A Pilot Study to Document the Return on Investment for Implementing an Ambulatory Electronic Health Record at an Academic Medical Center

Dara L Grieger, MD, Stephen H Cohen, MD, CPE, David A Krusch, MD, FACS

BACKGROUND: Adoption rates for electronic health records (EHRs) have been slow, despite growing enthusiasm. Cost is a frequently cited obstacle to implementing an EHR. The body of literature citing a positive return on investment is largely anecdotal and infrequently published in peer-reviewed journals.

STUDY DESIGN: Five ambulatory offices, with a total of 28 providers, within the University of Rochester Medical Center, participated in a pilot project using an EHR to document the return on investment. A staged implementation of the Touchworks EHR (Allscripts) was undertaken from November 2003 to March 2004. Measurements of key financial indicators were made in the third calendar quarters of 2003 and 2005. These indicators included chart pulls, new chart creation, filing time, support staff salary, and transcription costs. In addition, patient cycle time, evaluation and management codes billed, and days in accounts receivable were evaluated to assess impact on office efficiency and billing. The savings realized were compared with the costs of the first 2 years of EHR use to determine return on investment.

RESULTS: Total annual savings were $393,662 ($14,055 per provider). Total capital cost was $484,577. First-year operating expenses were $24,539. Total expenses for the first year were $509,539 ($18,182 per provider). Ongoing annual cost for subsequent years is $114,016 ($4,072 per provider). So, initial costs were recaptured within 16 months, with ongoing annual savings of $9,983 per provider.

CONCLUSIONS: An EHR can rapidly demonstrate a positive return on investment when implemented in ambulatory offices associated with a university medical center, with a neutral impact on efficiency and billing. (J Am Coll Surg 2007;205:89–96. © 2007 by the American College of Surgeons)

One of the many challenges facing modern surgical practice is the growing pressure to adopt an electronic health record (EHR). This pressure is coming largely from government agencies. Reports from the Institute of Medicine tout the benefits of the EHR and call for widespread adoption.[1] There is growing support for development of a national health-care information infrastructure. The recent success of several regional health information infrastructures in Indiana and California adds support to the idea that provider organizations will need to adopt EHRs to participate in such networks.[2] The widespread loss of medical records that occurred in New Orleans as the result of hurricane Katrina has led the lay press to push for the use of EHRs and development of a national health-care information system. Use of EHRs has been slowly growing. A survey conducted by *Medical Economics* in 2004 found that 15% of primary care physicians are using EHRs.[3] Similarly, a Deloitte research survey found 12.9% of respondents were using EHRs.[4]

There are several valid reasons for using an EHR. There is a small but growing body of evidence that the EHR can be a valuable tool for improving patient safety and quality of care, particularly in regard to compliance with guidelines

Competing Interests Declared: None.

Received March 28, 2006; Revised February 12, 2007; Accepted February 28, 2007.

From the Departments of Surgery (Grieger, Krusch) and Medicine (Cohen), University of Rochester Medical Center, Rochester, NY.

Correspondence address: Dara L Grieger, MD, Department of Surgery, University of Rochester Medical Center, 601 Elmwood Ave, Box SURG, Rochester, NY 14642.

ISSN 1072-7515/07/$32.00
doi:10.1016/j.jamcollsurg.2007.02.074

and prevention of adverse drug events.[5-7] Improved access to the information contained in the patient's medical record is another frequently cited benefit.[8]

Despite these benefits, adoption of EHR has been slow. One of the most common obstacles cited for hesitancy to use EHR is cost.[9] Although there has been an increase in the number of published reports citing a positive return on investment in recent years, most of these reports are anecdotal and difficult to substantiate.[10-12] Total savings vary widely and are not calculated or reported in any uniform manner. As part of an overall strategic plan to provide safer patient care and improve financial returns, the University of Rochester conducted a pilot project for implementation of an EHR for its ambulatory practices. As part of this project, data were collected to allow determination of the return on investment.

