Report of the AMIA EHR 2020 Task Force on the Status and Future Direction of EHRs

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Over the last 5 years, stimulated by the changing healthcare environment and the HITECH Meaningful Use (MU) EHR Incentive program, EHR adoption has grown remarkably, and there is early evidence of benefits in safety and quality as a result.[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] transferred new and burdensome data entry tasks to front-line clinicians,[4,5] and lengthened workdays.[6,7,8] Interoperability between different EHR systems has languished despite large efforts.[9,10] These frustrations are contributing to a decreased satisfaction with professional work life.[11,12,13] In professional journals,[14] press reports,[15,16,17] on wards and in clinics, we have heard of the difficulties that the transition to EHRs has created.[18] Clinicians ask for help getting through their days, which often extend into evenings devoted to writing notes. Examples of comments include “Computers always make things faster and cheaper. Not this time.” and “My doctor pays more attention to the computer than to me.”

Ultimately, our goal is to create a robust, integrated, interoperable health system that includes patients, physician practices, public health and population management, and support for clinical and basic sciences research. EHRs are an important part of this ecosystem, along with many other clinical systems, but future ways in which information is transformed into knowledge will likely require all parts of the ecosystem working together. This ecosystem has been referred to as the “learning health system.”[19] Potentially every patient encounter could present an opportunity for patients and clinicians alike to contribute to our understanding of health care 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 health care, 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.[22,23,24]

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

There can be a tension between efficiency and safety. Medication reconciliation is a good example
are a significant safety concern and represent a rationale for
time and process.[26] EHRs now include detailed processes to
s feel add to their workload and slow them down. Informed by
o be made to strike the right balance. However, there are many
y and this is the goal of the recommendations of the AMIA EHR

natics professionals, AMIA is well qualified to address many of the
f perspectives. AMIA members include informaticians, clinicians,
mentation scientists, change agents, and people who cross all
implement and study ways to manage information for patients,
, for public health and for clinical research. Within EHR activities,
ented, studied, and refined EHRs, and advocated for their
s recently addressed electronic documentation[30] and usability[31]
s to EHR success. The AMIA Board of Directors chartered the
develop recommendations on how we can resolve the EHR

ing health system, this report focuses only on near-term
n EHRs and does not address other areas of the learning health
y involve many changes as health care itself changes through
ion,[32] rising involvement of people in their own care,[33] evolving
ys. Our report focuses on some but not all of this future; we
n to those using EHRs today and on directions for the next five
novation.

these problems? We start now and with 10 recommendations in

ED DOCUMENTATION

**try burden for the clinician. Although medicine requires an
document the care patients receive, interpretation of CMS'
urden of office visit documentation on physicians.
Information entered by other care team members and patients should be as valued as that information entered by the physician. Much of the information relevant to the diagnosis and treatment of a patient 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.[35,36,37]**

Physicians' time investment in documentation has doubled by some measures in the last twenty years, and may consume up to half of a physician's day.[38,39] Time requirements for nursing documentation have also changed as has documentation workflow.[40] This growth in documentation burden was associated with changes in Medicare reimbursement rules,[41] possibly 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 in documentation. In a large survey, staff internists reported that EHRs take an extra 48 minutes per day of their time compared to their manual systems and entry of visit notes into the computer garnered the strongest complaints from the most respondents.[6] A large RAND survey documented analogous complaints.[43] To reduce the time cost of the EHR, some providers use "copy and paste" options to insert information from past notes, review of systems and laboratory results into their current note. This practice has caused its own set of problems,[44,45,46,47,48] including bloated visit notes, which can obscure the providers thinking and key facts about the patient, and inaccurate editing that yields incorrect or nonsense text[49] both of which raise concerns about patient safety. 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 the 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 the patient rather than charting. 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, family members and the care team, and 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; yet important aspects of the patients' stories can only be effectively captured by narratives. Compared to human narrative, purely coded templates do not distinguish the informational wheat from chaff nor do they capture the subtle special circumstances of each patient. Further, coded templates are a disservice to the communication needs of clinicians.[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 real-time natural language processing can reduce reliance on templates,[52] and should be bolstered. Vendors should enhance their patient portals to support data collection from the patient and increase support for multiple modes of data entry to accommodate provider preferences

including voice, typing, clicking, and handwriting recognition.

ote writing. Manual entry of encoded data needed to track
es time, and this often falls to providers at the point of care.
dardized interfaces between IT systems rather than manual
devices and other external sources. Lab interfaces are widely
odes (LOINC) needed for automatic filing has only begun.
chocardiography and other diagnostic systems also have
the standardization needed to deliver these results automatically
s, allergies, and problems to be discretely imported, but much of
s text. Expansion of bidirectional immunization registries will
ord (with clinical validation where appropriate), relieving the

ased purchasing. Less prescriptive and more flexible
s attention on outcomes and clinical relevance, and will speed the
documenting clinical care.

