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Adoption Of Electronic Health Records Grows Rapidly, But Fewer Than Half Of US Hospitals Had At Least A Basic System In 2012

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ABSTRACT The US health care system is in the midst of an enormous change in the way health care providers and hospitals document, monitor, and share information about health and care delivery. Part of this transition involves a wholesale, but currently uneven, shift from paper-based records to electronic health record (EHR) systems. We used the most recent longitudinal survey of US hospitals to track how they are adopting and using EHR systems. Only 44 percent of hospitals report having and using what we define as at least a basic EHR system. And although 42.2 percent meet all of the federal stage 1 "meaningful-use" criteria, only 5.1 percent could meet the broader set of stage 2 criteria. Large urban hospitals continue to outpace rural and nonteaching hospitals in adopting EHR systems. The increase in adoption overall suggests that the positive and negative financial incentives currently in place across the US health care system are working as intended. However, achieving a nationwide health information technology infrastructure may require efforts targeted at smaller and rural hospitals.

The nation's health care system is in the midst of an enormous change as hospitals and ambulatory care providers transition from paper-based to electronic record keeping systems. The Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 authorized nearly $30 billion to increase the adoption of electronic health record (EHR) systems, with much of this money in the form of incentive payments to hospitals and eligible providers for meeting requirements for "meaningful use."[1,2]

The actual amount of support provided will depend on the share of eligible hospitals and providers that meet federal criteria in the short term. The criteria, collectively characterized as an "escalator" designed to move hospitals toward higher-quality and more-efficient care, are being implemented in three stages with increasing requirements for participation. Stage 1 began in 2011; the more rigorous criteria for stage 2 were finalized in 2012.[3] The specific criteria for stage 3, now being developed, are scheduled to go into effect in 2016. Hospitals that have not met stage 1 meaningful-use criteria by July 1, 2014, will face financial penalties that increase over time.[4]

Early data on the impact of HITECH on hospitals' EHR adoption rates have been generally positive, but more work is needed to achieve universal adoption. Between 2008, when we began systematically tracking the rate of EHR adoption, and 2010, the percentage of hospitals with at least what we define as a basic EHR system increased by approximately three percentage points per year, rising from 9 percent in 2008 to 15 percent in 2010. However, during the first year that incentives were available, 2010–11, the proportion of US hospitals with

basic EHR systems nearly doubled, from 15 percent to nearly 27 percent. This increase appeared to be concentrated among large, urban, and teaching hospitals.[5]

The increase seen during the first year after the passage of HITECH is encouraging. Nonetheless, it is important to continue to track rates over time to examine whether the substantial public investment in EHR adoption is proving effective, and to understand whether adoption is increasing at a pace that is consistent with expectations and the relatively short timeline established by the meaningful-use program.

Previous data suggested a possible widening of the "digital divide," with smaller, rural, and non-teaching hospitals potentially falling behind other hospitals.[5] Provisions of HITECH were structured to help reduce the digital divide, but it is not clear whether they are working or if they are sufficient. Understanding whether hospitals in all regions of the country, and especially key groups of hospitals such as smaller and rural facilities, are progressing at the same pace toward a nationwide health information technology (IT) infrastructure is a substantial policy priority.

Hospitals may begin attesting to their meeting stage 2 meaningful-use criteria in October 2013. Thus, nationally representative survey data assessing the pace of EHR adoption overall and among different subgroups of hospitals can provide timely information for policy makers on the impacts of current programs.

We sought to answer the following questions. First, what proportion of US hospitals had a basic or comprehensive EHR system in 2012? Second, are certain types of hospitals making progress toward EHR adoption more quickly than other types? Third, what proportion of hospitals could meet proxy measures of stage 1 and stage 2 meaningful use at the time the 2012 American Hospital Association's Annual Health Information Technology Supplemental Survey was conducted? And fourth, which electronic functions of an EHR system appear to be the most difficult for hospitals to implement as they move toward stage 2 meaningful use?

Study Data And Methods

We used data from the 2012 health IT supplement to the American Hospital Association's annual survey. The survey is sent to the CEO of each hospital in the United States, who is then asked to assign the task of completing the survey to the most knowledgeable person in the organization. For the IT supplement, this is typically the chief information officer or someone in an equivalent position. All nonrespondents received multiple follow-ups by mail and telephone. The survey was conducted from October 2012 through January 2013.

