

# The Value Of Electronic Health Records In Solo Or Small Group Practices

Physicians' EHR adoption is slowed by a reimbursement system that rewards the volume of services more than it does their quality.

**by Robert H. Miller, Christopher West, Tiffany Martin Brown, Ida Sim, and Chris Ganchoff**

**ABSTRACT:** We conducted case studies of fourteen solo or small-group primary care practices using electronic health record (EHR) software from two vendors. Initial EHR costs averaged \$44,000 per full-time-equivalent (FTE) provider, and ongoing costs averaged \$8,500 per provider per year. The average practice paid for its EHR costs in 2.5 years and profited handsomely after that; however, some practices could not cover costs quickly, most providers spent more time at work initially, and some practices experienced substantial financial risks. Policies should be designed to provide incentives and support services to help practices improve the quality of their care by using EHRs.

ELECTRONIC HEALTH RECORDS (EHRs) have the potential to greatly improve quality, yet little is known about their costs and benefits in ambulatory care, especially in solo or small group practices, where more than two-thirds of U.S. physicians work.<sup>1</sup> These groups face some of the greatest challenges in successfully using EHRs, which in part explains their slow pace of health information technology (HIT) adoption.<sup>2</sup> Yet the literature on costs/benefits in solo and small group practices is scant, and policymakers have had to rely on estimates that are based on “expert opinion,” rather than evidence.<sup>3</sup>

Our study objective was to determine the costs and benefits of EHRs in current “early-adopter” solo or small primary care group practices.<sup>4</sup> EHRs' financial costs and benefits can affect the rate at which providers adopt them, while quality improvement (QI) benefits can affect patients' health—which may then result in fi-

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financial benefit to payers from avoiding “downstream” expenditures, especially for hospital and emergency room services.

Better cost and benefit data on EHRs in solo and small group practices can help policymakers formulate financial and nonfinancial incentives designed to achieve an acceptable rate of EHR adoption and higher levels of QI benefits at the lowest possible cost. How quickly physicians can recoup their investment in EHRs, and how much they can improve quality using EHRs, will help determine how, and how much, the Centers for Medicare and Medicaid Services (CMS) and health plans/employers need to pay for EHR adoption and use.

## Study Data And Methods

■ **Case selection.** We conducted retrospective qualitative case studies of fourteen solo or small-group primary care practices in twelve states. We selected practices from customer lists provided by PMSI Inc. (vendor of Practice Partner) and A4 Health Systems, two leading vendors of EHR software in the solo/small-group market. We set the following extensive selection criteria to enable appropriate comparisons before and after EHR adoption: Selected primary care practices had used EHRs for one to three years when first contacted (enough time to get over disruption surrounding implementation), had full practices prior to implementation (which eliminated new practices), had relatively stable complements of billing providers, and could provide needed data. Approximately 20 percent of practices meeting these criteria agreed to participate (eight from one vendor and six from the other). Practices were compensated \$1,400 (on average) for provider and staff time.

■ **Data.** We conducted semistructured interviews of self-identified EHR champions (physicians and office managers), observed providers’ use of EHRs (in eleven practices), and reviewed vendor contracts and practice reports. The questionnaire was adapted from previous studies of EHRs that had already identified key themes and data.<sup>5</sup> We obtained data on practice operations, EHR-related hardware and software, selection and implementation processes, costs, financial benefits, use of EHR capabilities, QI efforts, and barriers and facilitators for achieving benefits.

*Costs.* We obtained data on one-time and ongoing EHR-related costs for hardware, software, information systems staffing and external contractor services, installation, training, abstraction, productivity loss, and telecommunications.<sup>6</sup>

*Benefits.* We also obtained data on efficiency savings (decreases in compensation for medical records and other support staff full-time-equivalent [FTE] positions and overtime, and decreases in transcription and paper supply costs), efficiency financial gains (increased visits due to reduced provider time per visit), and efficiency nonfinancial gains (decreased provider time at work). We also obtained data on revenue enhancement from higher payment for increased levels of coding for visits; EHRs enable more complete documentation of visit activities and more thorough visits, thus providing justification for higher coding. We calculated benefits to practices only, not to other stakeholders.<sup>7</sup>