METHODS

Five ambulatory offices within the University of Rochester Medical Center were chosen to participate in this pilot project. These included three primary care internal medicine offices (designated as 12 Cor, SVIM, and GMU), a dermatology office (Derm), and a pediatric endocrinology (PedEndo) practice. The project team selected the TouchWorks EHR by Allscripts. This system consists of a series of modules that can be implemented independently. We chose to divide the project into three phases. The first phase consisted of implementing a core set of modules. These included a base module (consisting of medication, allergy and medical problem lists, call processing, and task management), a document module (providing document scanning and dictation functionality), and immunization and vital signs tracking modules. Two to 3 months after these core modules were put in place, we began using the prescription writing module. Finally, 6 months after the initial implementation, we began using the Note module with templated, dictionary-driven, visit documentation functionality. The project began with application of the core modules in November 2003.

To evaluate the return on investment, we measured a number of key indicators for which we anticipated cost savings, improved efficiencies, or increased revenue as a result of using the EHR. These indicators were chosen specifically because they are among those most commonly addressed in the current literature. Details of these measurements follow.

Chart pulls

Chart pulls are the number of times a paper chart is retrieved to be used for patient visits, patient phone calls, prescription refills, filing of results and reports, and other such activities. We requested that each office manager have the office staff keep a tally of the number of times a chart was pulled for each of these activities during 10 half-day periods over a 2- to 3-week time frame in September 2003, March 2004, and September 2005.

New chart creation costs

New chart creation costs cover both supplies and labor involved in creating a paper chart for each new patient seen in the office. We tallied the evaluation and management codes for all levels of new patient visits and new consults from July to September 2003 and again from July to September 2005. The cost to construct a paper chart for each new patient visit was estimated. From this information, an annual cost for construction of new paper charts for each of these visits was calculated.

Filing time

Filing time covered the average time needed to file various items, such as letters, laboratory reports, and radiology reports, into the medical record. We recorded the time necessary to file 100 items into the medical records, comparing traditional hand filing of pieces of paper into the paper chart versus the process by which documents are filed into the EHR (referred to as scanning and indexing). Filing time determinations were done in September 2003 and March 2004, and we used 3 of our study offices as benchmarks for this measurement.

Support staffing

Support staffing refers to the salary cost of nonprovider office support personnel. We requested that the office managers keep ongoing records, in terms of full-time equivalents (FTE), of staffing needs for nonprovider support personnel. This allowed us to determine changes in hiring patterns over the study period.

Transcription costs

Transcription costs, those associated with transcribing dictated history and physical examination and progress

notes, were obtained for the third quarter of the calendar year (July to September) for both 2003 and 2005.

Patient cycle time

Patient cycle time is the interval from patient check-in until check-out. Using a form adapted from the Institute for Healthcare Improvement, we recorded times as patients moved about the office. The form is designed such that the patient can self-record the times, or a member of the office staff can shadow the patient and record the times. We then asked each office manager to use this form to record the movement of 3 patients per provider during 4 different mornings or afternoons over a 2- to 4-week period (total of 12 patients per provider). All of our office managers elected to have the patients fill out the forms. We performed this measurement in September 2003 and September 2005.

Evaluation and management codes billed

Evaluation and management codes billed cover the number of visits billed at each of these codes for established patient visits. We compared visit numbers for the third quarter of the calendar year in 2003 and 2005. We then used the Medicare fee schedule for 2005 to compare the average billing per visit for both time periods. For this measurement only, we obtained the same data for five primary care offices within the University system not using any EHR. These offices were matched as closely as possible to the study offices in terms of geography and provider makeup.

Days in accounts receivable

Days in accounts receivable refer to the number of days from the time a bill is sent to a payor until the payment is received. Again, we compared this measurement for the third quarter of the calendar year in 2003 and 2005.

RESULTS

Chart pulls

At baseline, there were 1,193 chart pulls daily across the 5 sites. We found a 79% reduction in chart pulls 6 months after implementation of the EHR and a 96% reduction at 2 years. Previous internal time and motion studies estimated the average cost to be $0.86 per pull. On an annualized basis, assuming 50 work weeks per year, this reduction in chart pulls translates to an annual savings of $246,934 at 2 years (Fig. 1).

