

Adopting Information Technology to Drive Improvements in Patient Safety: Lessons from the Agency for Healthcare Research and Quality Health Information Technology Grantees

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Objectives. To document and assess the experiences of 104 Agency for Healthcare Research and Quality (AHRQ)-funded health information technology (health IT) grantees in planning and implementing health IT systems.

Data Source. Grant proposals and interviews with the AHRQ health IT grantees.

Data Collection Method. Extracted descriptive data from the health IT grant proposals; conducted telephone interviews with principal investigators.

Principal Findings. AHRQ funding of the health IT projects provided important support for health IT development work in various health care settings. Successful implementation required commitment from top management, dedicated staff and financial resources, an open process to encourage buy-in and enthusiasm by end users, and sheer persistence. Technologies required tailoring to the specific organization's needs. Grantees felt their projects could be replicated by others, if organizations had ample IT expertise and resources. Evaluating the value of health IT was hampered by the absence of validated instruments and measures, organizational demands that competed with data collection, and lack of evaluation expertise among health IT implementers.

Conclusions. Experiences of the health IT grantees provide rich information for use by health care providers, AHRQ, and other policy makers to help strengthen future health IT development efforts, including the need to improve evaluation design and standards to assess impact.

Key Words. Health IT, information technology, patient safety, evaluation

In its report, *To Err Is Human: Building a Safer Health System* (2000), the Institute of Medicine (IOM) called upon the health care community and policy makers to build a safer health care system, and it recommended use of innovative

health information technologies (health IT) that would provide system-wide support to reduce medical errors and improve the quality of care. At the time of the IOM report release, only a small number of hospitals and physician practices had made investments in health IT to manage patient care (Fonkych and Taylor 2005).

A number of studies suggest that effective implementation of health IT, such as electronic health records (EHRs), computerized physician order entry (CPOE), and data exchange networks have the potential to generate cost savings and improve patient safety (Audet et al. 2004; Classen, Avery, and Bates 2007). Hillestad et al. (2005) estimated that widespread, nationwide adoption of EHR systems could produce efficiency and safety savings of US\$142 billion in the ambulatory care setting and US\$371 billion in the inpatient setting over a 15-year period. A systematic review of the health IT literature concluded that “health IT has the potential to assist in dramatically transforming the delivery of health care, making it safer, more effective, and more efficient” (Shekelle et al. 2006).

As described in another article in this issue (Farley and Battles 2008), the Agency for Healthcare Research and Quality (AHRQ), within the Department of Health and Human Services, contracted with RAND in September 2002 to serve as its Patient Safety Evaluation Center (evaluation center) and perform a longitudinal evaluation of the AHRQ patient safety initiative. The evaluation was completed in September 2006. As part of this 4-year evaluation, the evaluation center characterized the health IT projects funded by AHRQ and examined the experiences of the health IT grantees. This paper presents the results of this portion of the evaluation. Critical lessons learned by these grantees are a valuable resource for policy makers and health care providers considering investments in health IT.

HEALTH IT PROJECT FUNDING BY AHRQ

AHRQ promoted the broad adoption of health IT as part of its patient safety initiative. In 2004, AHRQ awarded US\$139 million in grants and contracts to 104 health IT projects. The projects, which were distributed across 41 states

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and 100 communities, were designed to expand the adoption of health IT as a means to improve health care safety and quality. Three groups of health IT grants were funded: 38 Planning projects, 40 Implementation projects, and 26 projects (Value grants) that evaluated health IT that was being or had been adopted (Table 1).¹

The Planning grantees were eligible to submit proposals near the end of their 1-year Planning grant to implement their health IT. Of the original 38 Planning grantees, 16 were subsequently awarded Implementation grants in 2005.

A FRAMEWORK FOR THE HEALTH IT EVALUATION

To guide our evaluation of the health IT projects, we developed a conceptual framework that describes the key components involved in ensuring effective adoption of health IT by health care organizations. The conceptual framework builds on the work of Greenhalgh et al. (2004) and two systematic reviews that addressed the diffusion of service delivery innovations and health IT (Hillestad et al. 2005; Shekelle et al. 2006). We also searched the literature for studies published subsequent to the time periods covered by the systematic reviews.