We generated average costs and benefits per FTE billing provider for each practice and then averaged them across the fourteen practices without using weights. Data were more precise for financial costs than for benefits.<sup>8</sup>

■ **Quality improvement.** We examined QI activities for major chronic diseases/conditions (diabetes, asthma, coronary artery disease, and hypertension) and common prevention activities (immunizations, flu vaccinations, mammograms, and pap smears). We focused on key EHR-enabled QI activities that might lead to improved patient outcomes, including some in the Chronic Care Model.<sup>9</sup> We determined whether practices set specific QI performance targets, established care protocols, used templates (electronic forms) with or without coded data, provided flow sheets with longitudinal data (for example, tests and services), delivered reminders at the point of care, generated lists of patients needing services and followed up with those patients, created QI performance reports, provided patient self-management aids, or participated in QI collaboratives. We also examined external performance reporting and financial incentives to improve quality.

■ **Data collection, processing, and analysis.** We collected semistructured interview, contract, office report, and observational data from July 2004 through May 2005. We conducted initial interviews with EHR champions, summarized transcripts into Access databases and Excel spreadsheets, and then reinterviewed participants and followed up by phone and e-mail. In all, we conducted forty-five interviews, which took sixty hours; had numerous shorter communications; and conducted more than 200 hours of observation of forty billing providers.

## Study Findings

■ **Practice characteristics.** The fourteen practices averaged 3.3 FTE billing providers, ranging from one to six FTEs. They averaged 2.5 FTE physicians and 0.8 FTE mid-level billing providers (mostly family and advanced nurse practitioners, or NPs); ten practices had at least one part-time NP or physician assistant (PA).

Practices had used their EHRs for more than two years (26.6 months) on average, ranging from fifteen to forty-five months. Eleven practices had tightly integrated their EHRs into their practice management systems, which handled practice billing and patient scheduling; demographic data flowed from this system to the EHR, and clinical data for billing flowed from the EHR to the management system. Three practices had no such data exchange.

■ **Use.** Virtually all providers used the EHR for most common tasks, including prescribing, documenting, viewing, and within-practice messaging, and almost all used it to assist in billing. Providers typically used templates (electronic forms) to document activities; they also used electronic forms to generate prescription and lab orders that were printed out for patients. Transcription was rare, and ten practices no longer routinely pulled paper charts. Few practices used the EHR for reporting (patient lists or provider performance), patient-provider communication, or communication from providers in the practice to those outside it.

■ **Financial costs.** Initial EHR costs were approximately \$44,000 per FTE provider per year, and ongoing costs were about \$8,500 per FTE provider per year (Exhibit 1). Initial costs for twelve of the practices ranged from \$37,056 to \$63,600 per FTE provider. Variations in financial costs reflect exceptional heterogeneity among small practices in pre-EHR hardware and in technical and negotiating skills.

Software, training, and installation costs averaged \$22,038 per FTE provider. Where data permitted separate estimates, we calculated that software alone accounted for about one-third of overall costs. Software costs depended on such factors as interfaces, other EHR-related software, and the negotiating savvy of the EHR champion; one practice acquired sharply discounted software from another practice. Installation and training costs ranged from virtually none (where there were technically savvy EHR champions) to more than \$14,000 per FTE provider.

Hardware costs per provider averaged almost \$13,000 per FTE provider, ranging from under \$7,500 for four practices that had new equipment pre-EHR or acquired used equipment to more than \$23,000 for two practices that had little usable pre-EHR equipment, including networking.

Revenue losses from reduced visits during training and implementation averaged \$7,473 per FTE provider, ranging from none (in two practices) to \$20,000 per FTE provider in one practice. Losses depended in part on the extent to which providers worked longer hours initially instead of reducing patient visits.<sup>10</sup>

Estimated ongoing EHR costs averaged \$8,412 per FTE provider per year, or 19.5 percent of initial costs. Three ongoing cost categories—vendor software maintenance and support fees, hardware replacement, and payments for information systems staff or external contractors—accounted for 91 percent of these costs.

