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Forecasting the Use of Electronic Health Records: An Expert Opinion Approach

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Background: To promote the widespread adoption and use of electronic health records (EHRs), in 2011, CMS started making Medicare and Medicaid incentive payments to providers who demonstrate that they are "meaningful users" of certified EHR systems.
Data and Methods: This paper combines an expert opinion method, a modified Delphi technique, with a technological diffusion framework to create a forecast of the percent of office-based physicians who will become adopters and "meaningful users" of health information technology from 2012 to 2019. The panel consisted of 18 experts from industry, academia, and government who are knowledgeable about the adoption and use of EHRs in office-based settings and are recognized as opinion leaders in their respective professions.
Results: Overall, the expert panel projected that primary care physicians in large group practices are more likely to achieve the meaningful use of EHRs relative to primary care physicians in small group practices and all other specialists: the group projected that 65 percent of primary care physicians in large group practices, 45 percent of primary care physicians in small group practices, and 44 percent of all other specialists could achieve meaningful use by 2015. In 2019, these projections increase to 80 percent, 65 percent, and 66 percent for these three groups, respectively.
Conclusions and Policy Implications: The information from this study is especially valuable when there is a lack of data and a high degree of uncertainty in a new policy environment and could help inform and evaluate government programs, such as the Regional Extension Centers (REC), by providing data from leading experts.

Keywords: Health Policy / Politics / Law / Regulation, Incentives in Health Care, Information Technology, Primary Care, Program Evaluation, Qualitative Research, Technology Adoption / Diffusion / Use, Medicare Medicaid

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Introduction

The widespread adoption of health information technology has the potential to improve efficiency and quality in the health care system (Chaudhry et al., 2006; Goldzweig, Towfigh, Maglione, & Shekelle, 2009; CBO, 2008). In 2011, the Centers for Medicare & Medicaid Services (CMS) started making Medicare and Medicaid incentive payments to providers who demonstrate that they are "meaningful users" of certified electronic health record (EHR) systems. As part of the Health Information Technology for Economic and Clinical Health Act (HITECH), the stage 1 meaningful use regulation created a core set of 15 objectives and a menu set of 10 objectives from which providers can choose 5 to implement during 2011 and 2012 with an extension to 2013 (Blumenthal & Tavenner, 2010). Final stage 2 meaningful use criteria were released in September 2012 and begin in 2014, and the proposed Stage 3 meaningful use criteria were released for public comment in November 2012 and begin in 2016. These criteria were selected to ensure that physicians and hospitals use health information technology (IT) in meaningful ways that can improve the quality and efficiency of health care delivery.

In this context, accurate forecasts of EHR adoption and meaningful use are needed to guide the implementation of the incentive programs, plan for further rulemaking, and evaluate existing efforts. This paper combines an expert opinion method [a modified Delphi technique called estimate, feedback, talk, estimate (EFTE)], with a technological diffusion framework to create a forecast of the percent of office-based physicians who will become adopters and "meaningful users" of health information technology.

This analysis focuses on EHR adoption and meaningful use projections from 2012 to 2019 among three physician subgroups: Primary care physicians in small group practices (defined by having 10 or fewer physicians in the practice), primary care physicians in larger group practices, and all other physicians in medical or surgical specialties.[1] This breakdown is important, because primary care physicians differ from other specialists (e.g., they are more likely to be in solo and small practices) and because specific government policies exist to boost EHR adoption among primary care physicians in small group practices. While the majority of primary care physicians in the U.S. are in small practices, only 15% of this group had at least a basic EHR system in 2008, compared to 48% of primary care physicians in larger group practices.[2]

Literature Review

This paper contributes to the existing literature by being the first study to use an expert panel approach to forecast the use of EHRs. Several researchers have developed and analyzed surveys to assess EHR adoption rates among physician practices (DesRoches et al., 2008; Menachemi, Ford, Beitsch, & Brooks, 2007; Jha et al., 2006). At the time of the study in December 2010, the

[1]Projections for 2011 were collected but not reported here since actual data are now available. However, they are available upon request.
[2]Author's tabulation of the 2008 National Ambulatory Medical Care Survey.

most recent estimates from the National Ambulatory Medical Care Survey (NAMCS) indicate that 24.9% of office-based physicians had at least a basic EHR system. The definition of a basic EHR was created through an expert panel process as reported by DesRoches et al. in 2008. Systems defined as basic include the following functionalities: patient demographic information, patient problem lists, clinical notes, orders for prescriptions, viewing laboratory results, and viewing imaging results.

