About the Book
The Center for Information Technology Leadership’s (CITL) Value of Personal Health Records report examines the value proposition for implementing personal health records (PHRs) throughout the US. This analysis quantifies the cost-benefit of a variety of infrastructure, administrative, and clinical PHR functions including:

- Sharing of complete medication lists
- Sharing of complete test results
- Appointment scheduling
- Medication renewals
- Pre-encounter questionnaires
- E-visits
- Congestive heart failure (CHF) remote monitoring
- Smoking cessation management

CITL modeled these eight functions for provider-tethered, payer-tethered, third-party, and interoperable PHRs, examining differing deployment strategies to achieving 80 percent adoption by the US population. The report includes a detailed cost model for each type of PHR system.

About the Center for Information Technology Leadership
The Center for Information Technology Leadership (CITL) in Boston is a not-for-profit research organization chartered by Partners Healthcare System and supported by a strategic alliance with Healthcare Information and Management Systems Society (HIMSS). Using a rigorous analytic approach, CITL assesses clinical information technologies and disseminates its findings to help provider organizations maximize the value of their IT investments, help technology firms understand how to improve the value proposition of their healthcare products, and inform national healthcare IT policy discussions. For more information, visit www.citl.org.
This research was supported through unrestricted funding from the following organizations:

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CITL is generously supported by:
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Published and distributed by the Healthcare Information and Management System Society (HIMSS).

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ISBN: 978-0-9800697-4-7

For more information about CITL, please visit www.citl.org.
This research was supported through unrestricted funding from the following organizations:

Google

Healthcare Information Management and Systems Society (HIMSS)

InterComponentWare AG

Kaiser Permanente

Microsoft Corporation

Partners HealthCare
The Center for Information Technology Leadership (CITL), a research center based at Partners HealthCare System, received unrestricted research support from the Healthcare Information Management Systems Society (HIMSS) during the time this research was conducted.

Please refer to the CITL web site (www.citl.org) for a full listing of past and current sponsors. None of the sponsors played a role in the following: design and conduct of the study; the collection, management, analysis, and interpretation of the data; or the preparation, review, or approval of this manuscript.

*CITL is ultimately responsible for the projections and commentary presented in this report. We are indebted to those who advised us and offered suggestions during the project.*

The authors acknowledge the members of our Advisory Board for their contributions. Advisory Board members received financial compensation for their time and efforts, except those designated by an asterisk (*) who declined or whose employment status did not allow them to accept any financial compensation for their participation. The following individuals comprised the panel:

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We would also like to acknowledge the following individuals who provided valuable contributions to this project:

- Qi Li, MD, Carefx
- Tonya Hongsermeier, MD, Partners Healthcare
- Jesse Kramer, BA, Center for Information Technology Leadership
- Clara Mahdasian, BA, Center for Information Technology Leadership
- Barbara Massoudi, PhD, Research Triangle Institute
- Ellen Rosenblatt, BA, Center for Information Technology Leadership
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Personal health records (PHRs) have the potential to dramatically change healthcare over the coming years. They should enable patients to become more involved and engaged in their care and allow other authorized stakeholders to access information about patients that was previously not available, costly to obtain, or difficult to access electronically. The changes effected by PHR systems could have a significant, positive impact on the efficiency of administrative and clinical processes within healthcare, thus resulting in considerable cost savings to the healthcare system. However, many barriers exist to widespread PHR installation, adoption, and use, foremost among them the lack of evidence for a definitive value proposition. In this report, the Center for Information Technology Leadership (CITL) examines the value of PHR systems, primarily with respect to their direct financial costs and benefits.

CITL defines a PHR using the Markle Foundation’s description:

“The Personal Health Record (PHR) is an Internet-based set of tools that allows people to access and coordinate their lifelong health information and make appropriate parts of it available to those who need it.”

In this regard, CITL views a PHR as more than a patient-controlled, electronic repository of patients’ administrative and clinical data. While such repositories are at the core of a PHR, CITL views PHRs as patient-controlled health information systems—aggregations of different types of data and functions that enable a range of data storage, exchanges, and transactions among healthcare stakeholders. Accordingly, this report focuses on defining and analyzing the value of PHR systems.