**EXHIBIT 1**  
**Electronic Health Record (EHR) Financial Costs Per Full-Time-Equivalent (FTE) Provider, For Fourteen Solo/Small Group Practices, 2004–05**

	Average per FTE provider <sup>a</sup> (\$)	Percent of total	Median (\$)	Minimum (\$)	Maximum (\$)
Initial costs	43,826	100.0	45,747	14,462	63,600
Software training, installation	22,038	50.3	22,834	8,475	32,607
Hardware	12,749	29.1	12,492	5,261	23,600
Lost revenues from reduced productivity	7,473	17.1	7,473	0	20,000
Other	1,145	2.6	0	0	9,652
Ongoing costs per provider per year	8,412	100.0	7,231	5,957	11,867
Software maintenance and support	2,439	29.0	2,403	1,200	3,800
Hardware replacement	3,187	37.9	<sub>b</sub>	<sub>b</sub>	<sub>b</sub>
Internal IS staffing/external IS contractors	2,047	24.3	683	0	5,556
Other	739	8.8	586	0	2,742

**SOURCE:** Authors' study data.

**NOTE:** IS is information systems.

<sup>a</sup> Average costs per provider were calculated for each practice and then averaged across the fourteen practices.

<sup>b</sup> Average annual hardware replacement costs per provider were estimated for all practices, not by practice.

■ **Financial benefits.** Financial benefits averaged approximately \$33,000 per FTE provider per year (Exhibit 2). Providers obtained financial benefits from two main sources: increased coding levels, and efficiency-related savings or revenue gains. Increased coding levels accounted for more than half of financial benefits, or \$16,929 per FTE provider per year, ranging from \$3,040 to \$41,711 in the ten practices with coding-related gains. Efficiency-related savings and revenue gains combined accounted for 48.3 percent of financial benefits, or \$15,808 per FTE provider per year. Efficiency-related savings (40.1 percent of benefits) consisted mostly of a decrease in personnel costs. All practices reported some savings, ranging from \$1,000 to \$42,500 per FTE provider per year (for a practice with extensive medical record and transcription savings). Efficiency-related revenue gains from increased visits accounted for 8.1 percent of financial benefits, but only three practices reported gains.

Noticeably absent were substantial pay-for-performance rewards from health plans for QI. Two practices reported nominal quality performance rewards (one received under \$400). One practice received an annual \$300 per provider discount on malpractice insurance.

■ **Time to pay back EHR costs.** Assuming some lag time (say, six months) in generating benefits, the average practice paid for its initial and cumulative ongoing EHR costs within two and a half years and began to reap more than \$23,000 in net benefits per FTE provider per year. The median practice took even less time to pay for EHR costs. However, practices varied in benefits and costs: Although ten of fourteen practices would pay for their EHR costs within four years, one practice would

**EXHIBIT 2**  
**Electronic Health Record (EHR) Financial Benefits Per Full-Time-Equivalent (FTE) Provider, For Fourteen Solo/Small Group Practices (Benefits Per Year), 2004–05**

	Average per FTE provider <sup>a</sup> (\$)	Percent of total benefits	No. of practices with benefits	Among practices with benefits		
				Median (\$)	Minimum (\$)	Maximum (\$)
Total benefits per provider	32,737	100.0	14	38,450	6,600	56,161
Increased coding levels	16,929	51.7	10	21,250	3,040	41,711
Efficiency savings/gains	15,808	48.3	14	14,611	1,000	50,700
Efficiency savings	13,144	40.1	12	12,444	1,000	42,500
Personnel savings (excluding transcription)	6,759	20.6	9	8,333	5,333	30,000
Transaction savings	5,334	16.3	7	10,800	8,500	12,000
Paper supplies savings	1,051	3.2	9	1,000	500	5,333
Efficiency revenue gains from increased visits	2,664	8.1	3	8,200	6,600	22,500

**SOURCE:** Authors' study data.

<sup>a</sup> Average benefits per provider were calculated for each practice and then averaged across the fourteen practices.

take nine years, and two would never pay for their EHRs, assuming unchanged benefits. However, practices were optimistic about increasing benefits, including practices that were slow to realize financial benefits.