Prior studies have also generated varied forecasts of EHR adoption due to differences in modeling approaches, data, and assumptions. Ford, Menachemi, Peterson, and Huerta (2009) used a technology diffusion model (Bass model) and data from a meta-analysis of 13 studies conducted between 2001 and 2008 to predict that 47% of physicians working in small practices will have implemented an EHR by 2014 (Ford et al., 2009). In contrast, the Congressional Budget Office (CBO) predicted that the incentive payments under HITECH will result in physician adoption rates of 85% in 2014 and 90% in 2019, compared to only 40% and 65% in 2014 and 2019 under prior law (CBO, 2009). CMS used a similar approach in the regulatory impact analysis of HITECH, and produced both a low and high estimate of the percent of professionals who were eligible for Medicare and Medicaid incentive payments that achieved meaningful use (Federal Register, 2010). Older models from Girosi, Meili, and Scoville (2005) and Hillestad et al. (2005) generated adoption curves using various assumptions and simulation techniques. They simulated the effects of a 50% subsidy that began in 2006 and lasted three years, and assumed that the demand for EHRs had a constant price elasticity of -0.5. Overall, they found this type of subsidy will have a modest impact on EHR adoption rates among physicians, but the results vary depending on the assumptions used.

Methods

As an alternative to simulation models, this analysis relies on a modified version of the Delphi technique known as the EFTE framework. The Delphi technique was originally used by the RAND Corporation as a technologic forecasting process used to overcome the undesirable effects of group interaction (e.g., group pressure and effects), while retaining the positive aspects of interacting group judgments (e.g., consensus via feedback and iteration; Dalkey & Helmer, 1963). As a public policy tool, the Delphi technique attempts to make effective use of informed intuitive judgment. It derives its importance from "the realization that projections into the future, on which public policy decisions must rely, are largely based on the personal expectations of individuals rather than on predictions derived from a well-established theory" (Helmer, 1967). Modified Delphi methods have been used to systematically collect information and elicit consensus forecasts in several areas, including gathering data not accurately known or available, evaluating possible budget allocations, exploring urban and regional planning options, planning university campus and curriculum development, putting together an educational model, delineating the pros and cons associated with potential policy options, and exploring priorities

of social goals (Linstone & Turoff, 1975). As discussed by Skutsch and Hall (1973), one of the major strengths of these methods is to gain judgments on complex matters where precise information is unavailable. As such, this method is ideal for addressing the question of how many physicians and hospitals will adopt EHRs, where there is great uncertainty about how physicians and hospitals will respond to incentive payments, government outreach efforts, and technological innovation in the field. In addition, given the current lack of precise data on costs and benefits needed to estimate elasticities and generate accurate forecasts, Delphi techniques are likely to be more accurate than methods grounded in economic or statistical theory. Yousuf (2007) provides a more comprehensive discussion of the pros and cons of Delphi techniques.