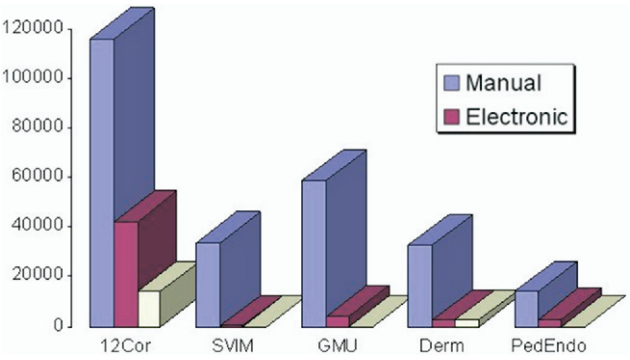

Figure 1. Annual chart pull expense. 12 Cor, SVIM, and GMU refer to primary care internal medicine practices; Derm refers to a dermatology practice; and PedEndo is a pediatric endocrinology practice.

New patient chart costs

There were 1,072 new patient visits in the third quarter of 2005, a 16% increase over the same period in 2003. Without the EHR system, preparation of a paper chart would have been required for each of these new patients. We previously estimated the cost of supplies and labor involved in preparing a paper chart to be $6.50 per chart. This cost is completely eliminated with the EHR, and, for 2005, represented an annual savings of $27,872.

Filing time

The time to file 100 items into the medical record decreased dramatically after implementation of the EHR. The time it took to file a stack of 100 items into the paper chart was an average of 98 minutes; the time it took to file a stack of 100 items into the proper electronic record was an average of 30 minutes. On a page per minute basis, the average electronic filing time was 3.37 items per minute (range 2.1 to 4.2 items per minute), and the average manual filing time was 1.02 items per minute (range 0.8 to 1.3 items per minute). This represents an average 230% improvement (range 61% to 438% improvement). To calculate savings, we assumed that 6,000 pieces of paper would need to be filed each week across the 5 sites. Assuming a manual filing time of 1 page per minute and an electronic filing time of 4 pages per minute, 75 hours are saved per week. This translates into an annual savings of $43,125. But because part of the workflow of manual filing includes chart pulls, we subtracted the cost of the associated chart pulls, which has been previously accounted for. So the net annual savings from reduced filing time was estimated at $25,000 (Fig. 2).

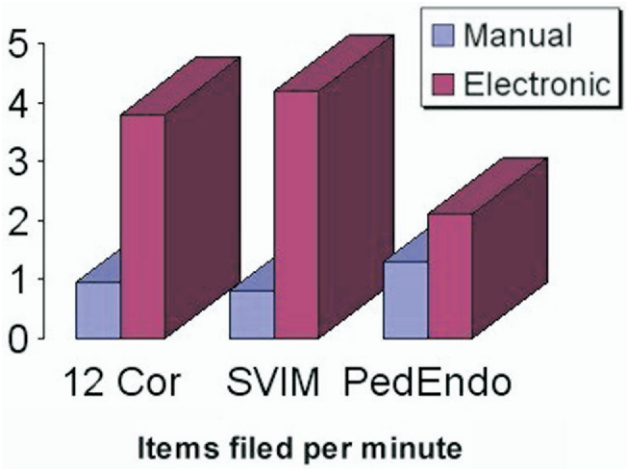

Figure 2. Filing time by office. 12 Cor and SVIM refer to primary care internal medicine practices, and PedEndo is a pediatric endocrinology practice.

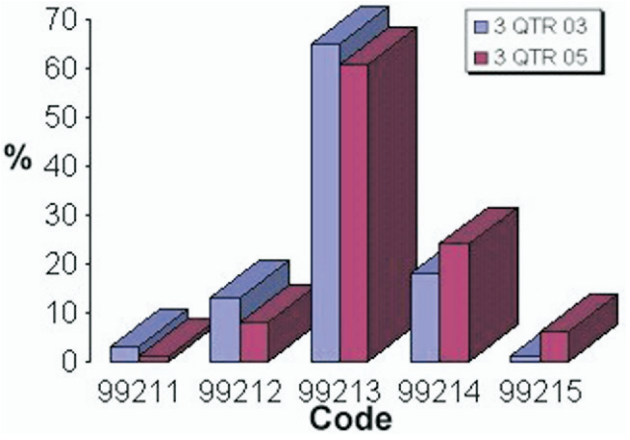

Figure 3. Visits by code: study offices.