■ **Risk.** Three practices experienced considerable financial risks, other than a long payback period. Two had severe billing problems that were at least partly EHR-related. One had no billing or revenue for three months; another had no revenue for ten months (and nearly went bankrupt). A third had to redo its billing for the first six weeks after implementation and later endured a complete system crash that resulted in total loss of data and several weeks of providing care with no computer access or paper charts. Moreover, this survey did not include practices that had implemented an EHR and then returned to paper, thereby losing their total EHR investment.

■ **Time costs and benefits, and quality of life.** Interviewees reported that providers worked longer hours for an average of four months (ranging from one to twelve months), mostly because of the need to enter clinical data during the patient's initial visit after implementation and to become familiar with using the software. EHR physician champions had especially heavy time costs, as they made complementary process changes to improve efficiency and quality—for example, they altered exam room/office procedures, revised templates (forms) to capture needed data, and resolved or prevented some technical difficulties. Champions that focused on QI incurred even greater time costs, as discussed below.

Quality of life improved for some providers after the implementation period. Three practices that saw the same number of patients in less time took the gain as more personal time, rather than seeing more patients. Providers in most practices particularly liked accessing records from home, which enabled some of them to go home earlier, spend time with family, and then work later in the evening. They also liked being able to immediately access records when on call.

■ **QI activities.** EHR use confers some “automatic” presumed quality benefits, such as improved data organization, accessibility, and legibility. However, although all practices engaged in some specific EHR activities that should result in QI, only two extensively used their EHRs to improve chronic and preventive care.

Of the fourteen practices, only five had specific performance targets for QI, and only four had specific protocols/plans for delivering needed care. All but one practice regularly used templates to document encounters, but only seven had templates with substantial coded data that can enable more extensive reminders and reporting. Similarly, although twelve practices reported using some form of computerized reminders beyond drug-related alerts, only five had reminders, set by the practice, for at least one type of chronic care patient (rather than having physicians set reminders for specific patients). Only four practices created lists of at least some patients requiring needed services—for example, diabetics overdue for a glycosylated hemoglobin test—or had a routine way of following up with patients on lists for needing services. Finally, only two practices generated reports on provider performance—both belong to external QI collaboratives.

## Discussion

A “typical” primary care physician in a solo or small group practice could generate the average gains in each financial benefit category by increasing coding levels for approximately 15 percent of visits, eliminating 0.25 of an FTE medical records staffer, eliminating transcription, and having 1 percent more patient visits. All of these benefit gains are plausible.

One recent peer-reviewed study estimated EHR financial costs and benefits to the practice.<sup>11</sup> Our cost estimates were about two-thirds higher; benefit estimates were similar, but the composition of costs and benefits differed greatly, as the other study obtained data from practices in a large integrated delivery network/academic health center, which had robust information systems and management staffing, extensive pre-EHR hardware, lower-cost software, and some capitated patients. That study also relied partly on estimates from the literature and an expert panel. Compared with our past study on EHRs in ambulatory care, EHR-related costs reported here are similar while benefits are more favorable.<sup>12</sup> Compared with a recent Connecting for Health report on EHRs in solo or small group practices, net benefits to practices reported here are much higher.<sup>13</sup>

■ **Practice factors affecting costs and benefits.** *Practice use of the EHR.* Almost all of the providers used the EHR for most common activities, a prerequisite for generating EHR benefits; this helps explain the level of financial benefits achieved. Consistent use of EHR templates (forms) to document visit progress notes helped reduce the need for medical records staff and transcription, and the resulting more complete documentation and more thorough visits increased providers’ comfort with higher coding levels. Practices that used disease-specific templates were more likely than others to engage in other QI efforts.

*Pre-EHR characteristics.* Costs depended on the state of existing hardware and support structure in the practice, while financial benefits depended on pre-EHR provider coding styles (conservative versus aggressive). For some practices, effecting some practice changes likely could have been made pre-EHR, but the EHR implementation and the reexamination of processes that accompanied it were catalysts for change.