The EFTE framework, a modified Delphi technique developed by Nelms and Porter (1985) in the context of forecasting clerical work technologies, has several advantages. First, it provides protection against group effects. The process does not push for consensus and individual participants provide their forecasts independently and anonymously. Second, the procedure permits face-to-face interaction and open discussion of ideas. The iterative process described below allows participants to receive and provide feedback and refine their original thinking. Finally, the process works quickly (less than two days) and data are immediately obtained. We slightly modified the EFTE method to form the following seven key steps:

Step 1: Select expert participants

The panel consisted of 18 experts: six from the health IT industry, six from the medical community, seven from the research community and academia, and two from government.[3] All of them are knowledgeable about the adoption and use of EHRs in office-based settings and are recognized as opinion leaders in their respective professions.[4] The initial list of potential experts was generated by soliciting suggestions from policymakers and leading academics; the research team categorized the suggestions and extended invitations so as to have a mix of different types of experts. The panel members had diverse backgrounds (medicine, business, health services research, economics, and actuarial science) and were willing to participate in an in-person meeting in the Washington DC metro area on November 8–9, 2010. Overall, 30 experts were initially invited to participate, eight of whom were unable to attend and four of whom did not respond to the initial request. Given the high response rate, non-respondents did not receive a follow-up invitation.

Step 2: Provide participants with key background information to be used in making initial opinion judgments

The authors emailed the participants background information about the purpose of the panel, the structure of the two-day event, background reading related to EHR adoption and ONC programs, and baseline basic and "basic+" adoption data from the NAMCS (Exhibit 1). Systems

[3]Numbers add to more than 18, because some experts fell into more than one of these categories.
[4]Names and specification affiliations are available upon request.

defined as "basic+" include all of the functionalities of basic systems, plus additional functionalities that could be stronger predictors for meaningful use.[5] These additional functionalities are drug interaction/contradiction warnings, prescriptions sent electronically to pharmacies, and orders for tests.

Exhibit 1. Baseline Adoption and Projected Meaningful Use Rates Among Active Office-Based Physicians

	Baseline Adoption			Projected Meaningful Use						
	2008	2009	2010*	2011	2012	2013	2014	2015	....	2019
Large Primary Care (N=43,000 physicians)										
Basic EHR	12.2%	7.6%	10.0%							
Basic + EHR	35.5%	40.3%	45.0%							
Total	47.6%	47.9%	55.0%							
Meaningful Use	0.0%	0.0%	0.0%							
Small Primary Care (N=226,000 physicians)										
Basic	6.0%	5.0%	8.0%							
Basic +	8.6%	9.6%	17.0%							
Total	14.6%	14.6%	25.0%							
Meaningful Use	0.0%	0.0%	0.0%							
All Other Specialties (N=221,000 physicians)										
Basic	7.0%	8.7%	9.0%							
Basic +	8.0%	12.3%	14.0%							
Total	15.0%	21.0%	23.0%							
Meaningful Use	0.0%	0.0%	0.0%							

*2010 adoption numbers are projected by ONC. Official adoption numbers will be released in December.
NOTES.
(1) SOURCE: 2008–2009 National Ambulatory Medical Care Survey (NAMCS) EMR Supplements.
(2) Systems defined as basic include the following functionalities: patient demographic information, patient problem lists, clinical notes, orders for prescriptions, and viewing laboratory and imaging results.
(3) Systems defined as basic+ include all of the functionalities of basic systems plus the following: Drug interaction/contradiction warning, prescriptions sent electronically to pharmacy, and orders for tests.

The NAMCS is widely used to define physician adoption, because of the survey's large sample size, high response rate, and rich information on EHR functionalities. NAMCS, conducted by the Centers for Disease Control and Prevention's National Center for Health Statistics (NCHS), is an annual nationally representative survey of patient visits that includes office-based physicians and collects information on the adoption and use of EHRs. Since 2008, a supplemental mail survey on EHRs has been conducted in addition to the core NAMCS, an in-person survey. In 2010, the mail survey sample size was increased five-fold to allow for state-level estimates, and survey questions were slightly modified to ask physicians about their

[5]These categories are mutually exclusive. Basic adoption rates decline from 2008 to 2009 while "basic+" rates increase. Overall, the share of physicians with at least a basic EHR increases each year.

intentions to apply for meaningful use incentive payments. The unweighted response rate of the combined surveys was 70% in 2009 and 68% in 2010 (Hsiao et al., 2010).