SURVEY CONTENT The contents of the survey have been well described elsewhere.[5-9] Briefly, each respondent is asked to report on whether his or her hospital has implemented each of the twenty-four clinical functions that may be part of an EHR system. The 2012 survey included additional questions about functions needed to meet the criteria for stages 1 and 2 meaningful use.

MEASURES We used previously developed measures that define *basic* and *comprehensive* EHR systems.[9,10] Hospitals meeting the criteria for a basic system had a computerized system for maintaining each of the following types of information fully implemented in at least one clinical unit in the hospital: patient demographic characteristics, physician notes, nursing assessments, patient problem lists, laboratory and radiology reports, and diagnostic test results, as well as computerized ordering for medications. A comprehensive system has all of the basic functions listed above and fourteen additional clinical functions implemented in all major units of the hospital. A complete list of functions required for a comprehensive system is available in online Appendix Exhibit 1.[11]

In previous work we developed a proxy measure for stage 1 meaningful-use criteria.[5] Since that time, additional items were added to the American Hospital Association survey that align with those criteria. These items assess each hospital's capability for electronic data exchange and ability to protect electronic data—the two core criteria for stage 1 meaningful use that had not previously been assessed in the survey. We used these new items to create a proxy variable that included all fourteen core criteria for stage 1 meaningful use (for the complete list of survey items used to create the stage 1 variable, see Appendix Exhibit 2).[11]

The 2012 American Hospital Association survey also included items assessing each hospital's adoption of all sixteen core criteria for stage 2 meaningful use, which we used as a proxy for those criteria. Although many stage 2 criteria are similar to those in stage 1, there are several notable additions focused on care transition processes, electronic data exchange, and patients' access to their own clinical data, as well as increased performance thresholds.[11]

ANALYSIS We excluded all federal, non–acute care hospitals and focused only on acute care general medical and surgical hospitals. We compared the characteristics of the responding hospitals to those of the nonresponders and found statistically significant differences (Appendix Exhibit 3).[11] We used the standard technique of

employing a regression model to predict a hospital's likelihood of responding to the survey, to develop weights to control for nonresponse bias. These weights were applied in all analyses to ensure that our data were representative of all acute care general medical and surgical hospitals in the United States.

We calculated the proportion of such hospitals that had adopted basic and comprehensive EHR systems in 2008–12 by calculating rates separately for each year. These trends were plotted as proportions over time from 2008 through 2012. We next examined whether changes in adoption of EHR systems varied by hospital size, ownership, teaching status, urban or rural location, and region of the country, using the relative change in percentage between 2010 and 2012.

We then calculated the proportion of US hospitals that could meet all fourteen core criteria of stage 1 meaningful use and the proportion that could meet all sixteen core criteria for stage 2 meaningful use. Finally, given the salience of understanding how hospitals are likely to fare under stage 2 criteria, we examined rates of adoption for each individual function included in the core stage 2 criteria.

LIMITATIONS There are important limitations to our work. In any survey, there is concern about nonresponse bias. Although our response rate of 62.5 percent was relatively high, it is possible that nonresponders were systematically different from responders, resulting in nonresponse bias. We used standard statistical techniques to account for this. However, such techniques—although quite helpful—are hardly perfect.

Our approach to measuring meaningful use,

according to criteria for both stage 1 and stage 2, may not have given us the precise number of hospitals that have attested to achieving meaningful use, as a result of both the regulations involved in the meaningful-use program and the nature of survey measurement.[12]

Furthermore, we required only that hospitals have implemented the core functions of an EHR system in at least one unit (or, for some functions, only that they are used it at all in the hospital). We did not assess hospitals' capacity to meet the menu criteria for meaningful use. Thus, our proxies were less rigorous than the actual regulatory requirements. However, the percentage of hospitals meeting our requirements closely parallels the proportion of hospitals that have attested to achieving stage 1 meaningful use. This suggests that our estimates could be used to examine trends over time and differences across groups of hospitals.[12,13]

Finally, we could not examine how use of the EHR systems by hospitals was affecting care. There are no national data on how effectively hospitals are using these systems, although they are required to report performance metrics on levels of use to the federal government.[13]

Study Results

There were 4,474 general, acute care hospitals in our sample, of which 2,796 responded. Hospitals that were large, located in the Midwest or in urban areas, nonprofit, and major teaching institutions—that is, hospitals that are members of the Council of Teaching Hospitals—were more likely to respond than other hospitals.[11] All analyses that follow adjust for nonresponse as described above.