**ble systematic learning and research at the point of care
tter understanding of the costs (in time) and benefits (to care
ent approaches to capturing and reporting clinical data. The
uality (AHRQ), the National Institutes of Health (NIH), the
Institute (PCORI), the National Institute of Standards and
support studies of the usage and unit-time cost of each
and the effect of different collection mechanisms such as
understanding, natural language processing, hand writing
ne to enter and the usability of such information. These
support the study of alternative approaches and media that
e, such as by sound recording of the history and physical
nstead of writing it all down.[53,54]**

cost effective strategies for improving patient care and
lt, they have developed sophisticated ways of assessing whether
s threshold and should be recommended for broader use. We
st and benefits of proposed data items to be recorded in the
me and effort required to enter documentation and its relation to
clinical team efficiency.

In addition to enabling the incorporation of research knowledge into practice to support evidence based medicine (EBM), EHRs can enable evidence generating medicine,[58] thereby creating a virtuous cycle of rapid evidence generation and evidence-based care delivery, an essential element needed to create a LHS and to advance precision medicine.[59] Examples of such activities at the point of care might include: (a) facilitating the identification and recruitment of potential research subjects during practice such as through clinical trial alerts directed at clinicians or patients; (b) enabling adherence to research protocols during practice; (c) enabling easy and customizable data collection approaches unique to research during patient encounters that have both research and clinical purposes. This should be accomplished without adding burden to the complexities of physician/clinician interaction and begs for additional innovation.

II. 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[60] so that vendors and providers can work together to streamline workflows, relieve data entry burden, promote innovation, and thereby enhance usability of EHRs.

Clarifying and simplifying certification and MU regulations

The first three 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 MU Stage I. 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. It has also led to proposed legislation to increase flexibility in the program. These changes suggest that the EHR incentive programs should take a different approach to 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 innovation in general. We believe that the 2014 Edition CEHRT has the necessary foundation of EHR functionality that will set the stage for better data exchange and interoperability, simplified workflows and data entry, and will support a quality and patient outcomes focused EHR. Future editions should focus on simplifying the certification

process while supporting improvements in interoperability, clinical quality measures, safety and security.

ements will allow Eligible Providers, Eligible Hospitals, and
gful use requirements while they upgrade their EHR systems in a
raining prior to taking the upgraded products live. It will allow
ze their products and improve workflows and usability.

d interoperability

us on technical requirements that will improve interoperability
measures, and provide for safer and more secure care.
ducing barriers to interoperability and efficient data flow. For
t that exist for laboratory and radiology test orders could save
ation system interfaces.[61] Data registries for quality,
nic surveillance could benefit from EHR standards for data and
f interfaces between different systems. Reducing costs of
lels funded through business interests or public good.

on patient outcomes

ld focus on outcomes that are consistent with national priorities
cialties, patients and communities. Data collected should only
treat the patient's condition and not add to the documentation
plement functionalities or document findings where the main
actice but rather to others such as payers or other secondary
ke it much easier to report accurate and meaningful quality
cts that outcomes attributed to providers and hospitals will be
payers and other stakeholders to develop payment alternatives
nore on quality and value is likely to promote EHR innovation and

**ursement regulations should support novel changes and
d changes to payment models as well as federal guidance
in health information technology.**

ted use of health information technology and have increased
outcomes, including electronic clinical quality measures. The CEHRT program has supported the standardization of this documentation, helping ensure the potential for future semantic interoperability. 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 patients voice (the informant) is rarely captured in the documentation except through the patient's health care 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 to collect data. MU 2014 requirements for a secure patient portal provide new opportunities to collect patient completed data in advance of the visit saving documentation time but 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 with health care reform. Pilot programs include an increased emphasis on outcomes including a reduction in disparities in access to health care for the individual patient as well as for the population served. 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 populations.

There is a natural tension between using EHR systems to guide and document care, and to provide adequate documentation to ensure appropriate reimbursement. Continued requirements to support E/M codes will slow progress toward new ways of defining the medical record, acquiring and integrating data, and supporting clinical documentation and 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.

