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Electronic Health Record Adoption In US Hospitals: Progress Continues, But Challenges Persist

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ABSTRACT **Achieving nationwide adoption of electronic health records (EHRs) remains an important policy priority. While EHR adoption has increased steadily since 2010, it is unclear how providers that have not yet adopted will fare now that federal incentives have converted to penalties. We used 2008–14 national data, which includes the most recently available, to examine hospital EHR trends. We found large gains in adoption, with 75 percent of US hospitals now having adopted at least a basic EHR system—up from 59 percent in 2013. However, small and rural hospitals continue to lag behind. Among hospitals without a basic EHR system, the function most often not yet adopted (in 61 percent of hospitals) was physician notes. We also saw large increases in the ability to meet core stage 2 meaningful-use criteria (40.5 percent of hospitals, up from 5.8 percent in 2013); much of this progress resulted from increased ability to meet criteria related to exchange of health information with patients and with other physicians during care transitions. Finally, hospitals most often reported up-front and ongoing costs, physician cooperation, and complexity of meeting meaningful-use criteria as challenges. Our findings suggest that nationwide hospital EHR adoption is in reach but will require attention to small and rural hospitals and strategies to address financial challenges, particularly now that penalties for lack of adoption have begun.**

For the past four years, US hospitals have been eligible for financial incentives through Medicare and Medicaid for adopting and using electronic health records (EHRs) in concordance with federal meaningful-use criteria. In 2015, hospitals participating in the Medicare portion of the EHR Incentive Program faced financial penalties for not meeting the requirements.[1] This "carrot-and-stick" approach was designed to address the biggest barrier inhibiting EHR adoption—substantial financial cost[2]—with the hope that with nationwide adoption and use, gains would be seen in the quality and efficiency of care delivered.[3] Since the onset of these incentives, hospital EHR adoption rates have increased substantially,[4–8] crossing above 50 percent for the first time in 2013.[4]

While achieving EHR adoption among a majority of hospitals is an important milestone, it is critically important to reach close to nationwide adoption of these systems to gain the network benefits of EHR adoption. However, with the "early majority" having adopted, the remaining hospitals may be those with the biggest challenges and, therefore, least likely to join in. This potential leveling off of adoption, if real, would hinder the goals of a true nationwide health information infrastructure. Therefore, there is a drive to continue to closely monitor EHR adop-

tion and make policy changes as needed. Small and rural hospitals, with persistently lower adoption rates, are key groups to monitor.[4]

Furthermore, the success of the federal policy effort depends on the extent to which hospitals are able to use their EHRs to meet meaningful-use criteria, and 2014 was the first year in which hospitals began attesting to the second stage of meaningful use. Stage 2 meaningful use goes beyond basic capture of structured data and focuses on more advanced uses of EHRs.[9] Data from 2013 suggest that 94.2 percent of hospitals were not ready to meet stage 2 objectives and that the subset of criteria related to electronic health information exchange with patients and other providers was often the limiting factor.[4] Not all hospitals were required to attest to stage 2 in 2014, but most needed to do so in 2015. It is therefore critical to assess progress in these areas and identify barriers faced by those attempting to advance through the stages of the meaningful-use program.

In this study we used data from the 2008–14 American Hospital Association (AHA) Annual Survey of Hospitals–IT Supplement to report on the state of EHR adoption across US hospitals, focusing on national trends, stage 2 meaningful-use readiness, and the challenges hospitals report in implementing EHRs that meet the federal requirements for meaningful use. Specifically, we assessed the proportion of US general acute care hospitals that have adopted at least a basic EHR system and whether the rate of adoption varies among different types of hospitals. We were particularly interested in tracking small and rural hospitals, which have persistently lagged in their adoption rates, as well as hospitals that disproportionally care for vulnerable populations, to look for signs of an emerging digital divide. Next, for hospitals that had not yet adopted at least a basic EHR system, we assessed how close they were and whether particular EHR functions appeared to be holding them back. Finally, we assessed the proportion of hospitals that can meet stage 2 meaningful-use criteria and compared challenges reported by those that could and could not meet the criteria.

