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in the second year following their publication. Four of the 5 journals showed an overall increase in the percentage of impact factor citations associated with citable items from 2002 to 2007, whereas 1 journal (*NEJM*) showed a slight decrease (from 88.8% to 87.4%), but increased the total number of citations (from 9921 to 14 172).

The demonstration that a journal's citation impact is determined primarily by citations to items defined as citable is consistent with a report by Golubic et al,⁷ which also found that most of the materials cited in an impact factor numerator were designated as articles or reviews. Golubic et al⁷ also noted that the majority of items indexed as articles or reviews (ie, counted in the denominator of the impact factor) contained original data, defined as "previously unpublished research results presented in numerical or graphical form." Although Golubic et al⁷ argued that the varying contribution of not citable materials to the impact factor was problematic, impact as a journal-level measure in the impact factor accommodates the notion that not citable items also contribute to a journal's influence in the literature because citations to any item reflect use of the journal. Considering that the impact factor then adjusts this according to the number of items most likely to attract citations because of their scholarly content, it is not a mathematical average of citations per item,¹⁻³ but rather reflects the journal's participation in and its influence on the scholarly literature.

The impact factor has had success and utility as a journal metric⁸ due to its concentration on a simple calculation based on data that are fully visible in the Web of Science.⁶ These examples based on citable (counted) items indexed in 2000 and 2005 suggest that the current approach for identification of citable items in the impact factor denominator is accurate and consistent.

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Electronic Medical Records at a Crossroads Impetus for Change or Missed Opportunity?

Leonard W. D'Avolio, PhD

THE PRESIDENT'S AMERICAN RECOVERY AND REINVESTMENT Act includes \$19 billion in incentives for the adoption of electronic medical records (EMRs)¹ and his health care reforms include an investment of \$50 billion to promote health information technology. For physicians considering adoption of an EMR system, the legislation features both the carrot and the stick. Medicare physicians adopting and making "meaningful use" of EMRs in 2011 and 2012 will be eligible for an initial payment of up to \$18 000, with reduced subsequent payment amounts in 2013 and 2014. Physicians can capitalize on similar incentives available through the Medicaid program (but not both). Those physicians who do not adopt EMRs by 2015 will face a reduction of 1% in their Medicare fee schedule, increas-

ing to a 2% reduction in 2016 and a 3% reduction in 2017 and beyond.

At the same time, leading US health care organizations, including the Department of Health and Human Services (HHS), its Centers for Medicare & Medicaid Services, and the Agency for Healthcare Research and Quality, are investing heavily in clinical data-dependent quality measurement and improvement initiatives such as Pay-for-Performance² and Healthy People 2010.³ Few would disagree that upgrading the information infrastructure of US hospitals and clinics is essential for improving the quality of US health care. It is therefore understandable that so much attention has been given to the promise of wide-

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See also p 1111.

spread EMR adoption to enable US health care improvement. Lost in the conversation thus far is the fact that today's EMR systems are not designed to improve the quality of health care.

Most EMR systems are designed to document individual patients' conditions, facilitate communication of patient conditions and treatments between clinicians, justify financial reimbursement, and serve as the legal records of events. In other words, they are designed to improve the efficiency of individual transactions. Widespread adoption of today's EMRs will introduce health care to the benefits of digitizing paper. However, for an investment equivalent to more than twice the annual research budget of the National Institutes of Health, more should be achieved than advancing health care to the state of information technology enjoyed by most other industries since the 1980s. Instead, leaders of health care must adopt a lesson long-since learned by manufacturers, insurers, and supermarkets: quality improvement requires access to measurable information captured from thousands of transactions.

Current EMR systems' lack of consideration for learning from aggregated health data has led to implementations and hospital information technology departments that can actually obstruct quality improvement. For example, much of the information contained in electronic records is formatted as unstructured free text—useful for the essential individual communication but unsuitable for detecting quantifiable trends. In addition, few data standards are widely implemented, limiting the ability to conduct analysis across institutions and even across departments. Hospital chief information officers and information technology departments responsible for supporting today's EMR systems may be understandably leery of permitting access to medical records for secondary purposes (such as quality improvement). In addition, the lack of emphasis on accessible data encourages EMR vendors to guard access to their systems' data models based on concerns for proprietary designs and system integrity. In light of the current state of the EMR, it is no surprise that quality initiatives such as Healthy People are forced to eliminate objectives, not because of their lack of importance, but for a lack of measurable data.