Support staff

During the study period, 2 full-time equivalent support staff positions were eliminated thorough attrition, and another 2.5 positions were avoided because of the increase in office efficiency within the first year of the pilot. These reductions occurred despite the addition of six providers during the study period. Total annual salary expense saved as a result was $91,000.

Transcription costs

Most of the pilot offices were able to reduce transcription costs dramatically, by 37% to 100%. All offices that began to use the electronic visit documentation module did reduce transcription costs. The dermatology office, which was using handwritten notes before implementation of the EHR, switched to dictated and transcribed notes during the pilot study and has not yet implemented the electronic visit documentation module. Despite this, we still achieved a small overall total net annual savings of $2,756 on transcription costs across all offices. For offices using transcription before implementation of the EHR, total annual savings were $30,560. One office virtually eliminated transcription costs (Table 1).

Table 1. Transcription Expense by Quarter

Office	Third quarter 2003, $	Third quarter 2005, $	Savings, $
12 Cor	8,070	4,928	3,142
SVIM	1,686	0	1,686
GMU	2,182	1,381	807
Derm	0	6,951	(6,951)
PedEndo	2,815	804	2,011
Total	14,753	14,064	689

12 Cor, SVIM, and GMU refer to primary care internal medicine practices; Derm refers to a dermatology practice; and PedEndo is a pediatric endocrinology practice.

Patient cycle time

When considering providers for whom complete pre- and postimplementation data were obtained (16 of 28, 57%), the average time required to move a patient through these offices was reduced by 5.4%. This difference was not statistically significant ($p = 0.17$) by the paired Student's *t*-test (Table 2).

Evaluation and management codes billed

There was an increase in the percentage of total visits billed at levels 99214 and 99215, with a decrease in the percentage of total visits billed at levels 99211 to 99213. We observed a similar trend for the 5 control offices not using the EHR (Figs. 3, 4).

To estimate the impact of the EHR on revenue, we used the 2005 Medicare fee schedule to estimate the

Table 2. Patient Cycle Time by Office

Office	September 2003, min	September 2005, min
12 Cor	53	45
SVIM	38	40
GMU	54	53
Derm	66	63
PedEndo	69	66
Average	56	53

12 Cor, SVIM, and GMU refer to primary care internal medicine practices; Derm refers to a dermatology practice; and PedEndo is a pediatric endocrinology practice.

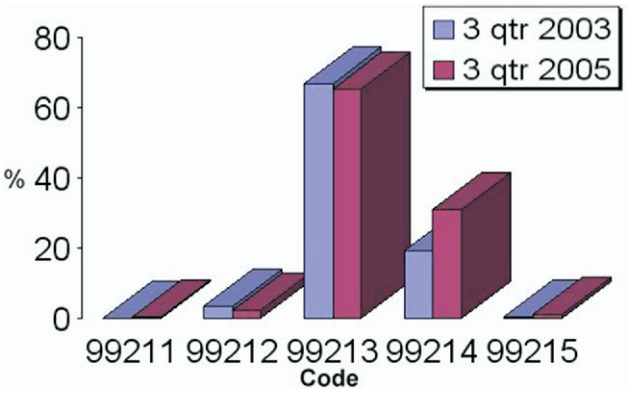

Figure 4. Visits by code: control offices.

dollar value of these visits for both time periods. The study offices had an average increase in billing per visit of $9.91; control offices had an average increase in billing per visit of $9.74, a difference of $0.17 per visit.

Days in accounts receivable

The number of days in accounts receivable decreased over the study period by 5 days, a 13.8% improvement. But this was not a statistically significant change ($p = 0.22$, paired Student's *t*-test, Table 3).

Table 3. Days in Accounts Receivable

Office	Third quarter 2003, d	Third quarter 2005, d
12 Cor	20	26
SVIM	24	23
GMU	56	47
Derm	49	38
PedEndo	31	23
Average	36	31

12 Cor, SVIM, and GMU refer to primary care internal medicine practices; Derm refers to a dermatology practice; and PedEndo is a pediatric endocrinology practice.