Study Data And Methods

SURVEY We used data from the AHA Annual Survey–IT Supplement for information technology adoption from 2008 to 2014. The survey is sent to the CEO of every US hospital, who is asked to complete it or delegate completion to the most knowledgeable person in the organization. All nonrespondents receive multiple mailings and follow-up phone calls to achieve a high response rate. The most recent survey was sent to 6,377 hospitals between November 2014 and February 2015. Hospitals could complete the survey online or by mail. Survey questions capture information about the extent of adoption of individual computerized clinical functions, the ability to meet individual stage 1 and stage 2 meaningful-use criteria, and whether or not hospitals experienced any of nine primary challenges to implementing an EHR system that meets the federal requirements for meaningful use. (Online Appendix Exhibit 1 includes the text of the survey question regarding the primary challenges.)[10]

MEASURES

▶ **ELECTRONIC HEALTH RECORD ADOPTION:** EHR adoption was evaluated using prior definitions of computerized functions required for *basic* and *comprehensive* EHR systems.[2] A hospital with at least a basic EHR system reported full implementation of the following ten computerized functions in at least one clinical unit of the hospital: patient demographics, physician notes, nursing assessments, patient problem lists, patient medication lists, discharge summaries, laboratory reports, radiologic reports, diagnostic test results, and order entry for medications. A hospital with a comprehensive EHR system reported that all basic functions, along with fourteen additional functions, were fully implemented in all major clinical units.

▶ **STAGE 2 MEANINGFUL USE:** Stage 2 meaningful use includes sixteen core objectives; the survey asked hospitals whether or not they were able to meet each of them. We identified hospitals able to meet all sixteen core objectives (Appendix Exhibit 2).[10] The regulations also require that hospitals meet three of six menu objectives, which we did not examine.

▶ **HOSPITAL CHARACTERISTICS:** We used the AHA annual survey to capture key hospital characteristics, including size (fewer than 100 beds, 100–399 beds, 400 or more beds), teaching status, ownership, region, and urban or rural location. To assess safety-net status, we used two proxy measures. First, we examined critical access hospitals, which have twenty-five beds or fewer and provide the majority of care in rural and remote areas, especially in areas where poverty is high or access to care is limited. Second, we used the Medicare disproportionate-share hospital (DSH) index, which is based on the fraction of a hospital's elderly Medicare patients who are also eligible for Supplemental Security Income and the fraction of a hospital's nonelderly patients with Medicaid coverage. This formula is used by the Centers for Medicare and Medicaid Services (CMS) to identify hospitals eligible for additional Medicare payments for caring for the poor. We used the 2013 Impact File

compiled by CMS to obtain each hospital's DSH index and categorized hospitals by quartile. A DSH index was not available for 28 percent of hospitals in our sample. We segmented the remaining hospitals into quartiles, with hospitals in the top quartile representing those with the highest DSH index.

ANALYSIS Of the 3,307 hospitals that responded to the survey, we limited our sample to the 3,277 that had also responded to the 2013 AHA annual survey (which captures a broad set of data on hospital characteristics) and then further limited our sample to the 2,640 nonfederal, general medical and surgical, acute care hospitals in the fifty states and the District of Columbia. This represented a 60 percent response rate (2,640 of 4,387 nonfederal, general acute care hospitals). We compared the characteristics of hospitals that responded to the 2014 IT Supplement to those that responded to the AHA annual survey but did not respond to the 2014 IT Supplement, and we found small but statistically significant differences (Appendix Exhibit 3).[10] We used a regression model that predicts the likelihood of responding to the survey based on size, ownership, teaching status, system affiliated, region, urban or rural location, and critical access status as the basis for developing weights to adjust for nonresponse bias.

We calculated the weighted proportion of hospitals that had adopted at least a basic EHR system or a comprehensive EHR system in 2014 and then compared those numbers to the weighted proportions reported in 2008–13[2,4–8] to examine trends over time. We next compared 2014 EHR adoption status—comprehensive, at least basic, or less than basic—across key hospital characteristics, including the two measures of safety-net status. To account for nonresponse bias, we reported weighted percentages and assessed differences across groups using Rao-Scott chi-square tests. We used a multivariate logistic regression to examine the independent relationship between each hospital characteristic and the odds of having adopted at least a basic EHR system. In addition, among hospitals that had not yet adopted at least a basic EHR system, we assessed the proportion of hospitals that had not yet adopted each function that constitutes a basic EHR system. We also calculated the median number of basic EHR functions adopted.