CITL considered two primary components in a PHR system—infrastructure, and applications utilizing the infrastructure. The PHR infrastructure includes components and functions that allow patients to collect and share their health information. PHR applications are any functions within a PHR system that allow patients to manage their own health and the health of others (dependents) through education and monitoring as well as enable the exchange of data with others regarding their health and well being. Privacy and security functionality is embedded throughout the PHR system in both infrastructure and applications. These components form the basis of a PHR function taxonomy:

- Infrastructure Functions for healthcare information exchange
  - Information Collection
  - Information Sharing
• Application Functions
  o Information Self-Management
  o Information Exchange

PHR infrastructure and applications can support a wide range of functions; however, for this analysis, CITL evaluated a sample set of eight functions best supported by existing literature. Using a computer-based simulation, CITL modeled the best-available evidence and expert opinion of costs and benefits of PHR systems offering these eight functions:

1. Information Sharing
   a. Sharing complete medication lists: PHRs can collect and share a patient’s complete medication history—including prescription drugs, over-the-counter medications, herbals, and supplements—with healthcare providers and their information systems.
   b. Sharing complete test results: PHRs can collect and share a patient’s laboratory test results and radiological study interpretations with healthcare providers and their information systems.

2. Information Self-Management
   a. Congestive heart failure (CHF) remote monitoring: PHRs can monitor a patient’s weight and blood pressure through wireless devices, collect and share this data with healthcare providers, and provide disease management and educational support to patients and/or their caregivers.
   b. Smoking cessation management: PHRs can offer a tailored, web-based educational and support tool for patients trying to stop using tobacco.

3. Information Exchange
   a. Appointment scheduling: PHRs can enable patients to view an outpatient provider’s availability and schedule certain types of visits directly in a scheduling or practice management system.
   b. Medication renewals: PHRs can enable patients to renew their existing prescription medications online.
   c. Pre-encounter questionnaires: PHRs can supply patients with a range of forms and questionnaires and allow patients to complete these at their convenience prior to a visit.
   d. E-visits: PHRs can support secure messaging and structured online communications between patients and providers, allowing patients to describe current symptoms and conditions and providers to evaluate and recommend courses of action.

CITL developed a model that estimated the costs to develop the PHR infrastructure and the applications to support these eight PHR functions. These costs included clinical and administrative data repositories, client user authentication and authorization, data interfaces, record and data matching services, user support, data centers, and messaging. The model also incorporated estimates for PHR software application costs (designing, coding, usability, and testing).
CITL examined the eight PHR functions in the context of four PHR system architectures: provider-tethered, payer-tethered, third-party, and interoperable PHRs. Provider-tethered, payer-tethered, and third-party PHRs refer primarily to the data inherently associated with the PHR, and all have related examples in the current marketplace. Interoperable PHRs represent a future type of PHR in which all entities have access to the same data due to health data communication standards and interoperability.

CITL modeled the costs and benefits for national adoption and use of these four PHR systems, each offering the eight PHR functions listed above. CITL determined PHR acquisition and annual costs, as well as potential annual benefits, for each architecture. Key assumptions include:

- A 10-year rollout period for installation, adoption, and use, regardless of architecture.
- A steady state achieved after this 10-year period.
- A PHR usage rate of 80% of the US population in each PHR adoption scenario.
- Independent adoption of each PHR architecture to achieve 80% use, although in the current marketplace, multiple types of PHRs co-exist, with varying degree of use.

Contrasting national adoption of PHRs with the same functions but different architectures, CITL's analysis found that, with the exception of certain instances of provider-tethered PHRs, the benefits produced by PHRs far outweigh the long-term implementation costs. Major findings on the value projection of PHRs are summarized below.

From the perspective of the healthcare system, interoperable PHRs provide the greatest value to the US with net value of $19 billion annually.

Providing interoperable PHRs for 80% of the US population could cost an estimated $3.7 billion to acquire and an estimated $1.9 billion annually to maintain. Even with just the 8 functions in this model, interoperable PHRs could save $21 billion annually. The net annual value of interoperable PHRs could be $19 billion annually. The break-even point for a single installation of an interoperable PHR is approximately 52,000 active users. Although not in existence today, these interoperable PHRs are the most valuable to the US healthcare system, and represent the maximum potential value of PHRs.

The net value of provider-tethered, payer-tethered, and third-party PHR architectures to the US healthcare system could range from a loss of $29 billion to a cost-savings of $11 billion annually.