*EHR champion and practice culture.* Costs for installation, training, software, hardware, and revenue losses depended heavily on the technical or negotiating savvy of the EHR champion (usually a physician, but sometimes also the office manager or practice administrator). Benefits relied heavily on this person’s technical and business skills. Clinical QI gains relied on the physician champion’s or practice’s interest in QI and willingness to make complementary process changes.<sup>14</sup>

Improving quality of care and notes were the primary stated reasons for initially implementing EHRs. However, stated reasons did not necessarily correspond with EHR-related benefits. For example, most practices that reaped the greatest coding benefits did not consider billing improvement an important motivation, and most practices that had not yet engaged in substantial QI efforts nevertheless

considered QI as a primary motivation for EHR implementation.

*Group size and duration of EHR use.* There was no apparent pattern to results by group size or by duration of EHR use.

*EHR vendor software and support.* There were no qualitative differences in EHR-related costs or benefits between the vendors. QI-related software limitations were greater for one vendor than for the other, but there were no discernible differences in QI efforts between the two groups of practices. Providers generally were satisfied with the software's usefulness and would not return to paper records, but they wanted more training on how to use the EHR more effectively.

*Data exchange/interfaces.* We expected greater benefits in practices with practice management systems that were integrated with their EHRs, but no clear pattern emerged from the data. Interviewees reported that lab interfaces were important in avoiding scanning and medical record costs, improving access to data, reducing providers' time spent seeking information, and improving quality of care.

■ **Policy implications.** Different stakeholders can interpret the results of this study differently. From providers' perspective, practices we studied achieved efficient quality improvement: They reduced inefficiencies in providing care and increased quality to some extent. From the same perspective, gains from higher coding levels rewarded providers' initial time costs and financial risk-taking for EHR implementation and corrected flaws in a reimbursement system that encourages providers to code conservatively (undercode) out of concern for "fraud and abuse" penalties.<sup>15</sup> Higher coding levels also reward more thorough visits that can improve quality. In contrast, from payers' perspective, providers achieved inefficient QI since payers paid much more for very modest QI gains.

Coding-related gains are equivalent to a policy whereby payers make bonus payments to practices for adopting EHRs. The primary cause of this unintended policy for EHR adoption is the current reimbursement system, which rewards more extensive coding of specific services but not more extensive provision of high-quality care. With an EHR, some visit coding changes are easy to make and are highly rewarded.

Efficiency changes are harder to make, because they require initial provider time to make process changes, yet such changes also are rewarded financially. In contrast, although QI changes are often the most difficult to make, most physicians receiving fee-for-service payment are scarcely rewarded at all for them. QI requires providers' time and willingness to make complementary practice process changes and to learn about more advanced EHR features. Providers need to revise templates for specific conditions or diseases, establish reminders at the point of care, and create lists to follow up with patients. Lack of reward for difficult tasks helps explain why only two study practices embarked on extensive QI changes.

*Performance rewards and support services programs.* Few would find fault with rewarding physicians for improved practice efficiency or for more thorough visits resulting from EHR use. In the short run, given the current reimbursement sys-

tem, also rewarding physicians for simply having an EHR may be acceptable to some, to spur diffusion of EHR innovation. However, over time, policies must deepen providers' efficiency gains and shift toward quality-related, rather than coding-related, revenue gains.

A well-designed quality performance incentive system—emphasizing greater pay-for-performance and less fee-for-service payment—could help correct the problems of outsized coding-related financial gains and undersized QI-related financial gains. Most current pay-for-performance initiatives would benefit EHR-using practices that could more easily capture and report on data, and use reminders and other EHR tools to improve performance, than paper-based practices could. Initiatives offering larger incentives and rewarding a wider array of clinical measures would especially benefit EHR-using practices and increase QI gains. Meanwhile, a policy of promoting well-designed support services for practices could reduce providers' time and financial costs for QI activities and increase the extent their use—and thus increase pay-for-performance payments to practices.