III. INCREASE TRANSPARENCY AND STREAMLINE CERTIFICATION

Recommendation 6. In order to improve usability and safety, to foster innovation and to empower providers and EHR purchasers, how a vendor satisfies a certification criterion, 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

each vendor satisfies each certification criteria, detailed data and information models for APIs, and m the EHR as part of the certification process. These the public on the certification body's website.

how to meet the MU certification criteria, ONC provides precise ive. The advantage of this approach is that vendors know with n. An unintended consequence is that vendors believe their programmed into the certified function and built into the d determination. This predetermined workflow built into EHR e products, often in a negative way.

escriptive instructions for meeting MU certification, and work with d the industry to develop clear, flexible, and transparent methods MU functional objective. Clearly stating the goal of the testing hing those goals, and then making sure that the testing approach vide testing solutions that meet the needs of both vendors and ould record the process of demonstrating that a product meets e recording on the certification body's public web site. Additional ke informed decisions could include posting of public APIs, o record data into the system, or to get data out of the system. and also inform the market about the usability of the vendor's ctive.

ot have visibility into how applications work. This lack of litive marketplace. Those choosing EHRs need clear knowledge nd, importantly, what workflows are incorporated into their use for tering data, reconciling medications, responding to decision research—so they can make more informed choices. There are that need to be balanced with encouraging competition and an cy will ultimately help everyone. An informed market would have wering consumers, and stimulating innovation.

e usability and safety and to foster innovation, health care should be fully transparent about unintended consequences alth information technology systems, including EHRs, as ese risks.

There is much evidence that health information technology can improve patient safety, but there is also evidence that these systems can introduce safety risks and other unintended consequences,[66] such as wrong patient errors, copy and paste errors, and alert fatigue. These issues can arise anywhere in the sociotechnical model,[67] 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 on how to improve.

Vendors, health care organizations and providers should not be competing on safety. Instead, they should be sharing identified problems and sharing ways to prevent or mitigate them. To facilitate information sharing, vendors and health care organizations should work with Patient Safety Organizations to share information about safety issues and best practices. All relevant data related to patient-safety risks (workflows, screenshots, data definitions, code sets, etc.) should be shared with these organizations so that all parties involved can better understand and mitigate safety risks.[68] We support the recent Food and Drug Administration Safety and Innovation Act (FDASIA) report that recommends a public-private partnership in creating 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.[69]

IV. FOSTER INNOVATION

Recommendation 8. EHR vendors should use public standards-based application programming interfaces (APIs) and data standards that will enable EHRs to become more open to innovators, researchers and patients. These standards should support extension and innovation 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 into better systems and empower patients to engage in their care. The public APIs and data standards should be consensus based, transparent, well documented, and openly available in a fair and non-discriminatory 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 benefit from innovations from academic centers and elsewhere 30 years ago, including functionality, data standards and even operating systems. However, nearly all of those academic centers are now switching to commercial EHR products, most of which are closed source, potentially restricting the ability to do 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 use;

patients do not have the ability to take their comprehensive longitudinal record (clinic visits, laboratory and y information and patient generated information) from one system eir own purposes.

n continue to tap the research capacity of academic informatics searchers and innovators who wish to participate in and advance rticularly important in light of the US government's Precision ability to capture, store, and present increasingly meaningful and to leverage that data for decision support and other uses. ors to help solve workflow and functionality gaps faced by current venture capitalists, academicians, private equity firms and lingness to take risks in the marketplace. In short, we believe that to both extracting data from the EHR as well as creating novel plications. To get there, we need APIs, data element standards and interact with commercial EHRs. Recent projects using the ability Resources (HL7 FHIR) standard have demonstrated the ed approaches that leverage existing web-based technology.

nt recommendation of the JASON Report[73] and the JASON Task ty should broadly support public APIs as core functionality to TF that these public APIs must be based on open, FHIR),[75,76] but must also be widely deployed and exposed to a a fair, reasonable, and nondiscriminatory way, such that new e believe that in order for these public APIs to be widely ome a component of the CEHRT program as the standards

s, we will want data access to include methods for more than just interact with data, either through APIs or through data standards ngitudinal record. Experience with the Blue Button initiative standardized way will drive and facilitate development of mobile aps, enhance communications, and facilitate greater interaction foresee the day when prescribing an "app" as part of a care plan a treatment record and subsequent care plans will be a routine will empower consumers to support national initiatives such as precision medicine.

The academic research community will also benefit from standardization around the public APIs and the accompanying data standards. Interoperable data element definitions or common data elements (CDEs) 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 emergence of new data-sharing networks focused on research uses.

There have been demonstrations that use APIs and have involved commercial EHR vendors and academicians where apps have been able to upload data from a commercial EHR, perform an operation such as decision support, and return messages to the EHR.[77] We hope these encouraging results will be the first steps toward developing an ecosystem that supports health care apps that will eventually import data from and export information to multiple EHRs. EHRs should also leverage innovations that occur outside the walls of health IT, just as other applications benefit from external resources they use but did not create, such as map services and GPS.