The cost to install existing PHR architectures for 80% of the US population could range from almost $5 billion for payer-tethered PHRs to more than $130 billion for provider-tethered PHRs. Annual costs could range from about $2 billion for payer-tethered PHRs to almost $13 billion for provider-tethered PHRs. Annual benefits could range from $11 billion for payer-tethered PHRs to $38 billion for provider-tethered PHRs.
tethered PHRs to approximately $43 billion for provider-tethered PHRs. Even with just the eight functions in this model, annual PHR benefits could range from $13 billion for payer-tethered PHRs to $16 billion for third-party PHRs. The steady-state net value could range from a loss of $29 billion annually for provider-tethered PHRs to a cost-savings of roughly $11 billion annually for payer-tethered and third-party PHRs. The break-even point for a single PHR installation ranges from approximately 59,000 active users for provider-tethered PHRs (equivalent to a practice size of roughly 30 full-time providers) to 47 million users for third-party PHRs.

Regardless of the type of PHR, direct healthcare savings could accrue to both payers and providers realizing the majority of the cost savings.

Payers consistently accrue the most savings from national PHR adoption across all types of PHRs – from five to 10 times the savings to providers, depending on PHR architecture. Third-party PHRs present a unique case in which entities not at risk for the costs of patient care (other than for their own employees), nor directly involved in delivery of healthcare services, are providing a technology that could yield significant net savings to payers and providers, with minimal or no cost to these stakeholders.

**PHR net value is highly dependent on the number of patients covered by a single PHR installation.**

CITL’s analysis demonstrates that PHR architectures experience considerable economies of scale; accordingly, their value proposition is significantly affected by the number of patients covered in one PHR installation. The number of users predicted to make a single installation of a PHR net positive are 47 million users for third-party PHRs, 62,000 users for payer-tethered PHRs, and 59,000 users for provider-tethered PHRs. In this model, to cover 80% of the US population, even small provider organizations need to install their own provider-tethered PHR, lowering the average number of users per PHR installation to 9,110, significantly below the average break-even point of 59,000 users. Thus, the large number of installations required significantly affects the cost–benefit of the provider-tethered PHR. The net value for provider-tethered PHRs decreases from $8 billion with only IDNs installing (50% coverage) to -$29 billion with IDNs, large, medium, and small provider groups (80% coverage). Therefore, the lack of economies of scale works heavily against provider-tethered PHRs in comparison to the other PHR architectures for national deployment.

**PHR net value is highly dependent on the reimbursement model of an e-visit.**

PHRs promise easier communication between patients and providers, an important dynamic that CITL modeled through e-visits. Although many patients perceive e-visits as valuable, the actual financial value to the healthcare systems depends on the reimbursement model. CITL modeled the predominant approach for e-visits that exists
in the marketplace today (i.e., the provider is not directly financially compensated for e-visits). Changes in the reimbursement assumptions could alter the value proposition for PHRs due to new costs for e-visits and could cause e-visits not to have a positive net value, possibly even causing PHRs with e-visit functionality to have a net negative value. For example, this model assumes that the average payment for an e-visit of $25 would decrease the overall benefit of PHRs by approximately 15% for provider-tethered PHRs to 45% for payer-tethered and third-party PHRs.

CITL’s analysis of PHR system value is conservative for several reasons: First, the model incorporates a limited number of PHR functions—a convenience sample of functionality, based on CITL’s literature review and expert opinion; the model underestimates the potential cost and benefit of PHRs that have additional functionality. Second, by restricting analysis to the direct impact of PHRs on the healthcare system, the potential direct financial impact of PHRs on people and organizations outside of the healthcare delivery system is not included. For example, additional benefit may arise if PHRs are used for clinical and population research activities, pharmacovigilence, and biosurveillance. Finally, PHRs could also provide indirect benefits, such as time and travel savings and improved patient and provider satisfaction, to patients and family members, or others who may facilitate care delivery. These indirect benefits are not included in the value model.

Although this analysis synthesized the best-available evidence and expert opinion into a simulation model of costs and benefits in different PHR scenarios, CITL recognizes that modeling the value of PHRs has inherent limitations. The model is an intentional approximation of the potential value for PHRs. Extrapolation from the model allows predictions of potential value. The model has only been validated by a consensus review process among domain experts and may differ dramatically from what will actually be experienced. Nevertheless, CITL hopes this analysis helps to inform the national debate about PHRs, PHR policy, and product strategy, allowing the US to move forward and use PHRs appropriately to help transform healthcare delivery.

