part 2 – intelligent uses of space in a drag/drop user-composable electronic health record. *J Biomed Inform.* 2014;52:177–188.

85. Smith SW, Koppel R, Kaushal R. Healthcare information technology's relativity problems: a typology of how patients' physical reality, clinicians' mental models, and healthcare information technology differ. *JAMIA.* 2014;21(1):117–131.

86. Lin C-P, Payne TH, Nichol WP, *et al.* Evaluating clinical decision support systems: monitoring CPOE order check override rates in the Department of Veterans Affairs' computerized patient record system. *JAMIA.* 2008;15:620–626.

87. Isaac T, Weissman JS, Davis RB, *et al.* Overrides of medication alerts in ambulatory care. *Arch Intern Med.* 2009;169(3):305–311.

88. Campbell EM, Guappone KP, Sittig DF, Dykstra RH, Ash JS. Computerized provider order entry adoption: implications for clinical workflow. *J Gen Intern Med.* 2009;24(1):21–26.

89. Koppel R, Wetterneck T, Telles JL, Karsh BT. Workarounds to barcode medication administration systems: their occurrences, causes, and threats to patient safety. *JAMIA.* 2008;15(4):408–423.

90. Berwick DM, Nolan TW, Whittington J. The triple aim: care, health, and cost. *Health Aff.* 2008; 27:759–769.

91. American Medical Informatics Association. AMIA Annual Invitational Health Policy Meetings. https://www.amia.org/public-policy/advocacy-activities/health-policy-meetings. Accessed March 28, 2015.

92. American Medical Association. Improving Care: Priorities to Improve Electronic Health Record Usability. http://www.ama-assn.org/ama/pub/news/news/2014/2014-09-16-solutions-to-ehr-systems.page. Accessed January 11, 2015.

93. Madara JL. James L. Madara, MD, Executive Vice President, CEO, American Medical Association, to Marilyn Tavenner, Administrator, CMS, and Karen DeSalvo, National Coordinator for Health Information Technology. May 8, 2014. http://www.ihealthbeat.org/~/media/Files/2014/PDFs/CMS%20ONC%20Letter%20Stage%203.ashx. Accessed January 11, 2015.

AMIA POSITION PAPER

94. Bowman S. Impact of electronic health record systems on information integrity: quality and safety implications. *Perspectives in Health Information Management*. Fall 2014. http://perspectives.ahima.org/impact-of-electronic-health-record-systems-on-information-integrity-quality-and-safety-implications/#.VLMTuMbIR_R. Accessed January 11, 2015.

95. Health Information and Management Systems Society, Electronic Health Record Association. Balancing the need for privacy and the value of big data, EHR Association response to the PCAST report, *Big Data and Privacy: A Technological Perspective*. HIMSS EHR Association Statements and Positions. October 2014. http://www.himssehra.org/docs/EHRA%20Response%20to%20PCAST%20Big%20Data%20and%20Privacy%20Final.pdf. Accessed January 11, 2015.

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