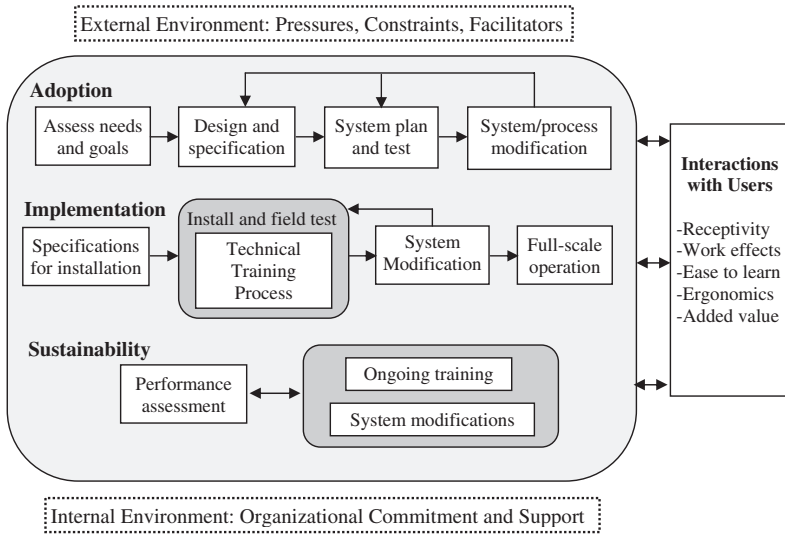
The conceptual framework (Figure 1) highlights three key phases that an organization implementing new health IT must manage: adoption, imple-

Table 1: Agency for Healthcare Research and Quality (AHRQ) Health Information Technology Grants (2004–2007)

<i>Type of Grants (n = 104 Projects)</i>	<i>Purpose of Grant</i>	<i>Funding Period</i>
Planning grants (n = 38)	Assist community partnership organizations with the development of plans to implement community-wide health IT	1 year (2004)
Implementation grants (n = 40)	Fund organizations or community partnerships with the adoption of specific health IT	3 years (2004–2006)
Value grants (n = 26)	Fund research documenting the clinical, safety, quality, financial, and other benefits of health IT	3 years (2004–2006)

At the close of the 1-year Planning grant period, AHRQ awarded implementation grants to 16 of the original 38 Planning grantees. These grants are only counted once in the table, under the Planning grants.

Figure 1: Conceptual Framework for Implementing Health Information Technology



mentation, and sustainability. Each phase consists of specific elements that must be addressed to successfully implement the IT system. Throughout each phase, the involvement of end users (such as physicians or nurses) is critical. Successful health IT implementation is also influenced by a host of internal and external environmental factors, such as resource constraints, organizational commitment and leadership support, and the extent to which a community has adopted other health IT solutions.

METHODS

To assess the experiences of the health IT projects, we extracted and tabulated descriptive data from the grant proposals, and we conducted interviews with the AHRQ health IT grantees. The study population consisted of all the 104 health IT Planning, Implementation, and Value grantees funded in 2004. The 16 Planning grantees that were awarded Implementation grants in 2005 were part of the study population only as Planning grants; we did not collect data from them about their subsequent implementation experiences.

Between May and December 2005, we conducted 1-hour telephone interviews with the AHRQ health IT grantees to elicit information about their experiences in adopting, implementing, and sustaining health IT, and environmental factors affecting those experiences. For the Value grants, we also asked about their experiences in evaluating effects of health IT. The project leads were interviewed approximately 12 months after their grants were awarded. They included hospital and health system CEOs, leaders of multistakeholder collaboratives, and researchers. The interviews were conducted by a group of researchers with extensive interview experience within this evaluation, as well as in other research.

We developed three versions of the interview guide, each tailored to be used with one of the three groups of health IT projects. All versions included a core set of questions, which enabled us to compare experiences across groups. The version for each project group also included other questions tailored to address the relevant phase(s) of health IT adoption for the group, as well as environmental effects on their activities, as delineated in the conceptual framework. For example, Planning grantee activity generally was limited to the adoption phase, although in some cases they also anticipated issues that would arise in subsequent stages of implementation, such as how to sustain their effort. The activities of the Implementation and Value grantees fell primarily in the implementation and sustainability phases. The following are examples of topics addressed:

- *Adoption*: Assessment of needs and goals, partnership issues, engagement of end users in planning.
- *Implementation*: Experiences in field testing and implementation, partnership issues, interactions with end users, facilitating factors, issues that arose.
- *Sustainability*: Facilitating factors for sustainability, assessment of IT impact, system modifications required, issues to resolve, requirements for replication elsewhere.
- *Internal and External Environment*: Effects on implementation progress from organizational culture, organizational infrastructure and processes, senior management support, changes in partners' commitment or roles, changes in external environment.