In presenting these findings, CITL recognizes that many factors will affect the realization of these projections. In the dynamic PHR marketplace, it is unclear how many PHRs of any architecture actually exist, and multiple PHR architectures will continue to exist for the foreseeable future. Millions of dollars may be spent on PHRs that ultimately fail.

Overall, this value of PHR analysis demonstrates that PHRs will have value to the healthcare system through reduction of waste and error, decreased administrative costs, and decreased clinical care costs. This analysis predicts that interoperable PHRs will have the greatest net value to the US healthcare system. Provider-tethered, payer-tethered, and third-party PHRs can all become interoperable PHRs through the development and adoption of standards that allow for easy data exchange among all types of PHRs.
Development and adoption of PHR standards are key to achieving PHR value. A second key to achieving PHR value is the need to develop business models so that alignment exists between those paying for the PHRs and those receiving the benefits of the PHRs. Finally, as with other types of health IT, PHRs benefit from economies of scale. Therefore, deployment strategies that maximize the numbers of users per PHR installation will maximize the overall value of the PHR. Achieving these three objectives should enable PHRs to save the US healthcare system billions of dollars per year by transforming the healthcare system and the patient’s role accordingly.
The US healthcare marketplace continues to face pressures from rising costs. Although many factors contribute to rising costs, these increases are in part due to inefficiencies in the exchange of patient information within the healthcare system—or poor data liquidity between disparate information systems. Patient information is often retained in various systems because patients, on average, have four outpatient visits per year, and typically these visits are not with the same provider.\textsuperscript{2, 3} The efficient exchange of this information is critical to improved quality of care and cost containment.\textsuperscript{4, 5}

Experts hypothesize that increased patient engagement in their healthcare can improve quality and outcomes and ultimately help control spiraling costs. Patients who have consistently high engagement with their care team may help lower costs through improved lifestyle choices\textsuperscript{6} and health behaviors, decreased utilization of health services through better disease management,\textsuperscript{7, 8} improved care coordination,\textsuperscript{9, 10} and improved adherence to recommended care.\textsuperscript{9} Evidence also suggests that patients’ engagement in their healthcare can result in better outcomes and improved quality via active communications with their provider, improved participation in shared decision making, and improved responsibility for their health.\textsuperscript{11} The landmark report from the Institute of Medicine, \textit{Crossing the Quality Chasm: A New Health System for the 21st Century},\textsuperscript{12} states 10 rules for improving healthcare quality and explains that the success of six of these 10 “rules” depends directly on patients’ involvement in their care.\textsuperscript{13} Furthermore, in 2003, the Markle Foundation examined the current state of patient engagement and patient decision-making activities, among which personal health records (PHRs) are included.\textsuperscript{14} As this report and other literature have shown, PHRs are a key factor in improving patient involvement in their care and, thereby, serving as one important means to help address quality and cost issues.

PHRs are a rapidly expanding area in the field of health information technology (IT). Health IT is perceived by many as a mechanism to help improve the availability and exchange of patient information among the various stakeholders in the healthcare system (e.g., payers, providers).\textsuperscript{4, 5} Experts have specifically identified PHRs as a technology that has the potential to improve healthcare delivery and the quality of care, improve data availability and exchange, control costs of care, and increase patient engagement in their care.\textsuperscript{14}

Currently, there are many PHR products in the marketplace. Sources estimate that there are between 100 to 200 PHR products in the US.\textsuperscript{15-17} PHRs are provided through a variety of platforms: free-standing, web-based, universal serial bus (USB)-based, or tethered to an electronic health record (EHR). The diverse array of products and variety of platforms contributes to the nebulous definition of this technology. In 2006, the Markle
Foundation proposed the following description:

“The Personal Health Record (PHR) is an Internet-based set of tools that allows people to access and coordinate their lifelong health information and make appropriate parts of it available to those who need it.”

Other experts have also proposed definitions of PHRs. In 2002, Kim and Johnson defined PHRs as a simple data repository that stores core health information from both providers and patients and allows this information to be reviewed or sent to outside users. In 2006, Tang et al. envisioned PHRs as both the personal data and tools that allow patients to manage their health more independently, such as remote monitoring for chronic disease management and related content to support patient decision making about their care. The common thread throughout all of these definitions is the emphasis on increased patients’ involvement in their care.