Next, we calculated the weighted proportion of hospitals that could meet each of the sixteen stage 2 meaningful-use core objectives, as well as the proportion of hospitals that could meet all sixteen objectives. We compared these proportions to those reported in 2013[4] (that is, a comparison of two cross-sections). We also compared ability to meet all stage 2 meaningful-use core objectives across key hospital characteristics. Finally, we compared the proportion of hospitals reporting that they encountered each of the nine EHR adoption challenges included on the IT Supplement, stratified by stage 2 meaningful-use readiness as well as by hospital size.

LIMITATIONS Our study had several limitations. Although the overall response rate of 60 percent was high for a national institutional survey, nonresponders may have been different from responders. We used statistical techniques described above to account for this potential bias; however, these adjustments are not perfect.

A second limitation was that our proxy measure of ability to meet stage 2 meaningful-use core objectives may not have resulted in the precise number of hospitals that attested to achieving it. This was likely a result of both the regulations involved in the program—the fact that the survey asks about capability, whereas attesting to meaningful use requires actual use of the capabilities—and the inherent measurement error in survey research.

Furthermore, we only examined whether hospitals had core meaningful-use functions, and we did not require hospitals to meet the menu criteria, which may overestimate the ability of US hospitals to meet stage 2 meaningful use. However, our estimate closely tracks the CMS-reported proportion of hospitals that have attested to meeting stage 2 criteria.[11]

Study Results

ADOPTION We found that 75.2 percent of hospitals had adopted at least a basic EHR system in 2014—up from 58.9 percent in 2013 (Exhibit 1). This increase reflects a continuation of the annual double-digit percentage-point gains since 2010. Between 2013 and 2014, basic EHR adoption rates increased from 33.4 percent to 41.1 percent, and comprehensive EHR adoption rates increased from 25.5 percent to 34.1 percent.

ADOPTION BY HOSPITAL TYPE Levels of basic and comprehensive EHR adoption varied by size, teaching status, ownership, and location (Exhibit 2). Large hospitals were more likely to have a comprehensive EHR system, and medium-size hospitals were more likely to have a basic EHR system, compared to small hospitals ($p < 0.001$ across size categories). Major teaching hospitals were more likely to have a comprehensive EHR system compared to minor and nonteaching hospitals. Similarly, not-for-profit hospitals were more likely to have such a system ($p < 0.001$) compared to for-profit and public hospitals. Finally, urban hospitals were more likely to have such a system ($p < 0.001$) compared to rural hospitals (Exhibit 2).

Our results varied between the two safety-net proxy measures. Thirty-two percent of critical access hospitals had not yet adopted at least a basic EHR system, compared to 21.9 percent of non–critical access hospitals. Critical access hospitals were less likely to meet the criteria for a comprehensive EHR system (p value across categories of EHR adoption less than 0.001) (Exhibit 2). However, when we examined the rates of EHR adoption by DSH index, we found no differences for either comprehensive or basic EHR system adoption levels (Exhibit 2).

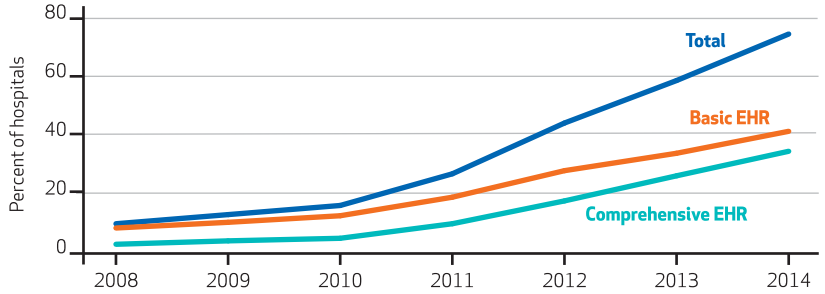
In multivariate regression, hospital size was an independent predictor of at least basic EHR adoption (compared to small non–critical access hospitals; medium-size and large hospitals had odds ratios of 1.41 and 1.72, respectively; $p = 0.014$) (Appendix Exhibit 4).[10] While teaching status was not associated with EHR adoption, ownership was, with a lower likelihood of adoption among public (OR = 0.82) and for-profit (OR = 0.60) hospitals compared to not-for-profit hospitals ($p = 0.003$ across categories). Hospitals in rural areas were less likely than those in urban areas to have adopted (OR = 0.67; $p = 0.005$). We did not observe any differences in the likelihood of EHR adoption by critical access status or DSH quartile.