Step 3: Participants fill out the Delphi questionnaire upon their arrival to the meeting (Round 1)

The research team gave a Delphi questionnaire (Exhibit 1) to each participant upon arrival at the hotel conference room. Participants were asked to project meaningful use rates by physician specialty group (primary care physicians in larger practices, primary care physicians in small practices, all other specialty physicians) and year (2012–2015, 2019). Discussion among the participants was prohibited until after the questionnaires were filled out. Questions related to the background information and questionnaire were resolved by the research team

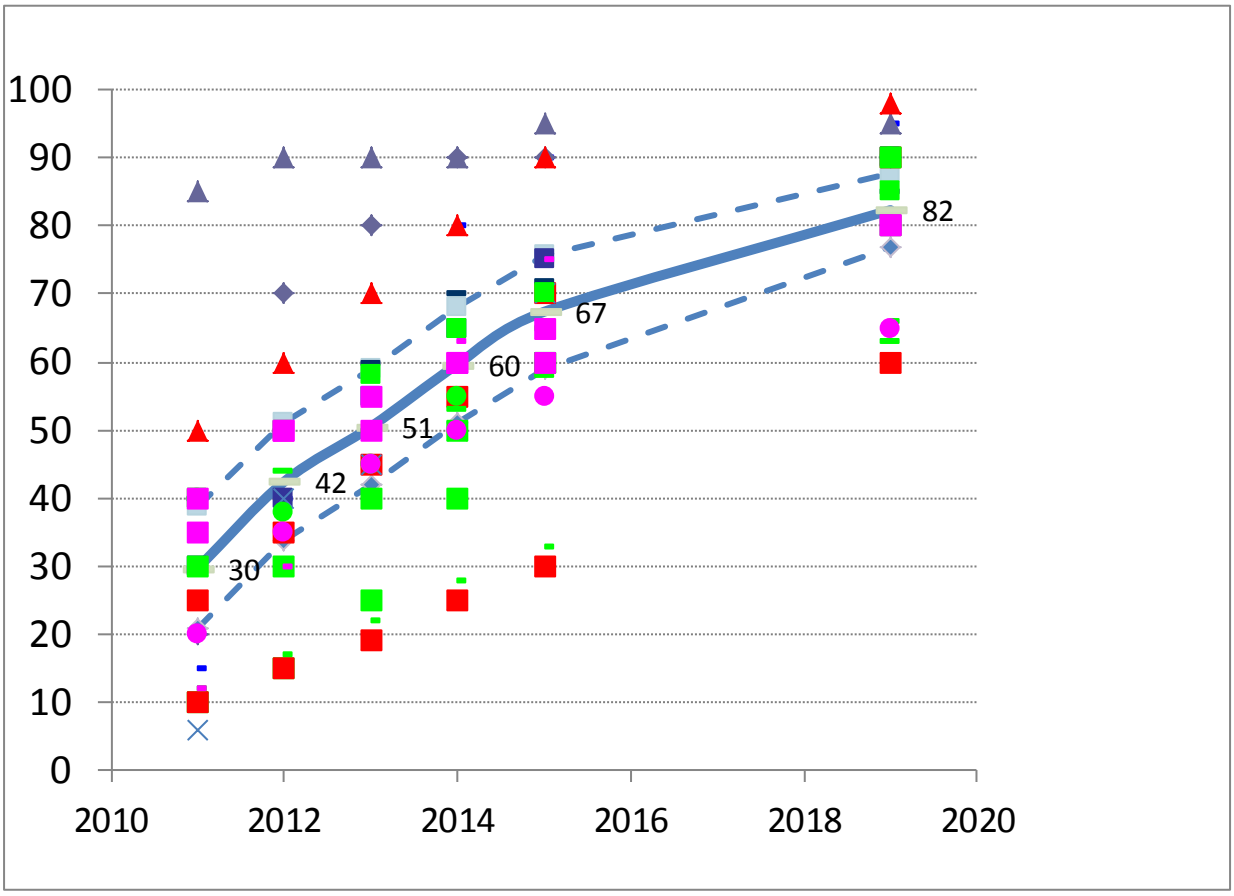
Step 4: Summarize and discuss questionnaire results and key drivers