In addition to this array of products and varying platforms, PHRs are sponsored by a variety of stakeholders. The sponsor (i.e., the responsible party providing the PHR to the patient) includes providers, payers, employers, and third-party organizations. Accordingly, the value proposition for different sponsors of PHRs may vary as well.

PHRs are a relatively immature health IT product, and the value proposition for this technology is still unclear. Despite the excitement about PHRs and the increasing proliferation of PHRs in the marketplace, solid evidence on the value of this technology has yet to be demonstrated, and a great variety of potential business models exist. CITL’s preliminary literature review revealed that the literature to date primarily examines the qualitative value of PHRs, the data elements necessary for a PHR, and the usability and acceptance of PHRs. However, few published reports on PHRs have analyzed their financial value, either on a large scale or by comparing different types of PHRs. Transparent value is critical to the adoption and effective use of this technology.

CITL asserts that the success of PHRs depends on several factors, including a clear value proposition, provider adoption, and patient use. Millions of dollars are spent each year in the US developing, implementing, and maintaining PHRs, and consumers are interested in using them. Currently, six in 10 Americans say they would use a PHR if given the opportunity. Roughly 75% of Americans say they would communicate electronically with their physicians, about 60% would look up test results and track medication use through PHRs if these records were available, and 70% believe that PHRs would improve the quality of healthcare. In addition, 60 to 70% of respondents in one study indicated that PHRs would improve provider-patient communication, allow patients to ask better questions, prevent medical mistakes, give patients more control over their healthcare, and change the way patients take care of themselves. Interest in PHRs is even greater among people with chronic health conditions and increased health expenses. This information clearly demonstrates the potential consumer demand for PHRs.
Strikingly, PHR use among patients who currently have access to one appears to be relatively low. Today, an estimated 70 million people in the US have access to some form of a PHR, generally through their health insurer, yet only 2% of Americans store their medical records on a computer. In addition, there are multiple third-party efforts underway to provide a PHR to all Americans with Internet access. Low PHR adoption may in part be due to ongoing challenges in gathering data from external data sources into a PHR and from a lack of robust functionality that patients want and need.

The success of PHRs will ultimately depend on a clear value proposition: to patients, to providers, and to those enterprises sponsoring PHRs. The lack of solid evidence for the value of this technology—whether financial, clinical, or organizational—prompted CITL to perform an analysis of the potential value of PHRs. Now is the optimal time to undertake such value analyses because millions of dollars, and millions of people, are already becoming engaged in PHRs with different data sources, architectures, and functions.

CITL sought to determine the cost-benefit of PHRs across a variety of PHR types: provider-tethered PHRs, payer-tethered PHRs, third-party PHRs, and interoperable PHRs. To estimate this value, CITL assessed the available evidence, interviewed experts in the field, and developed a taxonomy that accounts for PHR infrastructure and applications. Using this taxonomy as a framework, evidence was synthesized to develop a computer-based simulation model using the best-available data. The model projects costs and benefits of PHR systems to the US categorized by PHR architecture. This report details CITL's approach to this analysis, model projections, and implications given these results. The goal of this research is to help healthcare system stakeholders—providers, payers, and policymakers—make informed decisions about the potential value of various PHR models, implementation alternatives, and system capabilities.
CITL used its five-step methodology, described in Appendix A, to develop a value model for PHRs. CITL has applied this methodology to develop value models of other emerging health IT, including ambulatory computerized physician order entry,\textsuperscript{24} health information exchange and interoperability,\textsuperscript{4,5} information technology-enabled diabetes management,\textsuperscript{25} and provider-to-provider telehealth.\textsuperscript{26} The five steps of CITL’s process include the following:

- Creation of Advisory Board
- Literature Review
- Taxonomy Definition
- Evidence Synthesis
- Model Development

Further details on the application of this methodology to the PHR analysis are provided below.

**Creation of Advisory Board**

CITL worked with an Advisory Board of nationally recognized PHR experts throughout this project. The board met monthly via teleconference and participated in a face-to-face meeting in November 2007. It was consulted to advise CITL on the analytic framework, taxonomy, model estimates, preliminary findings, and review of the final report. Members of the Advisory Board include:

- Jane Barlow, MD, MPH, MBA, Medco Health Solutions Incorporated
- William Crawford, MBA, Children’s Hospital Boston
- Robert Heyl, Aetna Incorporated
- David Lansky, PhD, Pacific Business Group on Health
- Omid Moghadam, MS, MBA, Intel Genomics
- Kim M. Nazi, Veterans Administration
- Danny Sands, MD, MPH, Cisco Systems
- Paul Tang, MD, MS, Palo Alto Medical Foundation
- Jonathan S. Wald, MD, MPH Partners HealthCare