Policy initiatives can build on existing pay-for-performance programs in the private sector but would require accelerating research and demonstrations that address pay-for-performance issues for smaller fee-for-service practices, including ways to assign patients to a particular practice and collect and calculate common measures across multiple health plans.<sup>16</sup> The CMS already is developing and experimenting with several key elements of needed policies. The Medicare Care Management Program demonstration project would test pay-for-performance initiatives for practices receiving fee-for-service payment and provide a layer of technical and office redesign support services.<sup>17</sup> Several Medicare Quality Improvement Organizations (QIOs) have launched Doctor's Office Quality Information Technology (DOQ-IT) programs, which have begun to provide a range of support services to various layers of EHR adopters—considerers, implementers, and users.<sup>18</sup> Moreover, the CMS's Eighth Scope of Work for QIOs will build on the DOQ-IT projects, greatly expand the program, and encourage vendors to alter their software to permit easier and uniform QI reporting.

Technical and office redesign support programs are especially important because they lessen the current heavy reliance on physicians' technical and business savvy for lowering costs and increasing benefits. Support programs could help all physicians, especially those who are less proficient in effecting technical or process changes. However, support programs must be highly efficient and effective, since they consume providers' resources as well as those of the CMS/ QIOs, and time is money for most solo or small-group physicians. Both pay-for-performance and support-services programs would stimulate even greater efforts by software vendors to make their software easier to use, including for QI, which would speed the realization of benefits.

*RHIOs.* Funding for more rapid expansion of regional health information organizations (RHIOs) and other entities that can enable electronic clinical data ex-

change, ordering, and messaging would especially benefit solo or small group practices with EHRs by decreasing the costs of document scanning and data entry and providers' time to access information.

■ **Study limitations.** This qualitative study has several limitations. We obtained data from a small sample of fourteen practices using EHRs from two vendors. By design, participating practices were primary care, had used EHRs for one to three years, were not start-up practices, were already full, and had mostly stable provider complements over time. Study practices may not be representative of other practices using the same EHR products or of practices using software from other vendors. Moreover, other vendors can have somewhat different product pricing, capabilities, training, and support policies, although the two EHR vendors and products in this study were not atypical. The survey did not include practices that had implemented EHRs and then returned to paper. Given the spectrum of innovation adopters, study practices likely differ in important ways from practices considering EHRs (but have yet to adopt them) and even more from practices not yet considering EHRs.

Overall, participating practices likely were more successful than those that did not participate, while the study's early-adopting practices may be more enthusiastic about EHRs (and generate more benefits) than will newly adopting practices—which could result in overestimates of EHRs' financial benefits. Nevertheless, the benefits of EHRs may increase over time as pay-for-performance spreads, support services increase, EHR technology improves, and practices gain experience in using EHRs effectively.

Among other limitations, data were mostly self-reported and thus might not have captured some EHR-related effects on visit productivity, where even small changes can have large effects on benefits or costs. Clearly, data are urgently needed from much larger surveys that also use several methods and have a stronger quantitative focus.

**O**UR STUDY SUGGESTS THAT EHRs are financially attractive for some solo or small group practices and financially acceptable for most others; this assumes that the next layer of physician EHR adopters is not radically dissimilar from the early adopters. However, substantial revenue gains from coding increases and limited QI activities lower the value of EHRs in solo or small practices to payers, motivating policies that provide performance incentives and practice support services to spur EHR adoption and use for efficient quality improvement.