Afterwards, the research group summarized the results (mean, median, standard deviation, 95% confidence interval, min, and max), analyzed data plots for each specialty group, and displayed the information before the entire group. Each data point was color coded by the expert's background (e.g., academia, government, or industry) in order to maintain the anonymity of each individual's response. However, participants freely discussed the results and the drivers of their projections, and were allowed to talk about their specific estimates if desired. Exhibit 2, the round 1 results for primary care physicians in larger practices, displays the format of the data presented for discussion. The group was also asked to identify the key drivers of their estimates and the barriers to meaningful use for each group of physicians.

Step 5: Summarize and discuss ONC's internal forecasting model

As a modification to the original EFTE method, we presented a series of scenarios, ranging from low to high, of future meaningful use rates based on current levels of provider adoption, differences in physician practice size and specialty group, eligibility for Medicaid or Medicare EHR incentive payments, and level of price responsiveness to incentive payments and financial penalties. We presented baseline adoption estimates from the NAMCS and discussed with the panel the key parameters and assumptions that could potentially alter future meaningful use rates. We then compared these various scenarios with the panel's initial projections. In addition, we created breakout sessions at the beginning of the second day to highlight priority areas and develop ways to improve on the existing scenarios.

Exhibit 2. Round 1 Meaningful Use Panel Projections for Primary Care Physicians in Large Practices



NOTES. Color and shape coded points represent individual panel member responses. The solid line represents the group mean projection and the dashed lines represent the 95 percent confidence interval.
SOURCE: Expert panel projections.

Step 6: Participants fill out the Delphi questionnaire at the end of the conference prior to their departure (Round 2)

We provided the participants with the same questionnaire that they filled out at the beginning of day 1. However, based on the recommendation of the panel, we added a row for "at least basic EHR adoption" for comparison with the meaningful use projections.

Step 7: Perform statistical analysis and and distribute results to panel members. Solicate comments and observations

We analyzed and compared the results from the 1st and 2nd rounds of panel projections. In addition, we summarized and posted the results on an electronic collaborative space for discussion.

Results

The meaningful use and basic adoption (round 2 only) results from the EFTE procedure are shown in Exhibits 3, 4, and 5 for primary care physicians in larger practices, primary care physicians in small practices, and specialty physicians, respectively. Each table contains the mean, standard deviation, and quartile distribution for both rounds of projections. Without exception, for all specialty groups, the mean and median meaningful use projections increase over time and decrease between round 1 and round 2. In addition, the standard deviation also decreases in all but one cell (the only exception being the 2019 estimate for primary care physicians in larger practices) between round 1 and round 2.

Final projections: Primary care physicians in larger practices

Exhibit 3 shows that the panel predicts 35% of primary care physicians in larger practices will achieve meaningful use in 2012 and 65% will achieve meaningful use by the end of 2015, with an average of a 10 percentage point increase in each year between. In the long-run, the panel projects that the vast majority (80%) of this group will achieve meaningful use by 2019. This is the only group where the amount of variation in the meaningful use estimates decreases over time. The panel also predicts that 62% of primary care physicians in larger practices will have at least a basic EHR system in 2012, 79% in 2015, and 90% in 2019.

Final projections: Primary care physicians in small practices

The panel projections for primary care physicians in small practices are substantially lower than the projections for primary care physicians in larger practices (Exhibit 4). This result is consistent with the fact that primary care physicians in small practices have lower baseline EHR adoption rates relative to physicians in larger primary care practices. The panel predicts that 19% of primary physicians in small practices will achieve meaningful use in 2012 and 45% will achieve meaningful use by the end of 2015, with an average of a 9 percentage point increase in each year between. In the long-run, the panel projects that 65% of this group will achieve meaningful use by 2019. The amount of variation in the meaningful use estimates increases over time; however, the coefficient of variation (standard deviation/mean) trends downwards approaching 2019. The panel also predicts that 34% of primary care physicians in small practices will have at least a basic EHR system in 2012, 58% in 2015, and 76% in 2019.