DISCUSSION

Most of the initial expenses of implementing the EHR were capitalized. Total capital costs were $484,557. This included hardware and software purchase and much of the salary necessary for technical support and training. First-year operating expenses were $24,539, so the total cost for the first year was $509,096. Twenty-eight providers participated in the pilot project. The total initial cost per provider was $18,182, well within the cost range of $15,000 to $50,000 typically reported.[9,13,14] Ongoing annual expenses for subsequent years are $114,016. Most of this cost is attributable to salary for support and training and an annual software license fee. Ongoing annual expense is $4,072 per provider. Again, this falls well within ranges routinely cited in the literature.[9,13,14]

Total annual savings are $393,562. This represents a per provider savings of $14,055 annually. Based on these cost savings, the initial expense was recaptured in 16 months. In addition, once the ongoing annual operating expense is accounted for, we have a net annual savings of $9,983 per provider. Others have reported recapture of initial expense within 18 to 36 months.[15,16]

The most dramatic immediate benefit in our study was the reduction in chart pulls, which accounted for 63% of our total savings. Others have reported reduction in chart pulls by 35% to 100%.[15,17,18] Although the individual cost of each chart pull is usually not reported in the literature, our cost of $0.86 was significantly lower than the $5 reported by Wang and colleagues.[16] Our cost was established before this study by determining the number of charts pulled per hour and dividing this number by the hourly salary plus benefit cost of the clerk. In addition, our cost for new patient charts was well within the range reported by others: $3 to $8 per chart.[15,17,18]

Salary savings for nonprovider support staff were the next largest percentage of our savings, at 23%. We were able to eliminate a total of 4.5 positions despite the addition of 6 providers throughout the study period, reflecting increased efficiency. Two of these positions were eliminated through attrition, and 2.5 were positions that would have been filled by hiring new providers. Since completion of the pilot study, we have changed the hiring model for practices using the EHR from 2.5 full-time equivalent support staff per provider to 1.5 support staff per provider. This change was made as a direct result of the findings of the pilot study. Salary savings of $28,050 to $100,000[15,17,18] have been reported elsewhere. Organizations that have staff devoted entirely to chart management generally report higher savings than those whose staff perform multiple duties.

Overall, our transcription cost savings were minimal. Most authors document much more dramatic transcription cost savings, ranging from $9,600 to $380,000,[16,17] or a reduction of 50% to 100%.[18] We could find only one report of smaller transcription cost savings: $720 to $4,800 annually,[15] but this author estimated only a 20% reduction in transcription activity. In our study, one office (dermatology) was not using transcription before implementation of the EHR. This office had been using

handwritten notes, which could have been scanned into the EHR. But they chose instead to begin dictating notes and to use the University-wide transcription service, which automatically populates the transcribed notes into the EHR. The ultimate goal was that this practice would then switch to using the templated visit documentation system. But once the pilot was underway, the dermatology office elected not to proceed with the templated documentation system. This illustrates a secondary purpose of our pilot study, which was to determine best practices for future implementation of this EHR. Based on our experience with this dermatology practice, we are no longer using dictation as a transition from handwritten notes to the templated visit documentation module. Rather, we are now allowing practices that rely on handwritten notes to scan the notes directly into the record.

The four offices that were using transcription before EHR implementation saw a reduction in transcription costs from 37% to 100%. These offices had a total savings of $30,560 annually and an average 52% reduction. In addition, it is important to note that the University established a system-wide target of 50% of providers realizing a 50% reduction in transcription costs as a result of using the EHR. Our study population met this goal.

Filing time is not reported as commonly in the literature as our other measures are. Though we saw a large improvement (61% to 438%, average 230%), it was not as dramatic as the 800% improvement reported by Barlow and associates.[17] This could be, in part, from the fact that we conducted the filing time study a relatively short time after implementation. It is reasonable to assume that with more experience using electronic scanning and indexing, filing time would improve even more. Some of our offices were slower in scanning and indexing because many of the documents did not have individual identifiers on them, causing staff to have to stop and look up verifying information. Also, we did not have any individuals dedicated solely to scanning. Rather, staff members who were scanning also had to perform other tasks, such as answering the telephone, which would interrupt the scanning process. In addition, there are now fewer items that must be filed into the medical record, because items such as laboratory and radiology reports are now automatically populated into the EHR, so those paper reports are no longer used by the study offices. We believe our estimate of filing time savings to be very conservative.

