

The use of open source electronic health records within the federal safety net

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ABSTRACT

Objective To conduct a federally funded study that examines the acquisition, implementation and operation of open source electronic health records (EHR) within safety net medical settings, such as federally qualified health centers (FQHC).

Methods and materials The study was conducted by the National Opinion Research Center (NORC) at the University of Chicago from April to September 2010. The NORC team undertook a comprehensive environmental scan, including a literature review, a dozen key informant interviews using a semistructured protocol, and a series of site visits to West Virginia, California and Arizona FQHC that were currently using an open source EHR.

Results Five of the six sites that were chosen as part of the study found a number of advantages in the use of their open source EHR system, such as utilizing a large community of users and developers to modify their EHR to fit the needs of their provider and patient communities, and lower acquisition and implementation costs as compared to a commercial system.

Discussion Despite these advantages, many of the informants and site visit participants felt that widespread dissemination and use of open source was restrained due to a negative connotation regarding this type of software. In addition, a number of participants stated that there is a necessary level of technical acumen needed within the FQHC to make an open source EHR effective.

Conclusions An open source EHR provides advantages for FQHC that have limited resources to acquire and implement an EHR, but additional study is needed to evaluate its overall effectiveness.

BACKGROUND AND SIGNIFICANCE

In 2008, the Health Information Technology for Economic and Clinical Health (HITECH) Act authorized the Secretary of Health and Human Services to conduct a study to determine the availability and utility of open-source health information technology (IT) systems among federal safety net providers. This includes healthcare providers located in rural or medically underserved areas, as well as providers that deliver healthcare to uninsured individuals, Medicaid beneficiaries, state children's health insurance program (SCHIP) beneficiaries and other vulnerable individuals. In addition, the legislation also specifically required that the study examine the total cost of ownership of such systems, the ability of such systems to respond to the needs of, and be applied to, various populations (including children and disabled individuals),

and the capacity of such systems to facilitate interoperability.

Open source electronic health records (EHR) have taken on greater significance as the growing number of uninsured individuals has sharply increased the importance of federal safety net providers. These community health centers (CHC) serve over 20 million of the 60 million medically disenfranchised, and typically provide care for low-income, underserved communities.¹ Many health center patients lack consistent access to preventive and primary care services,² and the rates of chronic care diseases seen at health centers are increasing rapidly. Between 2000 and 2007, the number of patients treated for diabetes or hypertension rose faster than the total number of patients visiting a CHC.³

Open source is defined as the ability to copy, modify, use and distribute software source code.⁴ Because the source code is freely available to all potential users, open source software development is more flexible and transparent than other processes and, therefore, encourages a practice of collaboration among developers and users of the software.⁵ The open source community promotes sharing, enhancing and adding applications to the base source code, and provides an avenue to release modified versions of the application for the benefit of the user community as a whole.⁶ Moreover, the peer-review process associated with this governance structure of software development fosters innovation and validates the integrity of the changes made to the source code. The leading example of this process is the Linux operating system; although a substantial number of developers refined and contributed changes to the source code, only a number of these suggested changes are incorporated into the main application.⁷

Safety net providers, including CHC, have justified investments in health IT based on the clinical benefits expected to result from EHR adoption and implementation.⁸ The benefits of EHR technology have been particularly pronounced in health centers where many patients are transitory and experience the effects of poor chronic disease management.⁹ For instance, EHR-generated data enable health centers to notify patients who are in need of immunizations or routine health checks. For conditions such as diabetes or heart disease, the EHR may alert providers or clinicians to remind patients to have their blood pressure or blood glucose measured. In addition, many health center staff believe that the ability to coordinate care using health IT will provide patients with the opportunity to take a more active interest in their health.¹⁰

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Table 1 Key research questions

Domain	Research question
Availability	What is the current availability of open source health IT systems, especially for use by federal safety net providers?
Cost	What is the total cost of these systems and how does this compare to the total costs of commercial systems currently in use?
Specific populations	Can open source systems address the needs of diverse populations (such as children and the disabled)?
Interoperability	Are open source systems capable of facilitating the interoperability of health IT?
Meaningful use	Can an open source system be used to support reaching and maintaining meaningful use objectives?

IT, information technology.