FUNCTIONS NOT YET ADOPTED AMONG HOSPITALS WITH LESS THAN BASIC EHR Among the 24.8 percent of hospitals that had not yet adopted at least a basic EHR system, the majority were close. The median number of basic EHR functions adopted was nine of ten, and 75 percent of this group had eight or more basic EHR functions in place. Physician notes was the EHR function that was most often missing (for 61 percent of hospitals without at least a basic EHR) (Exhibit 3). This was followed by ability to view diagnostic test results (38 percent) and discharge summaries (26 percent).

READINESS FOR STAGE 2 MEANINGFUL USE We found that 40.5 percent of hospitals met our proxy measure of stage 2 meaningful-use readiness in 2014 (the ability to meet all sixteen core objectives). This is close to a sevenfold increase from the prior year (Exhibit 4) but still a minority of all hospitals. For most stage 2 core objectives, the vast majority of hospitals reported currently being able to meet some of the objectives. In 2014 the smallest proportion of hospitals were able to meet the objective to provide patients with the ability to view, download, and transmit information about a hospital admission (64.3 percent) and to provide a summary-of-care record for each transition (74.4 percent). While these objectives were at the bottom of the list in 2013, the one-year increases were large. In 2013 only 10.4 percent of hospitals were able to meet the view, download, or transmit objective, and 42.4 percent were able to meet the summary-of-care record objective (increases of 53.9 and 32.2 percentage points, respectively).

EXHIBIT 1

Electronic Health Record (EHR) Adoption Trends In US Hospitals, 2008–14



SOURCE Authors' analysis of American Hospital Association Annual Survey–IT Supplement data, 2008–14.

The same types of hospitals that were farther ahead in EHR adoption were more likely to have met the stage 2 proxy measure (large, teaching, not-for-profit, urban) (Appendix Exhibit 5).[10] For both safety-net measures, safety-net hospitals were less likely to have met the stage 2 readiness measure (28.9 percent for critical access hospitals, compared to 45.1 percent for non–critical access hospitals; 39.4 percent for highest DSH quartile, compared to 47.5 percent for lowest DSH quartile) (Appendix Exhibit 5).[10] Multivariate regression results are presented in Appendix Exhibit 6.[10]

CHALLENGES BY STAGE 2 MEANINGFUL-USE READINESS Despite substantial progress in EHR adoption and ability to meet core stage 2 meaningful-use criteria, many hospitals still reported ongoing challenges. Overall, more than half of hospitals reported challenges related to financial costs (up front and ongoing), obtaining physician cooperation, and complexity of meeting meaningful-use criteria in the required time frame (Exhibit 5). We found large differences in overall EHR challenges between hospitals that were ready for stage 2 meaningful use and those that were not. Hospitals not yet able to meet all stage 2 core objectives were more likely to report up-front and ongoing costs as challenges compared to hospitals able to meet all core objectives (56.7 percent compared to 45.9 percent for up-front costs, and 65.2 percent compared to 56.3 percent for ongoing costs, $p < 0.001$ for both). They were also more likely to report challenges finding adequate IT support compared to hospitals able to meet all core objectives (43.4 percent compared to 38.5 percent, $p = 0.014$). However, hospitals able to meet all stage 2 core objectives were more likely than

EXHIBIT 2

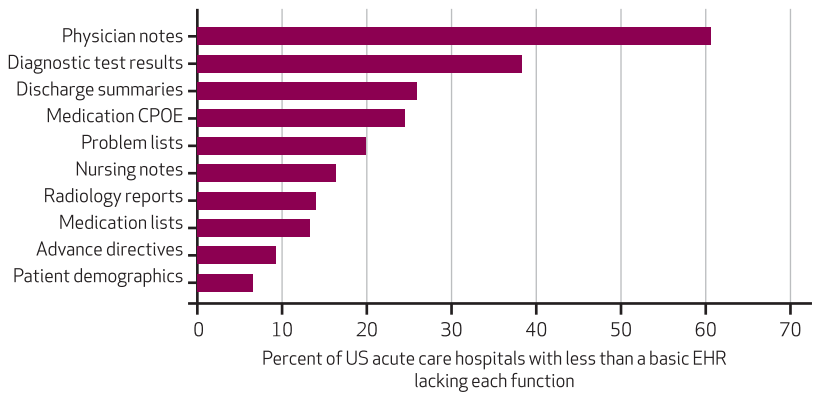
Percentage Of Hospitals Adopting Comprehensive, Basic, Or Less Than Basic Electronic Health Record (EHR) Systems, By Key Hospital Characteristics, 2014