We completed interviews with the principal investigators of 97 of the 104 projects. Of the seven grantees whom we were unable to interview, six either did not respond to interview requests or canceled the interview (and attempts to reschedule the interview failed), and one was unable to participate in an interview.

We analyzed the qualitative responses to interview questions by aggregating responses related to each topic within the framework. We then identified common themes that emerged from the collective information, as well as topics or issues for which grantees' perceptions or experiences varied. Working with these themes, we summarized the common experiences of the grantees within each group and identified the key issues they raised. We used the areas of differing perceptions or experiences to highlight variations across grantees and provide specific examples of relevant issues. Experiences were also compared across grantee groups.

RESULTS

The RFA for the health IT grants specified that funded projects were to involve health IT partnerships and that AHRQ was to spend 50 percent of the funding for projects in rural areas. We found that the projects varied in the number of partners involved, with most projects having significant representation of hospitals, physician practices or clinics, and universities. We also found that 72 percent of the health IT projects were rural, many of which involved both urban and rural areas and providers. Many of the projects also addressed issues for special populations, including the elderly, minority populations, or low-income populations (Farley et al. 2008).

Table 2 describes the types of health IT addressed by the AHRQ health IT projects. The projects emphasized use of health IT to alter the organizational infrastructure and to prevent errors, using system-wide interventions (within an institution or across partnered organizations), such as EHRs, decision support, CPOE, or community-wide data exchange. Care processes on which they focused included medication ordering and administration, hand-offs (transitioning patients from one health care provider to another), and coordination of care procedures (Farley et al. 2008; Sorbero et al. 2008, in this issue).

Adoption Phase

The Planning grantees reported that their decisions to implement health IT were primarily internally motivated, rather than driven by external pressures. They had identified needs within their organizations or partner organizations that they believed could be addressed by implementing health IT. They wanted to ensure the technology was designed to meet the needs and priorities of the end users, and most grantees reported including end users in efforts to assess the needs and establish goals for the project.

Table 2: Technologies Addressed by the Agency for Healthcare Research and Quality (AHRQ) Health Information Technology (Health IT) Projects

<i>Type of Health IT</i>	<i>Type of Grantee</i>			
	<i>Planning</i>	<i>Implementation</i>	<i>Value</i>	<i>Total</i>
Decision support	18	29	18	65
Computerized provider order entry	11	15	9	34
Electronic prescribing	4	4	1	9
Electronic health records	21	22	2	45
Patient decision support	3	3	5	11
Results reporting	6	5	3	14
Data collection and summary	9	13	4	26
Data exchange and information	32	24	3	59
Knowledge retrieval systems	2	0	1	3
Communication systems	8	7	7	22
Mobile computing	1	6	2	9
Administrative	3	4	0	7
Other	1	1	0	2
Not specified	1	0	1	2
Average number of technologies per project	3.2	3.3	2.2	

Note: Data were derived from the AHRQ master file of patient safety projects and grantee proposals. Categorization was based on a taxonomy developed by RAND (Giroi, Meili, and Scoville 2005).

The Implementation grantees similarly reported that their decisions were internally driven, and they selected the health IT they would implement based on identified needs of their patient population. They felt their internal decision processes provided important motivation and support for the project and the people involved.

There was universal recognition among the Planning and Implementation grantees that implementation of health IT would require workflow changes. The Implementation grantees highlighted that workflow redesign is critical and it is important to “spend time at the front end to get it right.” Some Planning grantees had engaged in extensive workflow mapping and redesign activities, while others were leaving this to the implementation phase. Some grantees specifically built time and flexibility into their work plans to assess potential impact on workflow and to allow adequate transition time.

Implementation Phase

The Implementation grantees repeatedly identified the importance of pilot testing the health IT before going live, to ensure the successful launch of the new technology. Pilot testing will help detect and correct early system

malfunctions, which can undermine support for the health IT. Grantees also noted that the reliability of the health IT system is important and that interruptions and reverting to back-up systems is painful. Because introducing health IT can have a negative short-term effect on productivity, it was important to monitor productivity changes during implementation.