OBJECTIVES

The National Opinion Research Center (NORC) at the University of Chicago was contracted by the US Department of Health and Human Services to conduct this study and develop a final report. The report addressed several research questions related to the use of open source health IT technologies and their potential, as shown in table 1.

The study also assessed the current state of open source health IT within safety net settings, such as federally qualified health centers (FQHC) and provided insights into the need for health IT technology within these environments, what constitutes open source, the currently available open source health IT systems, the licences that accompany these products, an estimate of the total cost of ownership for these systems, and an assessment of the utilization of open source health IT for diverse populations. While the report covered the overall environment of health IT, a specific focus was placed on EHR, because the current meaningful use criteria primarily applies to the use of an EHR system to support specific functionality.

MATERIALS AND METHODS

NORC conducted a comprehensive environmental scan that included the identification of relevant academic and trade literature, white papers, non-published literature, copies of testimony by key experts in the areas of open source, as well as speeches and presentations. In addition, NORC identified other key topics that were viewed as significant to a discussion of open source health IT, such as functional requirements for a system in rural health settings, interoperability standards, newly emerging technologies in open source not specifically related to EHR, use of open source for provider communities excluded from the HITECH payment incentives, and the commercialization of open source health IT products, such as the Veterans Information System and Technology Architecture (Vista), for

use outside of the federal government. The environmental scan was composed of three major components: a literature review, key informant interviews and site visits. Guidance and direction for the methodology were provided by a technical expert panel consisting of recognized experts in the area of open source and healthcare, and were approved by the US Department of Health and Human Services.

The literature review consisted of accessing databases such as MEDLINE, the Cochrane Database of Systematic Reviews, PubMed, Academic Search Premier, and others. The search terms included, 'open source EHRs', 'veterans information system and technology architecture', 'open source licensing', 'open source health IT communities', 'resource patient and management system (RPMS)', and 'Vista software alliance', among others. Key informant discussions were also conducted using a semistructured protocol with either developers of open source health IT products or implementers of open source solutions. Each interviewee was asked a series of general questions regarding either development or implementation in order to uncover key themes or concepts with the implementation and use of an open source EHR.

The NORC team also conducted a series of site visits to FQHC that were currently using an open source EHR and served both Medicare and Medicaid populations, as shown in table 2. FQHC is a federal designation from the Health Resources and Services Administration (HRSA) and refers to a CHC that is located in or serves a federally designated medically underserved area/population.¹¹ These visits provided a better understanding of the factors that affect the utilization of open source by providing insight into consistent practices, lessons learned or emerging trends.

RESULTS

This study was conducted between April and September 2010, with over 200 articles reviewed, in addition to a dozen key informant interviews as well as the site visits. Four of the six FQHC visited by the NORC team had implemented a version of either Vista from the Department of Veterans Affairs (VA) or the Resource Patient and Management System (RPMS) from the Indian Health Service. In addition, one site used ClearHealth, which is an open source practice management system and EHR based out of Arizona, while another site used OpenMRS, which is an open source software platform and a reference application, which enables the design of a customized medical records system. Each of these systems had been acquired and implemented for over a year, and in some cases, the EHR have been in operation for several years.

A number of the sites were satisfied with their EHR system, believing that it contained the appropriate level of functionality to support patient care and to streamline the workflow within their FQHC. The systems were acquired without significant

Table 2 Site visit locations and open source electronic health record (EHR) products

Name of facility	Location	Type of open source EHR
Primary Care Systems, Inc. (part of Community Health Network of West Virginia)	Clay, WV	MedLynks—(resource patient management system)
Family Health Centers of San Diego	San Diego, CA	WorldVista
JWCH Institute, Inc.	Los Angeles, CA	OpenMRS
Operation Samahan	National City, CA	ClearHealth
Adelante Healthcare	Surprise, AZ	WorldVista
Wesley Community Health Center	Phoenix, AZ	WorldVista

difficulty, either through a dedicated web site (such as openmrs.org) or through a third-party organization that acquired the software and made it available for download for those interested in acquiring an open source solution. The modifications made to the systems were done through collaboration between the providers, the administrators of the FQHC and either consultants or technical staff with both familiarity and understanding of the EHR product. Some sites had redesigned their care delivery system to focus on comprehensive care for their patient community and used the EHR to assist in that effort.