Full biographies for the Advisory Board are in Appendix B.
Literature Review

CITL completed a systematic review of the literature aimed at academic and trade journals that were most likely to contain data relevant to the analysis. CITL consulted a medical librarian to develop a search strategy that was then vetted with the Advisory Board. CITL identified 22 key words and phrases related to PHRs and searched PubMed, Business Sources Complete, and ABI/Inform. This search strategy yielded 493 references. The references were further reduced to 265 by limiting references to peer-reviewed articles in English over the last 10 years (1997-2007). Abstracts were obtained on the 265 references, and two researchers reviewed each abstract for consensus to fully abstract each article. Disagreements were discussed until consensus was met, and ultimately, 137 articles were abstracted.

Details on the search strategy and results of the literature review are in Appendix C.

PHR Taxonomies

CITL created two different taxonomies to frame the PHR analysis: a function taxonomy and an architecture taxonomy.

Function Taxonomy

CITL developed a function taxonomy to categorize the types of PHR functions. This taxonomy was then used to structure the value model. CITL used the Markle Foundation definition to develop a PHR taxonomy. The Markle Foundation defines a PHR along three dimensions: access medium (desktop-based PHRs, web-based programs, and portable devices); data (patient-sourced and professionally-sourced); and functions (both the viewing and sharing of patient’s core health information, which may include content or transactional functionality). CITL’s taxonomy starts from the perspective of the patient, since a PHR is meant to empower patients in their own healthcare. In order to empower patients, a PHR needs to provide them with the ability to use their data as well as the ability to interact with their healthcare providers, payers, and benefits managers. Accordingly, CITL defines a PHR as consisting of both infrastructure and application components, as shown in Figure 2-1, that support multiple types of interactions with multiple parties.
The PHR infrastructure consists of functions that allow patients to store and view their health information. In many ways, the PHR infrastructure is similar to the regional health information organization (RHIO) or national health information network (NHIN) model. A PHR infrastructure can function as a conduit between different data sources, bringing data into and out of the medical record. User authentication and authorization protocols ensure secure access and protect the patient’s data. These protocols include data encryption as well as application programming interfaces (APIs) through which authorized external parties can view and access data in the PHR. A PHR application is any function within a PHR system that allows patients to learn about, monitor, manage their own health and the health of others, and to exchange data with others regarding their health and well-being.

**PHR Functions**

Based on the PHR taxonomy, CITL defined four categories of PHR functions, two within the PHR infrastructure and two within the PHR applications:

1. Information Collection (IC)—functions of a PHR system that “pull” and aggregate data from multiple external data sources (e.g., payer, provider) and data types. Data types consist of clinical data (e.g., medications, test results, images), administrative data (e.g., claims, insurance), and self-entered data (e.g., over-the-counter medications, exercise, and dietary information).
2. Information Sharing (IS)—functions of a PHR system that allow patients and external parties to view health information in a PHR. The PHR infrastructure acts as a conduit between different data sources, bringing data into and out of the PHR.

3. Information Self-Management (ISM)—functions within a PHR system that enable patients to learn about, monitor, and/or manage their health and the health of others (i.e., children, dependent adults). These functions use all types of data stored in the PHR, ranging from blood pressure measurements to claims data to provider contact information.

4. Information Exchange (IE)—functions within a PHR system that allow patients to engage in automated data exchange transactions with others regarding their health or healthcare.

With these categories, CITL developed a detailed list of potential PHR functions (Table 2-1), recognizing that the set of potential PHR functions could be much larger.