Exhibit 3. Round 1 and Round 2 Panel Projections—Primary Care Physicians in Large Practices

	2012	2013	2014	2015	2019
Round 1 Meaningful Use Projections					
Mean	42	51	60	67	82
Standard Deviation	19	18	18	18	12
Max	90	90	90	95	98
Upper Quartile	50	57	69	75	90
Median	40	50	60	68	85
Lower Quartile	31	45	50	60	80
Min	15	19	25	30	60
Round 2 Meaningful Use Projections					
Mean	35	46	55	65	80
Standard Deviation	12	13	14	14	12
Max	65	75	80	85	90
Upper Quartile	40	50	60	78	90
Median	34	45	56	65	85
Lower Quartile	29	41	50	60	75
Min	12	15	20	40	50
Mean	62	68	73	79	90
Standard Deviation	14	15	15	12	10
Max	70	80	85	92	100
Upper Quartile	70	75	83	85	95
Median	65	70	75	80	90
Lower Quartile	65	70	75	80	90
Min	15	18	22	40	60

NOTE. Large practices have 11 or more physicians.
SOURCE: Expert panel projections, November 2010.

Final projections: Specialty care physicians

The projections for physicians in non-primary care specialties are comparable to the projections for small primary care physicians (Exhibit 5). The panel predicts that 19% of specialists will achieve meaningful use in 2012 and 45% will achieve meaningful use by the end of 2015, with an average of a 9 percentage point increase in each year between. In the long-run, the panel projects that 65% of this group will achieve meaningful use by 2019. The panel also predicts that 33% of specialists will have at least a basic EHR system in 2012, 58% in 2015, and 78% in 2019.

Exhibit 4. Round 1 and Round 2 Panel Projections—Primary Care Physicians in Small Practices

	2012	2013	2014	2015	2019
Round 1 Meaningful Use Projections					
Mean	24	33	43	51	70
Standard Deviation	13	17	19	19	20
Max	50	65	80	85	95
Upper Quartile	35	44	60	67	84
Median	22	30	35	50	73
Lower Quartile	15	20	33	40	54
Min	15	8	15	18	20
Round 2 Meaningful Use Projections					
Mean	19	27	37	45	65
Standard Deviation	9	11	12	14	16
Max	40	50	60	75	90
Upper Quartile	24	33	44	53	74
Median	18	25	35	40	63
Lower Quartile	14	20	31	38	54
Min	6	10	12	20	30
Day 2 Basic EHR Projections					
Mean	34	42	50	58	76
Standard Deviation	14	15	16	16	13
Max	70	75	80	85	95
Upper Quartile	39	50	61	70	85
Median	35	43	49	55	79
Lower Quartile	28	38	45	50	70
Min	8	12	15	30	50

NOTE. Small practices have 10 or fewer physicians.
SOURCE: Expert panel projections, November 2010

Exhibit 5. Round 1 and Round 2 Panel Projections—All Other Specialties

	2012	2013	2014	2015	2019
Round 1 Meaningful Use Projections					
Mean	24	32	41	49	68
Standard Deviation	11	13	15	16	20
Max	50	60	70	80	90
Upper Quartile	30	40	50	59	80
Median	21	30	40	50	73
Lower Quartile	15	21	30	40	54
Min	15	12	16	20	20
Round 2 Meaningful Use Projections					
Mean	19	25	35	44	66
Standard Deviation	7	8	10	11	14
Max	30	40	60	70	90
Upper Quartile	24	30	40	50	75
Median	17	25	34	40	68
Lower Quartile	15	20	30	40	53
Min	9	12	15	27	40
Day 2 Basic EHR Projections					
Mean	33	41	49	58	78
Standard Deviation	9	11	13	12	11
Max	45	60	70	80	90
Upper Quartile	40	45	60	70	89
Median	34	39	45	55	80
Lower Quartile	28	35	41	47	71
Min	12	15	20	40	55