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**NOTES**

1. American Medical Association, *Physician Socioeconomic Statistics, 2000–2002 Edition* (Chicago: AMA, 2001).
2. M.C. Reed and J.M. Grossman, *Limited Information Technology for Patient Care in Physician Offices* (Washington: Center for Studying Health System Change, September 2004); Connecting for Health, *Financial, Legal, and Organizational Approaches to Achieving Electronic Connectivity in Healthcare*, October 2004, [www.connectingforhealth.org/assets/reports/flo\\_sustain\\_healthcare\\_rpt.pdf](http://www.connectingforhealth.org/assets/reports/flo_sustain_healthcare_rpt.pdf) (28 June 2005); R.H. Miller and I. Sim, “Physicians’ Use of Electronic Medical Records: Barriers and Solutions,” *Health Affairs* 23, no. 2 (2004): 116–126; and Office of the National Coordinator for Health Information Technology, *Progress Report July 21, 2004: Framework for Strategic Action* (Washington: ONCHIT, 2004).
3. For peer-reviewed literature, see, for example, S.J. Wang et al., “A Cost-Benefit Analysis of Electronic Medical Records in Primary Care,” *American Journal of Medicine* 114, no. 5 (2003): 397–403. For an example of reports relying on expert opinion, see Connecting for Health, *Financial, Legal, and Organizational Approaches*.
4. E.M. Rogers, *The Diffusion of Innovations*, 4th ed. (New York: Free Press, 1995).
5. Miller and Sim, “Physicians’ Use of Electronic Medical Records”; and R.H. Miller, I. Sim, and J. Newman, *Electronic Medical Records: Lessons from Small Physician Practices*, October 2003, [www.chcf.org/documents/ihealth/EMRLessonsSmallPhysicianPractices.pdf](http://www.chcf.org/documents/ihealth/EMRLessonsSmallPhysicianPractices.pdf) (28 June 2005).
6. Hardware included computer equipment (desktops, notebooks, servers, storage), related ancillary equipment (printers, scanners, monitors), and networking (routers, wiring); hardware replacement costs assume a four-year life for initial hardware and continued decreases in hardware costs over time; because of differences in pre-EHR hardware, replacement costs were estimated as an average per provider across practices, not by practice. Software included license or maintenance costs for EHR or related software (for interfaces, databases). IS staff and external IT contractor costs included increases resulting from the EHR. Installation included vendor and contractor costs for installing software. Since several practices’ contracts did not consistently separate software, installation, and training costs, we combined them. Revenue losses at implementation were attributable to provider productivity decreases resulting from reduced visit schedules. “Other” costs included initial data abstraction costs and extra telecommunication costs.
7. S. Barlow, J. Johnson, and J. Steck, “The Economic Effect of Implementing an EMR in an Outpatient Clinical Setting,” *Journal of Healthcare Information Management* 18, no. 1 (2004): 46–51.
8. Benefits estimates likely are conservative, since they exclude benefits that respondents described only qualitatively (increase, large increase). Applying a discount rate (4–8 percent) to determine the present value of costs and benefits in later years did not greatly affect results.
9. For example, see “Overview of the Chronic Care Model,” [www.improvingchroniccare.org/change/model/components.html](http://www.improvingchroniccare.org/change/model/components.html) (27 July 2005).
10. Among “other” initial costs, chart abstraction costs were only 1 percent of the total, because providers almost always entered past clinical data during the patient’s initial visit after implementation, instead of populating the database in advance.
11. Wang et al., “A Cost-Benefit Analysis.”
12. Miller and Sim, “Physicians’ Use of Electronic Medical Records.”
13. Connecting for Health, *Financial, Legal, and Organizational Approaches*.
14. In solo practices, champion and group characteristics are almost synonymous.
15. J.A. Kusske, “Physicians under Fire: Waging the War on Fraud and Abuse,” *American Association of Neurological Surgeons Bulletin* 9, no. 2 (2000): 5–11.
16. A.M. Epstein, T.H. Lee, and M.B. Hamel, “Paying Physicians for High-Quality Care,” *New England Journal of Medicine* 350, no. 4 (2004): 406–410; and M.B. Rosenthal et al., “Paying for Quality: Providers’ Incentives for Quality Improvement,” *Health Affairs* 23, no. 2 (2004): 127–141. See also the Leapfrog Group’s compendium of pay-for-performance efforts, at [ir.leapfroggroup.org/compendium/compendiumsearch.cfm](http://ir.leapfroggroup.org/compendium/compendiumsearch.cfm) (27 March 2005).
17. See Medicare Payment Advisory Commission, *Report to the Congress: Medicare Payment Policy*, March 2005, [www.medpac.gov/publications/congressional\\_reports/Mar05\\_TOC.pdf](http://www.medpac.gov/publications/congressional_reports/Mar05_TOC.pdf) (27 March 2005).
18. For more information, see the Doctor’s Office Quality Information Technology home page, [www.doqit.org](http://www.doqit.org) (27 July 2005).