There are some reports of improved productivity in terms of increased patient visits per provider[18] after an initial period of decreased productivity.[9,16] Our study was not designed to include measures of productivity. We measured patient cycle time as a marker of patient throughput. This is of particular relevance because many providers, often even those who embrace the idea of using an EHR, express concern that using an EHR will slow office workflow and productivity. We have demonstrated that the use of an EHR does not slow office workflow. Though we saw a small improvement in patient cycle time, it was not statistically significant, so we cannot conclude that the use of the EHR improves patient cycle time. And although we encouraged offices to schedule lighter visit volumes in the initial implementation period, anecdotally, we saw visit volumes return to baseline by day 3 after "go live." We believe that this was because of our staged implementation plan, which allowed providers to gain familiarity with the basic system before using the more complex functions.

Others have reported significant increases in billing and revenue, because of improved coding, reduction in claims denial, and decreased days in accounts receivable.[15,17,18] One might expect that billing would improve, because the use of templated visit documentation could support documentation necessary for higher-level billing. Our billing per visit increased during the study period, but the control offices not using the EHR had a virtually identical increase. Others have attributed up to a $26 billable gain per visit to the use of an EHR,[17] but we cannot attribute any change in billing to the use of the EHR. During the study period, there was an ongoing billing compliance education effort throughout the University system. It is most likely that the up-coding demonstrated by both the study and control offices occurred as a result of this education effort. But we have not yet implemented the charge capture module. This would allow the EHR to suggest an evaluation and management code based on what is documented during the visit. It is possible that once this module is implemented, we might also experience an increase in billing per visit, because physician down-coding is a well-documented phenomenon.[19] Barlow and coworkers[17] attributed a $26 billable gain per visit to the use of an EHR. This group is a multispecialty group that includes orthopaedics and ear, nose, and throat practices. These authors did not provide any breakdown of savings by specialty.

This is a retrospective study, and, as such, a weakness is the fact that the data collected were initially intended for internal use. An additional weakness is that the data were collected by office staff, rather than through observation by outside personnel. Much of the savings realized are soft savings. These are cost savings that are not necessarily immediately directly reflected in salary savings but rather represent improved efficiencies in practices. Such cost savings take into account the fact that with the EHR, it is possible to multitask around the same record at the same point in time (ie, several people can use the medical record simultaneously). The soft cost savings include a wide variety of savings, such as reduced time searching for records and more efficient processing of prescription refills, and they go beyond the savings realized by reduction in salary expense. We chose to use chart pulls and filing time savings to estimate these expenses, because a detailed time and motion study of all office personnel would be prohibitively expensive.

Our study was not designed to measure any improvements in collections as a result of decreased denials, and we did not set out to measure cash flow changes from changes in days in accounts receivable. We did show that there was not a significant change in days in accounts receivable, so we cannot attribute the small improvement in this measure to the use of the EHR. Others have reported reduction in claim denial rates from improved documentation.[16,18]

We based our decision to use a staged implementation on classic change management theory,[20] which has identified three stages that are common to the adoption of a new technology. The first phase is the substitutive phase. In this phase, the user substitutes the new technology for the more familiar one. This is clearly illustrated by the term *horseless carriage*, used for the first automobiles, which closely resembled the carriages pulled by horses and used the infrastructure designed for horse-drawn transportation. This phase is essential to becoming familiar with the new technology. For medical records, this phase is using an EHR merely as a method to file information that would have been filed in the paper record. But in this phase, one is also unable to take advantage of the innovations possible with the new technology. For this first phase, we implemented modules that merely substituted a computer for paper as a form for storing a patient's medical information.

The second phase of technology adoption is the innovative phase. In this phase, users begin to become creative and make improvements to workflow processes using the new system. To continue the horseless carriage analogy, examples of this phase would be adding rubber tires and asphalt roads. We are currently in this phase, after implementation of the visit documentation and prescription writing modules.