As part of the American Recovery and Reinvestment Act's provision for health information technology, the HHS has until December 2009 to define the "meaningful use" of EMRs, upon which clinician reimbursement is contingent. Examples from the Veterans Health Administration and elsewhere have shown that it is the meaningful "reuse" of EMR data that leads to improved health care.⁴⁻⁶

If HHS capitalizes on this opportunity to mandate information systems that facilitate learning from existing data, US health care may finally begin to fulfill the decades-old promise of the EMR. Databases of vital signs, images, laboratory values, medications, diseases, interventions, and

patient demographic information can be mined for new knowledge. Rather than base guidelines for care on round-table discussions of few experts or a limited evidence base, practices that work best can be discovered based on analysis of entire populations. With just a few of these databases networked together, the power to improve health care increases exponentially. Regional networks of databases can be used to pinpoint outbreaks of infections or to highlight differences in care of patients from one hospital to the next. The eventual addition of genomic information, environmental factors, and family history to these databases will enable clinicians to begin to realize the potential of personalized medicine; the use of the most appropriate therapeutic intervention for each individual.

If instead, the definition of "meaningful use" remains centered on supporting individual transactions, access to measurable information will remain secondary. Consequently, so too will health care quality measurement. No amount of digitizing inaccessible or immeasurable information will lead to significant improvements in patient health. Instead, the US health care system will continue the tradition of world-leading spending for less than optimal health returns.⁷

Fortunately, "meaningful use" that requires accessible and measurable information is, from a technical standpoint, rather straightforward to implement. First, the databases on which EMR systems are designed must support access and analysis. This requires that data elements are named intuitively and clearly documented. Whenever possible, standards should be used to define data elements to facilitate "apples-to-apples" comparisons. Interfaces and workflows in EMR systems must be flexible enough to capture new information at the point of care and put lessons learned into action. Most important, data governance policies must be implemented that recognize that protecting patient privacy and learning from aggregated data are not mutually exclusive activities.

The time to make proper use of clinical data, medicine's most valuable untapped resource, is long overdue. The technologies required to reach these goals have matured in other industries during a period of years. The lack of investment traditionally blamed for health care's slow progress on this front may no longer be an issue. All that is missing is the collective realization that better health care requires access to better information—not automation of the status quo.

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Eight Rights of Safe Electronic Health Record Use

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COMPUTERS CAN IMPROVE THE SAFETY, QUALITY, AND efficiency of health care.¹ The pressure on hospitals and physicians to adopt electronic health records (EHRs) has never been greater. However, concerns have been raised about the safety of EHRs in light of the limitations of currently available software, the inexperience of clinicians and information technologists in implementation and use, and potential adverse outcomes associated with clinician order entry and other clinical applications.²⁻⁴

President Obama has referred to EHRs as a solution to reduce medical errors. To avoid medical errors resulting from EHR use and to achieve the promise of EHRs, this Commentary proposes 8 rights of safe EHR use. These rights are grounded in Carayon's Systems Engineering Initiative for Patient Safety,⁵ a human factors engineering model that addresses work-system design for patient safety.

Right Hardware or Software

An EHR system must be capable of supporting required clinical activities. If hardware or software is inadequately sized, configured, or maintained, the EHR will function poorly. Anything that slows or disrupts the clinician's workflow could negatively affect patient safety.⁶ For example, an EHR should be able to calculate a medication dose, transmit the order to the appropriate department, and notify the nurse of a placed order. A medication error could easily follow a breakdown in any of these functions.

Local software oversight committees are a way to help ensure proper and safe functioning.⁷ Another solution may be cloud computing, reliable computing services that are accessible from remote locations via the Internet. Although the cloud may reduce hardware procurement, configuration, and maintenance burdens for health care organizations, its benefits hinge on the improvement of Internet speed, reliability, and access.

See also p 1109.

Right Content

Right content includes standard medical vocabularies to encode clinical findings and knowledge used to create specialty-specific features (eg, posttransplant orders) and functions (eg, health maintenance reminders). Content must be evidence-based, carefully constructed, monitored, complete, and error free.

The federal government has taken a significant step toward advancing a controlled vocabulary with its support of Systematized Nomenclature of Medicine—Clinical Terms, the most comprehensive, multilingual clinical health care terminology in the world. The National Library of Medicine distributes it for free through an agreement with the International Health Terminology Standards Development Organization. Adoption of a standard vocabulary is prerequisite to implementing advanced clinical decision support (CDS). To increase access to a standards-based set of validated, evidence-based CDS, an open-access clinical knowledge base of interventions should be developed, focusing on helping clinicians achieve the quality and safety targets for meaningful EHR use.

Right User Interface

The right user interface allows clinicians to quickly grasp a complex system safely and efficiently. The interface should present all the relevant patient data in a format allowing clinicians to rapidly perceive problems, formulate responses, and document their actions. A key design consideration is the trade-off between clinicians' desire to see everything on 1 screen and limited screen space. Errors may follow when clinicians miss crucial information in applications that include too much information on 1 screen. Yet, systems with too many nested menu options or redundant pathways can be difficult to learn and time consuming to use. The physi-

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