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<th>PHR Function</th>
<th>Definition</th>
<th>Examples of PHR Function</th>
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<tr>
<td><strong>Information Collection (IC)</strong></td>
<td>Functions that aggregate data from multiple, external data sources</td>
<td></td>
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<tr>
<td>Patient Diaries</td>
<td>Allows the user to enter narratives to track healthcare information.</td>
<td>Disease diaries to chart the progress of the care and disease to be potentially shared with external parties, to capture questions or thoughts from recent visits, or events for future discussion with healthcare providers.</td>
</tr>
<tr>
<td>Family History</td>
<td>Allows users to enter data about their family’s medical history.</td>
<td>Can better track potential health problems for users, and if shared, their healthcare providers. May enable certain reminders.</td>
</tr>
<tr>
<td>Health Information Lists</td>
<td>Entry screens that allow patients to enter their own data as a supplement to data from other sources.</td>
<td>Entry screens for immunizations, medications, encounters, problems, allergies/reactions, and laboratory/radiology/test results.</td>
</tr>
<tr>
<td>Verification of Patient Information</td>
<td>Allows the patient to supplement/correct data in the PHR from other sources.</td>
<td>Screens that display and allow editing of immunizations, medications, encounters, problems, allergies/reactions, and/or laboratory/radiology/test results.</td>
</tr>
<tr>
<td><strong>Information Sharing (IS)</strong></td>
<td>Functions that allow patients and others to view health information</td>
<td></td>
</tr>
<tr>
<td>Laboratory/Radiology/Test Result Viewing</td>
<td>Allows users to share the results of any tests to approved external parties.</td>
<td>Used in avoiding redundant tests that were performed with other providers, comparing current tests with past ones to improve care delivery, and monitoring progression of certain ailments.</td>
</tr>
<tr>
<td>Provider Visit Summary Note Viewing</td>
<td>Allows users to share the results of any visits to approved external parties.</td>
<td>Used to inform current providers of past assessments by other providers, such as in the treatment of chronic conditions.</td>
</tr>
<tr>
<td>PHR Function</td>
<td>Definition</td>
<td>Examples of PHR Function</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Summary Sheets of Health Information</td>
<td>Allows for the sharing (e.g., printable, remote viewing) of summaries of health information to better facilitate healthcare delivery.</td>
<td>Presentations of problem lists, allergies, medications, encounters, and test results for new providers and/or emergency room visits.</td>
</tr>
<tr>
<td>Information Self-Management (ISM)</td>
<td>Functions that allow patients to learn about, monitor, and/or manage their own health and the health of others.</td>
<td></td>
</tr>
<tr>
<td>Reminders</td>
<td>Allows for active reminders (e.g., pop-ups in PHR, email messages) for healthcare events and maintenance.</td>
<td>Reminders for consults/referrals, immunizations, laboratory, medication, radiology, screening/preventive care, and/or upcoming visits.</td>
</tr>
<tr>
<td>Disease Management Plans</td>
<td>A list of personal health goals and steps for the user to follow for a chronic condition.</td>
<td>Chronic diseases such as asthma, obesity, CHF, and diabetes would have disease management plans available to the user.</td>
</tr>
<tr>
<td>Healthcare Education</td>
<td>Allows users to learn about their health to better manage themselves.</td>
<td>Educational materials on diagnoses/conditions, insurance coverage, lifestyle choices, medications, provider selection, treatment selection, and standards of care.</td>
</tr>
<tr>
<td>Healthcare Expense/Billing Tracking</td>
<td>Allows users to track and aggregate their healthcare expenditures.</td>
<td>Data views that capture when, where, and the amount of money spent for healthcare.</td>
</tr>
<tr>
<td>Information Exchange (IE)</td>
<td>Functions that allow patients to engage in automated data exchange transactions with others regarding their health/healthcare</td>
<td></td>
</tr>
<tr>
<td>Healthcare Support</td>
<td>Allows the user to interact with patients sharing similar conditions and share healthcare delivery experiences.</td>
<td>Support groups for diagnoses/conditions, insurance coverage, lifestyle choices, medications, provider selection, treatment selection, and shared patient experiences.</td>
</tr>
<tr>
<td>Appointment Scheduling</td>
<td>Allows users to self-select appointment times to meet with their provider.</td>
<td>Automated selection of visit times from a calendar or email messaging to obtain visit times.</td>
</tr>
<tr>
<td>Care Management Questionnaires</td>
<td>Information gathering pre-visit to facilitate clinical encounter, care monitoring, and improved feedback to provider.</td>
<td>Questionnaires that gather clinical and/or administrative data from the user either before or after a healthcare encounter.</td>
</tr>
<tr>
<td>Medication Management</td>
<td>Allows users to contact healthcare professionals regarding their prescriptions.</td>
<td>Messaging to check on the status of medication filling, requesting medication refills and renewals.</td>
</tr>
<tr>
<td>Secure Messaging</td>
<td>Allows users to contact healthcare professionals for any questions about their health as well as for the health of others for whom they are a healthcare proxy.</td>
<td>Emails, which would function as an e-visit, to ask questions regarding care management plans, new symptoms/ailments, and/or current health issues.</td>
</tr>
</tbody>
</table>
Architecture Taxonomy

CITL also created an architecture taxonomy to capture the costs and benefits of the potential types of PHRs. CITL modeled the differences between PHR architectures, both those that currently exist in the healthcare marketplace as well as PHRs that do not currently exist. CITL defined the architectures using four dimensions: methods of data incorporation, types of data systems, number of data sources, and type of data exchange.