To facilitate the adoption of EHR in safety net settings, the American Recovery and Reinvestment Act (ARRA) allocated nearly US\$1 billion to support the acquisition of health IT infrastructure, including the purchase of EHR software.¹² In addition, providers working in community health settings are also eligible to receive meaningful use incentive payments from CMS starting in 2011. The grant funds provided by ARRA and the potential to receive meaningful use incentives have created significant opportunities for CHC to adopt and implement health IT. Reported health IT adoption rates for these safety net settings range from 13% to 40%.¹³ Greater adoption, even with these accessible funding channels, has not occurred, as the resource-poor environments that characterize these safety net facilities and the areas in which these providers practice serve as cost restraints in adopting EHR systems.

Based on the literature, the financial needs of safety net providers are particularly unique. CHC 'tend to be chronically short of financial resources', because these organizations get most of their operating revenues from public grants and Medicaid payments.¹⁴ Together, these sources account for nearly 70% of all operating revenues for CHC, and approximately half of these facilities report negative operating margins each year. Even for those with positive operating margins, there is little flexibility in their budgets for investment in EHR due to the lack of capital to invest in a health IT system; as well as the lack of funds for the system's ongoing maintenance.

Through data collected from both the key informant interviews and the technical expert panel, one of the purported advantages of adopting and implementing an open source system is its lower cost in terms of both acquisition and operations relative to commercial systems.¹⁵ In the site visits conducted as part of this study, the FQHC examined already had a computerized practice management system used for scheduling and billing purposes and had integrated this with the open source EHR. Some of these open source systems were custom built for the practices they were serving, while others were part of a larger health IT system. For example, Primary Care Systems Inc. in West Virginia adapted the RPMS software for use in its CHC. This new system, called MedLynks, was configured to the unique needs of the facility by focusing on incorporating elements of the chronic care model without changing the underlying source code. Many of the CHC looked to the open source solution as an improvement tool that would help them substantially better serve their clients, rather than purely as an IT solution.

Some of the open source systems examined during this study required customization to correct problems that may not have become apparent during the initial acquisition. Within the RPMS EHR, the medication management module posed a daunting concern to the CHC within West Virginia. The module was designed in a manner in which the pharmacist finishes the medication order despite a lack of trade names within their database. It was necessary to modify the business logic and customize the software to allow for an auto-finish for providers entering prescriptions, by displaying trade names

along with generic names, in order to create familiarity with providers.

In addition, a safety net provider deciding on an open source EHR solution would incur acquisition costs for a one-time implementation of the system that chiefly consisted of training medical staff through a 'train-the-trainer' model used consistently at most FQHC. Ongoing implementation costs would vary based on the number of modules added into the core system, the type of technical expertise available within the CHC, and any future upgrades to the CHC's infrastructure.

Based on the data collected from the literature and the site visits, the average total cost of ownership for the acquisition, implementation and use of an open source EHR was 30–60% less than that of a similar commercial system, as was shown within each of the CHC visited during this study. However, the amount of data supporting this conclusion is sparse, as only a small number of CHC were able to produce specific cost data relating to the acquisition, implementation and operation of their system. There was only one published study that researched the acquisition, implementation and maintenance costs of commercial EHR systems across CHC, and that did not include an open source comparison. As the characteristics between CHC are varied, it was difficult to make a direct comparison to determine the difference in total cost of ownership between the open source and commercial EHR systems with any degree of certainty.

A few of the open source EHR that were part of the site visits were modified to take care of specific populations or conditions. Operation Samahan, located outside of San Diego, California, provides a full suite of healthcare services, ranging from clinical care to family planning, dentistry and elder care. They worked with ClearHealth to modify the system to create a care record that incorporated all of the services they provided. The JWCH Institute in Los Angeles was using an altered version of the OpenMRS system to focus on the tuberculosis vaccination status of the homeless population within their community, which totaled approximately 12 000 individuals. Furthermore, they developed a comprehensive data sharing agreement with the Los Angeles Department of Social Services to include the housing status of these individuals within this system. Finally, Primary Care Centers, Inc. in West Virginia incorporated tenets of the chronic care model and used their RPMS system to assist in the facilitation of care teams, provide prompts and clinical reminders to alert patient and providers of routine health checks for diabetes, hypertension and hypolipidemia, and assist patients in better self-management practices for their health.