EHR ADOPTION AND CHANGES OVER TIME We found that in 2012, 44.0 percent of general, acute care hospitals had at least a basic EHR system—an increase of seventeen percentage points from 2011 and a near-tripling of the proportion in 2010, the year prior to the onset of financial incentives (Exhibit 1). The percentage of hospitals achieving comprehensive status in 2012 (16.7 percent) nearly doubled from 2011 (8.7 percent).

Compared to hospitals without an EHR system, those with at least a basic system were more likely to be large, midwestern, and major teaching hospitals (Exhibit 2). Rural hospitals were considerably less likely than urban hospitals to have at least a basic system.

In examining trends over time, we found differing rates of progress on EHR adoption across groups of hospitals, with those hospitals starting at a lower base rate of adoption generally making greater progress but remaining considerably
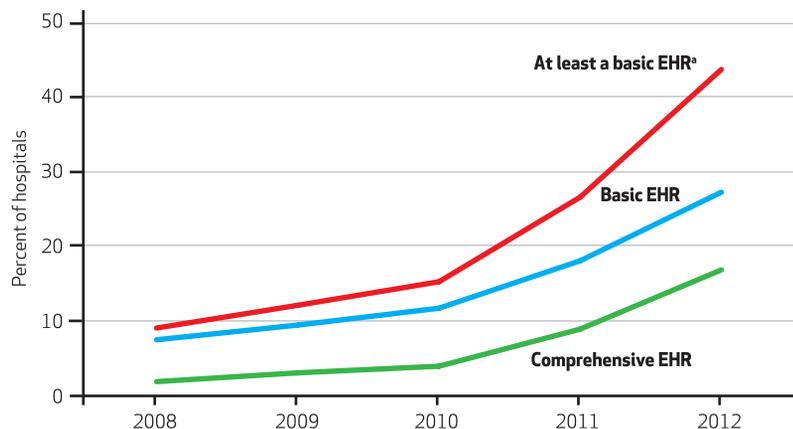
44%

Had basic EHR

In 2012, 44 percent of general, acute care hospitals had at least a basic electronic health record system—nearly three times as many as in 2010.

EXHIBIT 1

Hospitals' Adoption Of Electronic Health Record (EHR) Systems, 2008–12

SOURCE Authors' analysis of data from American Hospital Association, Annual Health Information Technology Supplemental Survey, 2012. **NOTE** All analyses were statistically weighted to account for potential nonresponse bias. ªHospitals with either a basic or a comprehensive system.

behind their counterparts. For example, small hospitals were still less likely than large hospitals to have at least a basic system in 2012. But small hospitals appeared to be narrowing the gap somewhat, with a larger percentage change than that of large hospitals between 2010 and 2012 (Exhibit 3). We found similar trends of lower absolute rates of adoption but higher relative changes when we compared nonteaching to teaching and rural to urban hospitals.

MEETING STAGE 1 MEANINGFUL-USE CRITERIA We found that 42.2 percent of US hospitals could meet all fourteen core criteria of stage 1 meaningful use in 2012 (Appendix Exhibit 4).[11] Although our metric in 2011 and 2010 (meeting twelve of the fourteen core criteria) was somewhat easier to achieve, the latest numbers represent a substantial increase from 2011 (18.4 percent) and 2010 (4.4 percent). Hospitals able to meet our proxy of stage 1 meaningful-use criteria were more likely to be large, teaching, private nonprofit, and located in urban areas, compared to hospitals that did not meet our proxy.

MEETING STAGE 2 MEANINGFUL-USE CRITERIA Applying our proxy of stage 2 meaningful use, we found that 5.1 percent of hospitals could meet all sixteen criteria (Appendix Exhibit 5).[11] The profile of hospital types more likely to meet these criteria was similar to that of hospital types more likely to meet stage 1 criteria: larger, urban, nonprofit teaching institutions. An additional 63.3 percent of hospitals had implemented between eleven and fifteen functions required to meet stage 2 criteria in at least one unit, and 21.3 percent had implemented between six and ten functions. The remaining 10.3 percent reported having implemented five or fewer functions required for stage 2 meaningful use (Appendix Exhibit 6).[11]

KEY STAGE 2 CRITERIA The most commonly implemented stage 2 functions were computerized systems recording patients' smoking status and vital signs (Exhibit 4). Additionally, more than 80 percent of hospitals had implemented the following functions in at least one major unit: incorporating laboratory test results as structured data—that is, data entered into fixed fields in an EHR, in contrast to data added by simply scanning paper records into the electronic record; generating patient lists by specific conditions; tracking medication administration; maintaining patient demographic characteristics; generating patient-specific education resources; and protecting the confidentiality of electronic health information. Nearly 70 percent of hospitals now use computerized ordering for medications, labs, and radiology tests in at least one clinical unit—a large change over the past

few years.