V. THE EHR IN 2020 MUST SUPPORT PERSON-CENTERED CARE DELIVERY

The EHR is a shared record between the patient, the care provider teams and the institutions that pay for and provide 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 recommends the following:

Recommendation 9. Promote the integration of EHRs into the full social context of care, moving beyond acute care and clinic settings to include all areas of care: home health, specialist care, laboratory, pharmacy, population health, long-term care, and physical and behavioral therapies. We need a record of care that provides views that can vary the timeline, the level of aggregation and abstraction, the scope ranging from the problem to the entire sociocultural context, and the point of view of the user. The ability to incorporate data from different sources is essential. Including patient-generated data, population data and community contexts into an EHR will spur 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's decision-making in many areas,[78] it is extremely difficult to access. Social data may often be key to accurate decision making,[79] but the data are often widely distributed or simply absent.[80,81]

At the other end of the precision medicine spectrum is the patient's molecular profiling data. With nology, patients' genomes are likely to be sequenced routinely in stant future. The Precision Medicine Initiative[59] is initially focused me into focus as researchers learn more about their underlying nics (the study how genes affect a person's response to drugs) two other areas that are already reaping the benefits of genetic rs—e.g., proteomics, metabolomics, and epigenetic onal types of data may quickly emerge as important data

models of health care delivery are being promoted as core to the e EHR adds substantial capability to any PCMH system.[83] EHRs e PCMH principles of care, i.e., care that: 1) is personal, es teams with shared awareness of the patient's situation across rson perspective where the patient's context and life-story is d; 4) supports enhanced coordination so care can be tracked, ntegrates evidence-based practice deep into the patient's record ovement tools, and 6) expands access to care through the use of ent-provider communication, expanded hours, and the sharing of

e than simple interoperable platforms, but a new care data. Abstracted and summarized patient data should be als across a myriad of views. The principles of person-centered gration of new systems, such as smart phones, biometric sensor y of these technologies have improved the way that our society nicates, educates and informs. Although there are technologies ners to interact with their own health data (Fitbit, Apple HealthKit, bility and ubiquity in the health care domain.

has been presented by the ONC's Blue Button campaign.[84] utton has shown that access to data can drive creativity and and developers. Today it is possible for consumers and patients and other technologies into their EHR record. But while it is ue to impediments such as proprietary datasets, unique coding ation, 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. The core functions, however, should be focused on the benefits that they provide to patients—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 PCORI 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 we can do and the real-world infrastructure required to actually make it operational and scalable.

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

Usability is a real science and goes beyond screen design. [85] 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 we know that experts use automatic cognitive processing, we have not designed information displays to support our pattern matching abilities with minimal cognitive effort. Nor have we designed tools that allow clinicians to control their information environment.[86] Current EHRs do not align with patient's situation and clinician's mental models.[87]

EHR systems often use alerts as a blunt instrument to inform and motivate clinicians, creating significant complaints and alert fatigue.[88,89] Designing EHRs to match work processes is difficult but essential in order to maximize functionality and safety; future work should expand the evidence on effective implementing of decision support systems. Health information technology has disrupted communications, workflow and increased workarounds.[90,91] Maintaining safety requires more than design; it requires participation by the whole institution involved in the EHR implementation. True tests of usability rigorously and independently studied as well as *in vivo* assessments of ongoing performance would necessitate provider and patient input, eventually leading to a common set of core features and functions.

SUMMARY

The problems we face today in EHR use are complex and 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 a supportive national policy. We recommend a focus on these five areas during the next 6-12 months, while we develop a long-term framework for innovation for EHRs.

AMIA has always been in the forefront in the world of EHRs. The EHR 2020 Task Force is the next step in our involvement. We look forward to working with other groups, government agencies and professional

organizations to find creative ways to solve EHR problems we face today and to further create a
HRs. We look forward to continuing work with policymakers on
ard better use of EHRs to achieve the Triple Aim.[92] AMIA's 2015
irely to EHRs.[93] Individual AMIA members should also continue
ents through their influence on EHR purchase decisions, criteria
proposed regulations and legislation, continued research on EHR
and through other means.

r organizations have expressed about addressing current EHR
oluble and the future for EHRs is bright.

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EER REVIEW

ating this paper, AMIA has further delineated critical issues
d of Directors reviewed the paper and endorsed its findings,
oard will continue to encourage other organizations to work
ublic discourse.

S

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