Each of the open source systems was designed to be interoperable as they were all variants of VistA or RPMS, which can transmit information among other, similar systems. The flexibility of open source provides a development community that can create, modify or redevelop source code to align with nationally published messaging or vocabulary standards. Furthermore, each of these systems supported a number of the requirements of Stage One of meaningful use. Those EHR at a number of locations had electronic prescribing functionality, monitored vaccination status for children and adults, could order laboratory tests and receive results electronically, and other functions. While each site did not require the full suite of functionality associated with meaningful use, they could reach back to the development community for a module or source code to accommodate their needs.

DISCUSSION

It remains a question as to why open source EHR are not more widespread, given the number of implementations within

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FHQC and their effective use in assisting with the provision of care to their communities. One of the barriers discussed between both the technical expert panel and the key informant interviews was misperception: the belief of what constitutes open source as compared to what it actually is. One of these misperceptions is the identification of open source software with public domain software. Open source and public domain are two different paradigms in developing and releasing software. Public domain software is a product that has been placed in the public domain, in which there is no ownership of the intellectual property that the software represents. The author or designer of the source code disclaims all ownership rights of the product once it is released to the public.¹⁶ In contrast, an open source environment distributes source code through a licensing agreement. The original authors or designers of the product do not release their intellectual property rights over the original code. Therefore, private products (ie, not publically distributed modifications and enhancements to open source code) can remain private.¹⁷

Another common misperception described to the NORC team is that the acquisition and implementation of open source software is free, providing significant financial savings for organizations that have limited resources. While the acquisition of the source code is often free or available at a nominal cost, the implementation and use of the system is not. In most cases, organizations that lack the appropriate technical experience and understanding of the product will need to hire consultants or companies with the acumen to install and maintain the product as well as train staff to use it. Moreover, a number of the products identified in this study were modified to adapt to the clinical processes and needs in other environments outside the Department of VA and the Indian Health Service. In organizations in which those resources are available, the overall cost can be lower than a commercial product depending on the complexity of the application, the amount of time needed for implementation, and the type of ongoing support and training needed.

A final misconception is that open source EHR cannot meet and satisfy meaningful use requirements. However, the users of the EHR are often the co-developers and testers of the product, and often incorporate software code modifications to increase usability or to tailor the product to the needs of their facility. Many of the sites visited during this study indicated that this flexibility within open source allowed developers to respond directly to and incorporate meaningful use provisions into their product, and in a number of cases, certain functions such as electronic prescribing were already designed into the system. Furthermore, they noted, a number of these systems, such as VistA and RPMS, were specifically designed for chronic disease and population health management,¹⁸ which are key goals of meaningful use.

Other barriers were identified through the site visits and the literature, such as the general lack of expertise individuals have with these open source systems, particularly with its components, such as FileMan and with the MUMPS programming language. As a result, some safety net providers must turn to consultants or outside organizations to provide the support needed, potentially negating the cost savings realized through a free software licence. While some open source EHR organizations offer subscription-based support to assist in the implementation, maintenance and support of the system, those prices can still prove to be burdensome, depending on the size of the setting and the functionality that is needed.

Although the allocation of funds under the stimulus act provided a means of offsetting the initial expenditure of an EHR,

the burden of care for the uninsured and moderate reimbursement through either Medicaid or Medicare brought about low margins, which restricted the use of discretionary funds for any type of infrastructure acquisition. Furthermore, the funds under the EHR incentive program are designated for eligible providers, who can opt to designate the money to the FQHC, but are not required to do so. This led to some uncertainty about how many dollars were available for an EHR, and drove the discussion in looking for lower-cost alternatives that provided the needed functionality, such as a WorldVistA or ClearHealth system.

Even with the possibility of receiving incentive funds, a number of CHC sought to reduce costs by using internal staff to implement, maintain and support the EHR system. However, the NORC team noted some potential risks associated with this approach, such as safety net settings that did not have the adequate technical expertise to maintain a system or network using programming languages of open source systems, such as RPMS. In most cases, one single person had most of the technical expertise and was responsible for the implementation and maintenance of the open source EHR system for the entire organization, which created a 'single point of failure'. If this individual left the organization for any reason, the expertise and institutional knowledge would leave as well. Unless the safety net provider appropriately trained a successor, the organization would find itself in the precarious position of trying to maintain and support a system with limited expertise. The health centers would then find themselves in the position of hiring consultants or an outside organization to assist with the process, which could be a potentially financially burdensome course of action.