The functions least likely to be implemented were electronically submitting laboratory reports and syndromic surveillance data—that is, the systematic data required by public health agencies to detect and characterize outbreaks of disease in a timely manner; generating and transmitting a summary care record for patient transitions between settings; and functions allowing patients to view online, download, and transmit their health information.

Discussion

We examined the state of adoption of EHR systems among US hospitals in 2012 and found substantial increases over the prior year. Over the past four years, the proportion of hospitals with a basic system has increased nearly fivefold, suggesting that many institutions are making substantial progress. Although we saw progress across all types of facilities, differences across groups of hospitals remain. Smaller and rural facilities still lag behind their large and urban

EXHIBIT 3

Relative Change In Adoption Of Electronic Health Record (EHR) Systems, 2008–12

Characteristic	Percent of hospitals that have at least a basic EHR[a]					Percent change, 2010 to 2012
	2008	2009	2010	2011	2012	
SIZE						
Small	6.1	8.3	10.7	20.8	38.3	257.1
Medium	9.8	13.0	17.8	29.8	46.5	161.1
Large	18.5	24.1	25.7	43.0	61.9	140.8
REGION						
Northeast	10.0	12.2	16.1	26.9	44.4	176.2
Midwest	8.3	11.6	16.5	29.7	49.2	197.8
South	8.7	10.0	12.4	24.8	38.7	212.6
West	8.9	15.7	18.0	25.1	46.2	157.1
PROFIT STATUS						
For profit	6.5	8.1	7.8	16.7	29.8	282.1
Private nonprofit	9.9	13.9	17.6	31.0	49.6	181.3
Public	7.5	9.2	13.7	23.2	39.0	185.0
TEACHING STATUS[b]						
Major	21.1	31.6	40.9	55.1	68.6	67.9
Minor	13.0	15.0	18.2	33.9	50.8	179.1
Not teaching	6.9	9.6	12.4	22.7	40.4	225.0
LOCATION						
Rural	4.6	7.9	9.8	19.4	33.5	240.6
Urban	10.3	15.0	17.0	29.1	47.7	180.1

SOURCE Authors' analysis of data from American Hospital Association, Annual Health Information Technology Supplemental Survey, 2012. **NOTE** All analyses were statistically weighted to account for potential nonresponse bias. [a]Hospitals with either a basic or a comprehensive system. [b]Major teaching hospitals are members of the Council of Teaching Hospitals. Minor teaching hospitals have either a medical school affiliation, as reported to the American Medical Association, or approval to participate in residency training from the Accreditation Council for Graduate Medical Education.

EXHIBIT 4

Percentage Of Hospitals That Have Implemented Specific Functions Of Electronic Health Record (EHR) Systems, 2012
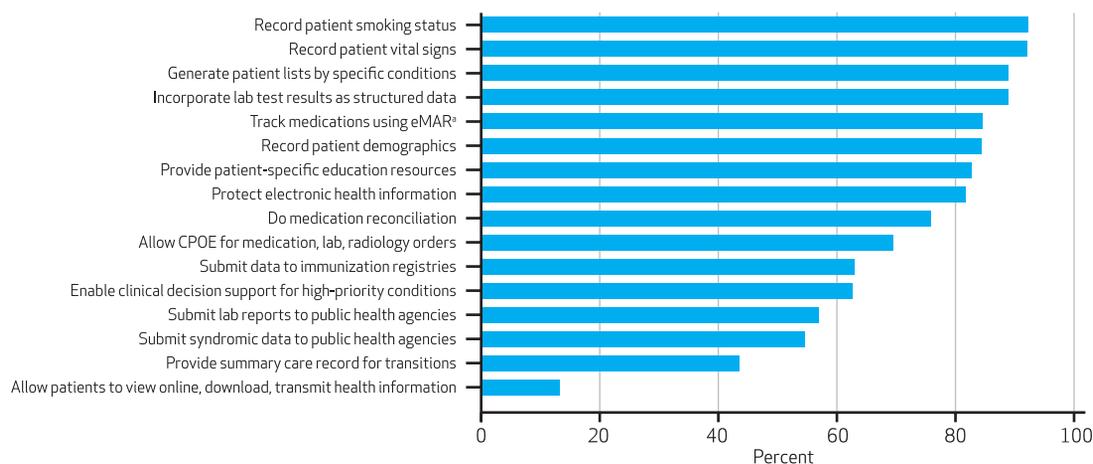
SOURCE Authors' analysis of data from American Hospital Association, Annual Health Information Technology Supplemental Survey, 2012. **NOTES** All analyses were statistically weighted to account for potential nonresponse bias. Structured data are data that are entered into fixed fields in an EHR rather than paper records that are scanned into the record. Syndromic data are the systematic data required by public health agencies for the purposes of detecting and characterizing outbreaks of disease in a timely manner. CPOE is computerized physician order entry. [a]Stage 1 meaningful-use criteria require the use of a barcode for medication administration. The American Hospital Association survey includes only the use of an Electronic Medication Administration Record (eMAR) and does not specifically ask about the use of barcodes.