SOURCE: Expert panel projections, November 2010

Discussion

As part of the EFTE process, we asked the panel to identify the key facilitators and barriers behind their estimates. The majority of these drivers were identified in the following categories: prior trends, government policies and programs, market structure and innovations, and physician characteristics. This section summarizes these facilitators and barriers and identifies the comments that apply to all physicians and those that apply to specific physician groups.

Prior trends: The vast majority believed that the existing trends in adoption will continue to drive future meaningful rates. For example, physicians in larger group practices are most likely to achieve meaningful use relative to the other physician groups, because they have a stronger cost-benefit business case to do

so. Relative to solo or smaller practices, larger groups are more likely to take advantage of EHR features and face fewer workflow changes and other costs associated with the use of EHRs.

Government policies and programs: The experts also believed that government incentive payments would strongly influence future meaningful use rates. However, the group thought it was too early to assess the effectiveness of the Regional Extension Center (REC) program in overcoming the barriers to adoption among physicians in small group practices. The experts also thought that the uncertainty over stage 2 and stage 3 meaningful use requirements and changes associated with health care reform could have a negative impact on future adoption.

Market structure and innovations: The group discussed several market factors that could have a positive impact on meaningful use projections. These factors included levels of competition (e.g., the number of hospitals and providers in the local market), the level of EHR adoption in the local market ("network effects"), the presence of active data exchange, product innovations among EHR vendors, and the potential for increased consolidation among physicians in small group practices. While the group reached a consensus that market forces will primarily drive future EHR adoption and meaningful use rates, there was variation in responses related to the relative importance of each factor. For example, there was considerable disagreement over the potential magnitude of network effects, the feasibility and timing of active data exchange, and the role of consolidation.

Physician characteristics: The majority of the panel believed that there will be an ageing effect, where current and future cohorts of residents will be trained to practice medicine using EHRs. Practices will need to implement EHR systems in order to recruit newly trained physicians and, as a result, adoption and meaningful use rates will increase over time. Similarly, the increase in the rate of adoption and meaningful use could be partially attributable to patients and consumers demanding providers that use EHRs.

Conclusion

This is the first study to use an expert opinion technique to forecast the use of electronic health records. Overall, the expert panel projected that primary care physicians in large group practices are more likely to achieve the meaningful use of EHRs, relative to primary care physicians in small group practices and all other specialists: The group projected that 65 percent of primary care physicians in large group practices, 45 percent of primary care physicians in small group practices, and 44 percent of all other specialists could achieve meaningful use by 2015. In 2019,

these projections increase to 80 percent, 65 percent, and 66 percent for these three groups, respectively.

These results could help inform and evaluate government programs, such as the RECs, by providing the most recent data from the leading experts in academics and industry. For example, these projections can help individual RECs assess their current progress, relative to the national average projected by the expert panel, and provide insight into the major barriers that physicians face on the pathway towards meaningful use. While the panel predicts that HITECH will stimulate EHR use, it is important to emphasize that not all physicians and RECs are the same, and differences across regional markets and practice groups will play a critical role moving forward.

The information from this study is especially valuable when there is a lack of data (e.g., there are no empirical estimates on how responsive physicians are to changes in EHR prices) and a high degree of uncertainty in a new policy environment. In the future, the results can provide insight into the accuracy of expert opinion forecasts compared to more traditional economic methods, and can help government and industry set realistic expectations on how responsive physicians will be to future policy changes. Experts do not always get it right—for example, studies show that expert opinions in the political arena are inaccurate due to overconfidence (Tetlock, 2005)—but they can provide a viable framework to expand and improve upon.

Disclaimer

The views expressed in this article are the authors' and should not be interpreted as those of the Congressional Budget Office.

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