The grantees identified effective communication as a key to successful implementation. They found that understanding the upstream and downstream consequences of changes in processes is important, and that the changes need to be managed proactively, which requires ongoing communication. They also identified the need to strike a balance between standardization and tailoring in the choice of health IT, taking into consideration variations across providers in practice preferences—which again required communication. When working across multiple decision makers, effective communication becomes more difficult and requires more time.

Technical issues commonly experienced by grantees were limitations of IT technical “know-how” within their organizations and inadequate prior experience with health IT implementation. They reported having difficulty in keeping up with rapidly changing technology. Many found they got inadequate support from IT vendors, and they needed to seek additional external consulting support to be able to fully implement. They also needed to continuously refine application software to meet end users’ requirements, and they had to manage interdependencies across sites for consistency in software and procedures. They found that new health IT that complemented and integrated with other existing products was easier for physicians and others to use. Training of end users was more demanding than they expected, requiring one-to-one training with physicians as well as long durations of training.

For the implementation process itself, the Implementation grantees underscored the importance of leadership by a good project manager. With sufficient time allocated to the task, this person could keep the project a high priority both for the leadership of partnering organizations and for departments within each of the partnering organizations.

Human dynamics also needed to be managed actively in health IT implementation. Most grantees reported that many end-user staff resisted change because it would involve significant changes in the way they do their daily work, and they often felt overwhelmed by the extent of change. Grantees sought to lower user resistance by customizing the systems to minimize impact on workflow, tailoring the interface to the specific needs of end users, demonstrating how IT can make end user jobs easier, and making it simple to use. They also noted that successful implementation required commitment

from top management, dedicated staff and financial resources in place and ready for implementation, an open process to encourage buy-in and enthusiasm by end users, and sheer persistence throughout implementation.

Sustainability

The AHRQ funding for health IT provided many of the Planning grantees with the ability to pursue health IT in their organizations, and it supported the Implementation grantees in moving from an idea to a reality. For many, the funding gave them the necessary legitimacy to make health IT a priority for their organization and acted as a catalyst to bring organizations together. However, many grantees reported that they still needed to obtain additional financial resources for their projects. While most were able to find the needed funding for at least the initial phases of the project, concerns existed about keeping health IT a priority for the organization over the long term, in light of conflicting priorities and competing projects. In partnerships involving diverse organizations, many grantees were concerned about the ability of low-resource organizations to sustain the health IT over time.

Interaction with Users

The majority of grantees indicated that end users were involved in planning for health IT implementation, typically in needs assessments and priority-setting activities. End users were most involved in figuring out the purpose and content of the health IT, but not its specific functions. Several Planning grantees also found it useful to assess the computer skills and literacy of potential end users, and so they could plan for the education required to support successful implementation. In the implementation stage, the Implementation grantees emphasized the importance of involving end users in testing the technology and obtaining their feedback, which enabled them to make modifications before going to full-scale operation.

As discussed above, several Planning grantees experienced resistance from end users in the early stages of planning, which they said “pushed us to make more of an effort to involve end users in the planning process.” The Implementation grantees suggested that end user willingness to adopt tended to be related to the age of the user and their familiarity with the systems (i.e., computers, PDAs) on which health IT operates.

Both Planning and Implementation grantees noted that physicians tended to be the most resistant to health IT adoption. Planning grantees worked hard to engage physicians early in the planning process to minimize

resistance during implementation. The Implementation grantees stressed that physician “buy-in” was essential for implementation to be successful.

Experiences Working with Partners

Virtually all the information obtained about working with partners was from the Planning grantees, who were very much in the process of establishing those relationships. Partnerships varied in size, and grantees observed that a large partnership sometimes brought great value to the project and at other times created challenges. Often, a business relationship already existed between the partners or evolved from existing working groups, whereas for some, the partners were brought together because they shared a common patient population or health care priorities.

Partner roles tended to be well defined, generally with one organization having primary responsibility for managing the progress and administrative tasks of the project. Lead partners typically were those with the greatest financial resources, the most IT experience, or representative of the largest number of providers to be affected by the health IT being adopted. Partner traits deemed most critical for project success were contribution of significant financial resources, availability of IT expertise and capabilities, or filling a central role in the health care delivery system (which conferred credibility).