Hospital characteristic	Comprehensive EHR	Basic EHR	Less than basic EHR
All	34.1%	41.1%	24.8%
Bed size****			
Small	28.9	40.8	30.3
Medium	36.5	42.9	20.6
Large	49.9	35.3	14.7
Teaching status****			
Major	56.7	30.5	12.7
Minor	38.9	39.8	21.3
Nonteaching	31.1	42.3	26.7
Ownership****			
For profit	22.7	48.7	28.7
Not for profit	40.6	37.2	22.2
Public	24.2	46.7	29.2
Location****			
Urban	37.6	40.8	21.6
Rural	24.1	42.0	33.9
Region***			
Northeast	28.0	45.7	26.4
Midwest	38.6	36.1	25.3
South	33.4	43.3	23.2
West	32.6	41.6	25.9
Critical access status****			
Yes	27.0	41.0	32.0
No	37.0	41.1	21.9
Disproportionate-share hospital quartile			
1 (lowest)	37.0	41.1	21.8
2	39.5	40.5	20.0
3	35.2	43.7	21.2
4 (highest)	35.1	41.2	23.7

SOURCE Authors' analysis of American Hospital Association Annual Survey–IT Supplement data, 2014. **NOTES** $N = 2,640$. Results are weighted so that they are nationally representative. Omnibus p values were calculated using Rao-Scott chi-square tests. ***$p < 0.01$ ****$p < 0.001$

EXHIBIT 3

Prevalence Of Functions Not Yet Adopted Among Hospitals With Less Than A Basic Electronic Health Record (EHR) System



SOURCE Authors' analysis of American Hospital Association Annual Survey–IT Supplement data, 2014. **NOTE** CPOE is computerized provider order entry.

hospitals that were not to report physician cooperation as a challenge (65.3 percent compared to 57.1 percent, $p < 0.001$) (Exhibit 5).

We also examined challenges by hospital size. For all challenges (except vendor capacity and uncertainty about certification, in which there were no differences by hospital size), small hospitals were more likely to report facing challenges (Appendix Exhibit 7).[10]

Discussion

In the most recent data on EHR adoption and meaningful use in US hospitals, we found another year of substantial progress. This likely reflects a combination of the availability of financial incentives for the past four years and the impending penalties, at least from the Medicare part of the meaningful-use program. Our findings suggest that close to 100 percent hospital adoption of basic EHRs is possible in the near future, particularly if hospitals receive help with the transition to physician notes. However, given that physician resistance continues to be cited as a challenge, it will be important to identify ways to ease the conversion to electronic documentation in parallel with other changes required to meet stage 2 meaningful-use criteria.

Encouragingly, our findings suggest that hospitals are able to make substantial progress from year to year, and particularly notable is progress in hospitals' ability to meet stage 2 objectives. Hospitals undoubtedly invested a lot of time and energy in the criteria that require health information exchange: the summary care record for each transition objective (provider-to-provider exchange) as well as the patient's ability to view, download, and transmit objective (provider-to-patient exchange). However, this is counterbalanced by our finding that the majority of hospitals might not be ready to meet the stage 2 core objectives when required to do so. Moreover, hospitals that are not yet ready to meet the criteria were more likely to report facing challenges. Of particular note is the financial challenges, which are likely to be worsened because hospitals that are not successful in meeting stage 2 objectives when required to do so will face financial penalties. The reductions in Medicare reimbursement for those that do not meet meaningful-use objectives are 1.2 percent for 2016.[12] More broadly, our data point to the need to consider strategies that address ongoing financial challenges related to EHRs that hospitals face, despite the incentives that have been available.