The HITECH incentives, designed to encourage hospitals and other providers to switch to EHR systems, are likely spurring adoption of the systems.

counterparts, in both the adoption of systems and the ability to meet meaningful-use criteria.

The adoption rate in the last two years, with HITECH incentives in play, has increased much more substantially than it did in the two previous years, when no incentives were in effect. This rapid increase suggests that the HITECH incentives, designed to encourage hospitals and other providers to switch to EHR systems, are likely spurring adoption of the systems. However, despite this progress, the nation is not yet close to the goals of widespread adoption of such systems and their broad interoperability to support the information exchange needed to improve care.[14]

Our findings suggest that some important challenges still need to be addressed before the US health care system can realize the benefits expected to accompany widespread EHR use.[14] Three challenges are particularly worth highlighting. First, despite the fact that stage 2 criteria for meaningful use have already been finalized, in 2012 more than half of all acute care hospitals could not meet our proxy of criteria for stage 1 meaningful use. Second, only a small proportion of hospitals could meet our proxy for stage 2 meaningful use. Although many are making progress, nearly 30 percent of hospitals have implemented ten or fewer of the functions required to meet stage 2 criteria. Third, our findings suggest that there has been a tremendous amount of activity across all subgroups of hospitals, including small and rural institutions. However, there is still a great deal of work to be done before they can catch up to their better-off counterparts.

The state of EHR adoption among rural hospitals is a telling example. Rural hospitals have made substantial progress, with one in eight of them acquiring at least a basic system in 2012 alone. By the end of 2012 one-third of rural hospitals had at least a basic system—remarkable progress from 2008, when just 4.6 percent of them did. However, the gap between urban and rural hospitals remains. Policy makers need to pay additional attention to these institutions, which, similar to small physician practices, often lack the financial and human resources to purchase, implement, and effectively use EHR systems.[15,16]

We found that only a small proportion of hospitals could meet all sixteen criteria of stage 2 meaningful use that we could model. Most hospitals appeared to be having trouble implementing the functions of EHR systems that would allow their patients to view, download, and transmit their own clinical data; would generate care summaries and transmit them outside of the institution; and would electronically submit reports and clinical data to public health agencies.

Giving patients access to their own clinical data is a new criterion for meaningful use in stage 2. Many EHR systems have a portal feature that allows patients to view test results and request appointments and prescription refills online. However, prior research has identified giving patients complete access to their medical records as a barrier to meeting meaningful-use criteria.[17] It will require a great deal of effort for hospitals to implement this new function while ensuring that the security of their systems is not compromised by increasing access to confidential health information via the Internet.