This was the case with Adelante Healthcare, which had installed WorldVistA almost 2 years before the site visit, and was in the process of disabling the system to replace it with a product more suited to their needs. The EHR was not specifically addressing the needs of their clinical staff or patient population; it was producing patient documentation that was inaccurate, and it was becoming difficult to modify or maintain as there was a lack of expertise with the VistA platform within this FQHC, which made them heavily dependent on contractors to correct these problems. This became a financially prohibitive solution that eventually forced Adelante to discontinue its use.

Finally, even with the flexibility that open source provided to a number of sites and the ability to utilize a robust development community for modification or fixes, there is still a limited number of integration and/or services ecosystems that promote open source EHR solutions. While many of the products identified in this study have a dedicated organization that designs and implements these systems as well as promoting a developer ecosystem, there is not a singular group that brings together all of these products and associated services, as well as the methods for integrating them within their clinical environment. It can become difficult for users or implementers to identify potential solutions to their problems, such as standard application programming interfaces for their system, or for developers to submit changes or additions to a system that can potentially affect a number of open source EHR.

However, there are potential solutions to this, in that organizations such as the Open Source EHR Agent (OSEHRA) provides a community of users, developers, service providers, and researchers engaged in advancing open source EHR software and related health information technology. Created by the Department of VA as an agent to collect information, contributions and solutions regarding the VistA EHR, the community has evolved to provide key modules to the VistA architecture, refactoring services for VistA, and a comparison tool to identify

differences between the open source EHR application and production VistA instances in VA hospitals and clinics. It has become a singular point of access for users, implementers and developers to find solutions and ideas.¹⁹

CONCLUSION

Despite the fact that both VistA and RPMS have been in existence for some time and that systems such as ClearHealth and OpenMRS have achieved successful domestic and international implementations, there are still a number of factors that inhibits widespread implementation, such as: a strong misperception as to what open source truly is; that significant technical expertise is needed to install and maintain an open source application successfully; and that an open source product is not free and can, over time, prove to be as costly as a commercial product. These factors were echoed repeatedly between those serving on the technical expert panel, the key informants interviewed for this study, and those interviewed as part of the site visits.

However, the benefit and utilization of open source EHR within the FQHC visited by the NORC team provided ample evidence to indicate that these systems created workflow efficiencies within their clinical environments. The open source systems possessed tools and functionality to provide comprehensive chronic disease management, as well as serving as a catalyst to change or modify the care delivery system within these settings. This enabled providers not only to focus on the immediate clinical need of a patient, but also to provide better tools to track prevention and wellness of chronic conditions common within these communities, such as diabetes or high blood pressure. The open source EHR also provided robust functionality that assisted in the management and administration of the FQHC, and provided immediate benefits to patients by incorporating the functionality propagated by the meaningful use requirements. In addition, open source EHR on the whole achieved high user satisfaction. Although some users encountered issues with implementation and maintenance, a strong majority concurred that these problems did not detract from the utility and future potential of these systems.

A common theme echoed by a number of the individuals interviewed as part of this study was that because of its experience in the successful development and implementation of open source EHR such as VistA and RPMS, as well as its ability to assist in the promotion and advancement of open source health IT systems, the federal government should do more to help safety net health providers make use of EHR. The government should provide this assistance in a number of forms, including a re-examination of the 330 grant applications presented under ARRA that allowed for the acquisition and implementation of certified EHR solutions and the development of a community of practice for developers and implementers of open source health IT solutions.

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methodology for the site visits and key informant interviews, assisted in the development of the background and significance section and reviewed and gave final approval before the paper was sent. AEM assisted in the development of the site visit protocols, assisted in the development of the results section, and reviewed and gave final approval before the paper was sent. AB developed the background section on open source, contributed content on open source governance, and reviewed and gave final approval before the paper was sent. KC conducted a significant part of the literature review for the project and the paper, assisted in the development of the key findings and conclusions, and reviewed and gave final approval before the paper was sent.

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