The Planning grantees noted that the key to maintaining partnerships was honest, open, and frequent communication with the aim of building trust, understanding other partners’ priorities, and grasping their organizational and operational environments and constraints. They reported that developing a shared vision among the partner organizations and the process of working together were just as important to project success, if not more so, than the technological product being developed.

Also posing challenges for projects were philosophical differences among the partners and the potential for competing priorities, which often were manifested in discussions about data sharing and governance structures. A number of grantees suggested that finding an “early win” is a key factor for success in multiorganizational initiatives to encourage sustained commitment of partners and end users.

External and Internal Environmental Influences

The most commonly cited environmental factors affecting health IT implementation were internal ones: leadership commitment, adequate financial resources, and an organizational culture that supports the goals to be achieved

through adoption of health IT. In particular, the importance of organizational leadership was mentioned repeatedly by the Implementation grantees. Most often, upper level management staff were involved in their health IT projects, especially in shaping the project vision, requesting project updates, and assisting in removing barriers to implementation. Grantees noted that keeping health IT as a high priority across their partnerships was especially challenging because every institution had its own priorities for use of financial and non-financial resources.

The most important external environmental factor identified by the health IT grantees was the Health Insurance Portability and Accountability Act (HIPAA). HIPAA privacy provisions raised legal issues regarding acquiring, storing, and sharing health care information. It was also important to involve patients in the health IT implementation process because, under HIPAA, patients would need to give permission for accessing and transmitting their medical information through data exchange systems. Technical factors also surfaced, such as the need for nationally recognized standards for health IT interoperability.

Issues in Evaluating Effects of Health IT

Evaluation of the effects of health IT was a component of both the Implementation grants and the Value grants, although their focus differed substantially.

Implementation Grants. The AHRQ grant required the Implementation grantees to assess effects of the systems they implemented, to help build the evidence base for health IT. At the time of our review, the majority of grantees either were unsure how to evaluate or had formulated relatively weak evaluation plans. Most grantees were relying on pre-post or post-only study designs, many without control groups. Therefore many of the grantees were not likely to yield results that could contribute to the evidence about effects of health IT adoption.

Implementation grant staff tended to be frontline health care professionals who lacked expertise regarding how to devise and conduct a robust impact assessment. The grantees encountered challenges with data collection because the implementing organizations placed a priority on health IT implementation, not on evaluation. They also reported there was a deficiency of validated evaluation instruments and measures.

Value Grants. The Value grantees were to assess the value of health IT being implemented across a variety of health care settings. These grants were led by researchers who had evaluation research experience. Sixteen of the 25 grantees interviewed reported they were evaluating health IT that was in place for < 1 year; the others were evaluating health IT that had been in place for longer. At the time of interviews, projects were just starting either the implementation of the health IT or collecting baseline data.

The Value grantees reported they were using a variety of data sources to measure health IT effects related to clinical issues, such as process of care delivery, clinical outcomes, coordination among providers, and patient involvement and satisfaction. The majority were also measuring benefits related to patient safety (e.g., reductions in errors, near misses, and adverse events) and financial outcomes (e.g., improved efficiency and provider productivity, reductions in costs, and enhanced revenue).

The care processes assessed by the Value grants are shown in Table 3. Most grantees were assessing changes in clinical practices and workflow, with smaller numbers assessing other changes. Change in clinical practice was defined by whether health IT has become a standard component of clinical

Table 3: Topics and Designs of Evaluations by the Health Information Technology (Health IT) Value Grant

<i>Evaluation Element</i>	<i>Number of Grantees (N = 25)</i>
Changes in care processes assessed	
Clinical practices	18
Clinical workflow	15
Administrative practices	3
Staff deployment	4
Patient relations	2
Cultural factors	7
Evaluation design components	
Measurement type	
Pre-post measurement	13
Time series	10
Posttest only	2
Unknown	2
Used control groups	19
Sampling strategy	
Random assignment to intervention/control	10
Population-based samples	7
Samples matched on characteristics	4
Convenience sampling	3

practice. To assess it, grantees were examining the frequency of use of the health IT by providers, the degree of compliance with the recommendations from the health IT, and changes in productivity.