The other two measures require hospital systems to be able to exchange health information with other institutions—a challenge that has been well described in prior work.[18,19] Electronic data exchange between organizations is not widespread, and the broadband Internet service needed for these transactions is still limited in many rural areas.[20] Under HITECH the Office of the National Coordinator for Health Information Technology has provided grants through the State Health Information Exchange Cooperative Agreement Program to increase the resources available for information exchange. However, the impact of these efforts is not yet clear.[21]

An important function related to national health surveillance is hospitals' ability to share data with public health departments. The capability of these departments to receive data electronically varies from county to county and is another impediment to the broader exchange of health information. A hospital will be exempted from meeting this requirement if its public health department is not able to support connectivity.[22,23] However, efforts to improve the electronic infrastructure and exchange capabilities of local and state health departments, such as

those the Association of State and Territorial Health Officers has advocated for, will be key to ensuring broad interoperability.[24]

Policy Implications

This study has specific policy implications. Although our findings demonstrate considerable progress on the whole, they suggest the need for a focus on hospitals that are still trailing behind, especially small and rural institutions. This will be especially important as stage 2 meaningful-use criteria become the rule, and positive incentives are replaced by penalties for noncompliance.

Specific policies and programs have been implemented to support small and rural hospitals' attainment of meaning use. The Office of the National Coordinator for Health Information Technology and its federal partners have implemented new programs to provide technical assistance in adopting and implementing EHR systems, as well as funding for broadband services and telecom infrastructure. Policy makers should closely monitor the initiatives to make sure they are sufficient for small and rural facilities to overcome the revenue and workforce challenges that they face.

Finally, it seems necessary to craft a special set of efforts targeted toward those hospitals that are furthest behind. Nearly a third of hospitals have implemented ten or fewer of the sixteen core functions needed to meet stage 2 criteria for meaningful use. It would be especially helpful to understand what is holding these institutions back, and how they can be brought along.

All hospitals face financial penalties in the form of reductions in their annual Medicare payment increases if they do not meet at least stage 1 meaningful-use criteria by July 1, 2014. Penalties will also apply to hospitals that meet those criteria but cannot later meet stage 2 criteria. These penalties increase over time and never expire. Although the formula for calculating them is complex, the expected impact will be 1–3 percent

> # It seems necessary to craft a special set of efforts targeted toward those hospitals that are furthest behind.

of all Medicare payments for inpatient care. As the penalty phase draws nearer, efforts to assist these hospitals will become even more important because the decrease in their revenue could further exacerbate barriers to their adoption of EHR systems.

Conclusion

During the second year of HITECH incentives we found ongoing, rapid uptake of EHR systems by US hospitals. This result suggests that federal policy can have a dramatic impact on health care delivery transformation when it combines positive and negative financial incentives, a clear and incremental road map, and alignment with other policies and institutional goals. But in spite of these encouraging findings, the use of EHR systems is not yet widespread: Fewer than half of hospitals could meet the stage 1 criteria for meaningful use, and fewer still could meet the stage 2 criteria.

Our findings suggest that the critical policy goal of achieving a nationwide health IT infrastructure will require special efforts to enable these trailing institutions to catch up. Otherwise, the US health care system will not be able to achieve the broad interoperability necessary to support improved care. ∎

NOTES

1 Blumenthal D. Implementation of the federal health information technology initiative. N Engl J Med. 2011;365(25):2426–31.

2 Blumenthal D. Launching HITECH. N Engl J Med. 2010;362(5):382–5.

3 Centers for Medicare and Medicaid Services. Medicare and Medicaid programs: electronic health record incentive program—stage 2. Final rule. Fed Regist. 2012;77(171): 53967–4162.

4 Stage 1 standards for a hospital are meeting fourteen "core" objectives and five of ten "menu" objectives. Stage 2 standards are meeting sixteen core objectives and three of six menu objectives. Many of the stage 2 objectives are similar to stage 1 objectives but impose more stringent requirements. In addition, hospitals must meet fifteen core clinical quality measures for stage 1 and sixteen of twenty-nine clinical quality measures for stage 2. Medicare payment adjustments begin October 1, 2014. However, July 1, 2014, is the latest date for an eligible hospital to meet the ninety-day reporting period for first-time stage 1 meaningful-use attestation to avoid payment adjustments. Critical access hospitals may report within the same fiscal year as the payment-adjusted year to avoid adjustments. Once a hospital reports achieving stage 1 meaningful use, it must continue to attest that achievement in each subsequent year (or in 2013, if it first attested in 2011) to continue to avoid payment adjustments. For more information, see Centers for Medicare and Medicaid Services. Payment adjustments and hardship exceptions tipsheet for eligible hospitals and CAHs [Internet]. Baltimore (MD): CMS; [last updated 2012 Aug; cited 2013 Jun 11]. Available from: http://www.cms .gov/Regulations-and-Guidance/ Legislation/EHRIncentive Programs/Downloads/PaymentAdj_ HardshipExcepTipsheetforHospitals .pdf

5 DesRoches CM, Worzala C, Joshi MS, Kralovec PD, Jha AK. Small, non-teaching, and rural hospitals continue to be slow in adopting electronic health record systems. Health Aff (Millwood). 2012;31(5): 1092–9.