The third phase of technology adoption is the transformative phase. In this phase, users begin doing things that they would not have imagined possible without the new technology. In the horseless carriage analogy, this would be the addition of items such as global positioning systems and parking radar. One possibility here is the use of EHR to document physician performance data.

Our study was not designed to measure any savings from decreased drug cost or radiology use, which others have reported,[17,18] because our payor mix is primarily fee for service. In this setting, any of these savings would go to the payor rather than the provider. We also did not account for any savings realized from the elimination of space needed for chart storage. One of our offices did move into a new physical facility with no space for chart storage during the study period. Based on these results, we have begun an aggressive process to roll out this system over all ambulatory offices within the medical center system. Our goal is complete utilization by all 350 providers by early 2008.

In conclusion, we have demonstrated that an EHR can produce a rapid return on investment when implemented in ambulatory offices associated with a university medical center. Ongoing annual savings can be realized as well. A staged implementation can have a neutral effect on patient throughput. Impact on billing can be neutral as well.

Author Contributions

Study conception and design: Cohen, Krusch
Acquisition of data: Cohen, Grieger
Analysis and interpretation of data: Cohen, Grieger, Krusch
Drafting of manuscript: Grieger, Krusch
Critical revision: Cohen, Krusch

REFERENCES

1. Dick RS, Steen EB, Detmer DE. The computer based patient record: An essential technology for health care, revised edition [monograph on the Internet]. Available at: http://fermat.nap.edu/books/0309055326/html. Accessed April 11, 2007.

2. Rishel W. Regional health information networks: The key to a national health information infrastructure. Gartner Healthcare, August 31, 2004. Special Report for Ascential Software Corporation.
3. Terry K. Doctors and EHRs. Med Econ 2005;82:72–74, 77–78, 80–84.
4. Miller RR, Hillman JM, Given RS. Physician use of IT: Results from the Deloitte Research Survey. J Healthc Inf Manag 2004; 18:72–80.
5. Hunt DL, Haynes BH, Hanna SE, Smith K. Effects of computer-based clinical decision support systems on physician performance and patient outcomes: A systematic review. JAMA 1998;280:1339–1346.
6. Balas EA, Weingarten S, Garb CT, et al. Improving preventive care by prompting physicians. Arch Intern Med 2000;160:301–308.
7. Bates DW, Gawande AA. Patient safety: Improving safety with information technology. N Engl J Med 2003;348:2526–2534.
8. Kian LA, Stewart MW, Bagby C, Robertson J. Justifying the cost of a computer-based patient record. Heathc Financ Manage 1995;49:58–60, 62, 64–67.
9. Gans D, Kralewski J, Hammons T, Dowd B. Medical groups adoption of electronic health records and information systems. Health Aff 2005;24:1323–1333.
10. Khoury A. Finding value in EMRs. Heath Manag Technol 1997;18:34–35.
11. Sandrick K. Calculating ROI for CPRs. Health Manag Technol 1998;19:16–20.
12. Nelson R. Computerized records improve practice efficiency and patient care. Healthc Financ Manage 1998;52:86–88.
13. Terry K. EMRs what you need to know. Med Econ 2003;80: TCP5–TCP14.
14. Adler KG. Why it's time to purchase an electronic health record system. Fam Pract Manag 2004;11:43–46.
15. Renner K. Cost-justifying electronic medical records. Heathc Financ Manage 1996;50:63–64, 66, 68.
16. Wang SJ, Middleton B, Prosser LA, et al. A cost-benefit analysis of electronic medical records in primary care. Am J Med 2003; 114:397–403.
17. Barlow S, Johnson J, Steck J. The economic effect of implementing an EMR in an outpatient clinical setting. J Heathc Inf Manag 2004;18:46–51.
18. Ambulatory EMR. Establishing a business case. Available at: http://www.medicalogic.com/emr/business_benefits/index.html. Accessed July 15, 2005.
19. King MS, Sharp L, Lipsky, MS. Accuracy of CPT evaluation and management coding by family physicians. J Am Board Fam Pract 2001;14:184–192.
20. Stein T, ed. The electronic physician. Chicago: Allscripts; 2005.