Also as shown in Table 3, the Value grantees' evaluations used a variety of research designs. A majority of them used control groups, either pre-post or time-series measurement, and either random sampling or population-based samples, which suggests a strength in study design that we did not find for the Implementation grantees' evaluations.

For successful evaluation, the grantees highlighted the importance of giving early thought to the type of information needed at the conclusion of the project, being explicit about the measures and types of data to be used, and being clear in analysis about who is accruing the value of the technology and looking at value from multiple perspectives. They also noted the need for health IT projects to have continuous monitoring for real-time feedback and adjustment.

The Value grantees faced several methodological challenges to assessing health IT effects. Owing to lack of validated measurement tools, both internal and external peer inputs were needed to explore how to define and operationalize new data elements. They also had to develop new analytic methods to better understand the complexity of the processes involved (e.g., patient-provider communication).

Several grantees found the process of collecting financial data to estimate the value of the health IT to be complex and difficult. As a result, they did not include financial measures in the evaluation designs, or they used just a few discrete measures, such as hardware or personnel costs, which do not capture all costs associated with implementation. Measures of return on investment were rarely included due to problems obtaining the requisite data.

Grantees experienced data acquisition problems when data were held by a different organization or when organizations lacked the staff resources to do the data collection. Grantees who had greater success in securing data tended to be those who already had relationships with their implementation partners before the grant, had a data collection and reporting infrastructure in place before the grant started, and conducted the work entirely within one organization.

Replicability

Across the Planning, Implementation, and Value grants, most of the grantees felt that other organizations could replicate their work. They reiterated that

technology alone is not enough and that projects will need to address the “human side of things,” including personal interactions, relationships, and building trust among each partners and around the technology. The Planning grantees noted that the key components of successful planning are collaboration, effective leadership, and trust, but that each community will need to design its planning and development process to be responsive to unique local needs. Implementation grantees noted that implementation would be facilitated by organizations having IT expertise and substantial funding resources, and that success would depend on the sophistication of the implementing organizations. The Value grant projects generally were using standard research methods that could be used by others.

DISCUSSION

Twelve months into their projects, the AHRQ-funded health IT grantees were experiencing success in implementing technologies that held promise for improving patient safety. Also encouraging was the finding that most of the grantees from all three groups were in strong agreement that knowledge gained and technology systems and products developed could be transferred to other organizations.

Key factors related to their success encompassed several of the components of the conceptual framework. For instance, engaging end users in all steps of the adoption and implementation process was critical to ensure that the technology met the needs and priorities of the end users, and users were ready to work with it. Factors considered important to project sustainability included offering continuous training opportunities and assessment of the technology, monitoring its use and usefulness, and identification of any necessary modifications. An important facilitator for sustainability was having an organizational environment where the leadership is supportive, in terms of autonomy and the commitment of financial and nonfinancial resources.

To facilitate diffusion of technology necessary for improving patient safety and quality, others need to learn what are the determinants of a successful implementation and which IT applications do in fact have an impact. Therefore, it is important for these health IT projects to monitor and evaluate their implementation processes and effects. Given our finding about the weakness of evaluation designs developed by the Implementation health IT projects, they may be unable to adequately document the effects of their health IT systems on clinical effectiveness, clinical outcomes, and efficiency.

AHRQ has developed technical support to help them strengthen their evaluations, and continuing follow-up and support likely will be needed. The stronger evaluation designs used by the Value grants, on the other hand, suggest they will have greater success in assessing the effects of the health IT being implemented, and therefore, contributing to the evidence for health IT effects.

CONCLUSION

The information gathered in this patient safety evaluation activity documents the experiences and progress made by the AHRQ-funded health IT projects, providing rich information for use by health care providers, AHRQ, and other policy makers to help strengthen future health IT development efforts. It also highlights the usefulness of gathering qualitative information to “tell the story” of the planning, implementation, and evaluation processes undertaken by the funded projects, as well as the value of establishing a conceptual framework to guide the evaluation data collection and analysis. Important issues were identified regarding the evaluations performed by the projects of their health IT systems, including the technical issues faced by grantees during implementation and the inadequacy of the evaluation designs used by the Implementation grants, which also merit attention by AHRQ and other policy makers.

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NOTE

1. AHRQ also funded five state-level Regional Health Information Networks projects that were evaluated separately.

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