6 Jha AK, Burke MF, DesRoches CM, Joshi MF, Karlovec PD, Campbell EG, et al. Progress toward meaningful use: hospitals' adoption of electronic health records. Am J Manag Care. 2011;17:117–24.

7 DesRoches CM, Jha AK, Painter M, eds. Health information technology in the United States: moving toward meaningful use, 2010. Princeton (NJ): Robert Wood Johnson Foundation; 2010.

8 Jha AK, DesRoches CM, Karlovec PD, Joshi MF. A progress report on electronic health records in U.S. hospitals. Health Aff (Millwood). 2010;29:1951–7.

9 Jha AK, DesRoches CM, Campbell EG, Donelan K, Rao SR, Ferris TG, et al. Use of electronic health records in US hospitals. N Engl J Med. 2009; 360:1628–38.

10 DesRoches CM, Painter M, Jha AK, eds. Health information technology in the United States: driving towards delivery system reform. Princeton (NJ): Robert Wood Johnson Foundation; 2012.

11 To access the Appendix, click on the Appendix link in the box to the right of the article online.

12 Office of the National Coordinator for Health Information Technology. Unpublished analysis of payments to hospitals for attestation data from the Medicare and Medicaid EHR incentive program.

13 Beginning in fiscal year 2011, hospitals attesting to meeting stage 1 meaningful-use criteria had to demonstrate their achievement of meaningful use through the web-based Medicare and Medicaid EHR Incentive Program Registration and Attestation System. In this system providers fill in numerators and denominators for the meaningful-use objectives and clinical quality measures, indicate if they qualify for exemptions from specific objectives, and legally attest that they have successfully demonstrated meaningful use. Once providers complete a successful online submission through the system, they qualify for a Medicare EHR incentive payment.

14 Berwick DM. Launching accountable care organizations—the proposed rule for the Medicare Shared Savings Program. N Engl J Med. 2011; 364(16):e32.

15 Hsaio CJ, Hing E, Socey TC, Cai B. Electronic medical record/electronic health record systems of office-based physicians: United States, 2009 and preliminary 2010 state estimates [Internet]. Atlanta (GA): Centers for Disease Control and Prevention; 2010 Dec [cited 2013 Jun 11]. Available from: http://www.cdc.gov/ nchs/data/hestat/emr_ehr_09/ emr_ehr_09.htm

16 Rosko MD, Mutter RL. Inefficiency differences between critical access hospitals and prospectively paid rural hospitals. J Health Polit Policy Law. 2010;35(1):95–126.

17 Jha AK, Burke MF, DesRoches CM, Joshi MS, Kralovec PD, Campbell EG, et al. Progress toward meaningful use: hospitals' adoption of electronic health records. Am J Manag Care. 2011;17(12 Spec No): SP117–24.

18 Adler-Milstein J, Bates DW, Jha AK. A survey of health information exchange organizations in the United States: implications for meaningful use. Ann Intern Med. 2011;154(10): 666–71.

19 Adler-Milstein J, DesRoches CM, Jha AK. Health information exchange among US hospitals. Am J Manag Care. 2011;17(11):761–8.

20 Severson K. Digital age is slow to arrive in rural America. New York Times. 2011 Feb 18.

21 Williams C, Mostashari F, Mertz K, Hogin E, Atwal P. From the Office of the National Coordinator: the strategy for advancing the exchange of health information. Health Aff (Millwood). 2012;31(3):527–36.

22 Association of State and Territorial Health Officials. ASTHO meaningful use readiness survey [Internet]. Arlington (VA): ASTHO; 2011 [cited 2013 Jun 11]. Available from: http:// www.astho.org/display/assetdisplay .aspx?id=5567

23 Lenert L, Sundwall DN. Public health surveillance and meaningful use regulations: a crisis of opportunity. Am J Public Health. 2012;102(3): e1–7.

24 Association of State and Territorial Health Officers. Public health meaningful use—position statement [Internet]. Arlington (VA): ASTHO; [cited 2013 Jun 11]. Available from: http://www.astho.org/Policy-and-Position-Statements/Position-Statement-on-Meaningful-Use/