The complexity of meeting meaningful-use objectives was also a frequently reported challenge. While CMS recently proposed policy changes to simplify stage 2 meaningful use,[13] there have

EXHIBIT 4

Percentage Of Hospitals Able To Meet Stage 2 Meaningful-Use Core Objectives, 2013 And 2014

Objective	Able to meet (%) 2013	2014	2013–14 percentage-point increase
Patient ability to view, download, and transmit	10.4	64.3	53.9
Summary care record for each transition	42.2	74.4	32.2
Electronic syndromic surveillance data	63.6	79.2	15.6
Electronic reportable lab results	63.9	82.4	18.5
Clinical decision support	72.8	90.2	17.4
Electronic data to immunization registries	73.5	87.9	14.4
CPOE for medication, lab, and radiology orders	84.3	93.1	8.8
Perform medication reconciliation	89.5	91.6	2.1
All stage 2 core objectives	5.8	40.5	34.7

SOURCE Authors' analysis of American Hospital Association (AHA) Annual Survey–IT Supplement data, 2013–14. **NOTES** Limited to core criteria in the AHA IT Supplement that were less than 90 percent adopted in 2013. See Appendix Exhibit 8 for a full list (see Note 10 in text). "All stage 2 core objectives" does not include "protect electronic health information" in 2013 because this could not be assessed; in 2014 the proportion of hospitals that could meet this requirement was 94 percent. CPOE is computerized provider order entry.

been calls to further simplify the program and to remove the "all or nothing" nature of the requirements and modify requirements that hold providers accountable for the actions of others. Providers and policy makers have also called for a delay in establishing rules for stage 3 meaningful use until more providers have experience with stage 2.[14] Responding to these calls and continuing to work toward streamlined regulations could free up resources to focus on complementary priorities, such as making the transition from volume- to value-based payment.

Finally, our results suggest a renewed focus on small hospitals that are lagging behind in both EHR adoption and ability to meet stage 2 meaningful-use criteria. The EHR adoption gap is persistent: Since 2008 there has been more than a 10-percentage-point gap between small and large hospitals in adoption of at least a basic EHR system.[2] Lower meaningful-use readiness among these hospitals may reflect disproportionate participation of small hospitals in the Medicaid meaningful-use program, which has a more flexible attestation timeline. However, for small hospitals participating in the Medicare meaningful-use program, the inability to keep up with attestation deadlines in the penalty phase could create even greater challenges for resource-constrained hospitals by reducing payments. Policy makers should consider additional tools

EXHIBIT 5

Key Challenges For Hospitals Not Able To Meet And Hospitals Able To Meet Stage 2 Meaningful-Use Core Objectives, 2014

Challenge	Not able to meet (n = 1,544)	Able to meet (n = 1,096)	Percentage-point difference
Up-front capital costs****	56.7%	45.9%	10.8
Ongoing costs****	65.2	56.3	8.9
Obtaining physician cooperation****	57.1	65.3	–8.2
Lack of adequate information technology support**	43.4	38.5	4.9
Obtaining staff cooperation	27.2	29.6	–2.4
Vendor capacity	23.4	24.8	–1.4
Complexity of meeting meaningful use within specified time frame	57.1	58.1	–1.0
Security concerns	26.1	26.0	0.1
Uncertainty about certification	19.1	19.2	–0.1

SOURCE Authors' analysis of American Hospital Association Annual Survey–IT Supplement data, 2014. **NOTE** Unweighted sample sizes reported in the table; weighted sample sizes are 2,609 for non–meaningful use and 1,774 for meaningful use. **$p < 0.05$ ****$p < 0.001$

to support these hospitals. For example, prior work suggests that EHR adoption in critical access hospitals has been spurred by outside technical assistance as well as system ownership and group purchasing arrangements.[15] Building on this work, a closer look at whether there are systematic differences in the capabilities and resources available to small facilities may point to the existence of specific meaningful-use criteria that are less feasible for them to achieve. Discussions of when and how to raise the bar in stage 3 would benefit from an understanding of how small hospitals will fare.

Conclusion

The latest national hospital EHR adoption trends reflect both substantial progress and areas of concern. Today, more than three-quarters of US hospitals have at least a basic EHR system, and early participants in the meaningful-use program are making substantial gains in ability to meet stage 2 meaningful-use criteria. However, our data reveal specific domains in which hospitals are struggling—with implementing physician notes, with physician resistance, with complexity of meeting meaningful-use criteria, and with controlling both up-front and ongoing costs associated with EHR adoption. Policy strategies that target these issues will disproportionately benefit small and rural hospitals, which continue to lag behind. With such strategies in place, nationwide hospital EHR adoption could be achieved in the near future, enabling the US health care system to use EHRs to improve performance. ■

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

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