Methods of Data Incorporation

Data incorporation is the means by which information of any kind is entered into a PHR—typically either through automatic electronic population or through manual data entry. The source of data often determines the method of incorporation. There are three primary types of data sources: professionally-sourced, patient-sourced, and patient-rekeyed. Professionally-sourced data consists of any clinical (e.g., provider, laboratory) or financial (e.g., payer, pharmacy) data provided by entities responsible for the delivery and administration of healthcare. These data are usually entered into PHRs automatically via data exchange among different types of healthcare information systems or interfaces among different applications. Patient-sourced data is any data entered by the patient that is not provided by a professional organization, such as a patient diary, over-the-counter medication lists, or medical device data. Patient-rekeyed data consists of any data provided to the patient by a professional source that is then manually typed into the PHR by the patient rather than uploaded electronically.

CITL used professionally sourced data as the first dimension of its architecture taxonomy. Patient-sourced data were considered to be available by all types of architectures and were therefore not useful in distinguishing PHR architectures. Patient-rekeyed data were excluded as they significantly decrease the value of the information in the PHR due to the possibility of data entry errors and the significant workload on patients.

Types of Data Systems

CITL considered three types of data within professionally sourced data: clinical, administrative, and mixed. Clinical data is information from a healthcare provider's electronic health record (EHR), such as problem lists, test results, current medications, and appointment schedules. Administrative data is information from a payer organization's data system, such as information found in evidence-of-benefit statements or claims on cost of care, diagnoses, procedure codes, encounter dates, and coverage information. Mixed data consist of a combination of these two data sources, thus creating a more complete and robust data set.

Number of Data Sources

A PHR has either one or multiple data sources. A PHR with one data source considers a single connection to a data silo. A PHR with multiple data sources considers the connection to any number of systems and applications.
**Type of Data Exchange**

There are two types of data exchange between a PHR and other healthcare information systems: machine-organizable and machine-interpretable. Machine-organizable, or manual data exchange, applies to data sent electronically from one organization to another with no standards used; this exchange requires human involvement to import the data into local data systems.\(^4\), \(^5\) In addition, the recipient of the data cannot update, correct, or otherwise respond to the originating system. An example of machine-organizable data exchange is when a PHR system can import data from a physician’s EHR system yet a patient’s annotations and corrections in the PHR to the data cannot flow back to the EHR from the PHR. Another example is when a PHR system can send an electronic appointment request to a physician’s practice management system (PMS) yet the PMS does not acknowledge nor confirm the appointment electronically, thus requiring the patient to manually key the appointment into the PHR. Machine-interpretable, or automated data exchange, allows the PHR and any external data sources to exchange data electronically bi-directionally without manual intervention. The adoption and use of data standards enables this exchange.

**Modeled PHR Architectures**

CITL used these four dimensions—methods of data incorporation, types of data systems, number of data sources, and type of data exchange—to distinguish the four PHR architectures evaluated in this analysis: provider-tethered, payer-tethered, third-party, and interoperable. CITL chose to model the first three PHR architectures because they are the most prevalent in the current market. Interoperable PHRs were modeled as the fourth architecture to examine the impact of standards on PHR data aggregation. The following descriptions explain how each architecture differs based on the dimensions outlined above. The architecture taxonomy does not consider stakeholder sponsorship and endorsement. CITL recognizes that sponsorship and endorsement will influence the value of PHRs, but the particular design and architecture of the PHR is a stronger driver of value.

**Provider-Tethered**

Provider-tethered PHRs represent healthcare delivery organizations that offer a PHR to their patients. Provider-tethered PHRs are internally connected to the database of the provider’s EHR and PMS systems. Patients can send messages to payers and other providers via manual communication channels such as secure email but are unable to directly integrate external data. The important distinction is that the provider-tethered PHR reflects the source of the underlying data and not the legislative or business entities supplying the PHR. For example, a provider-tethered PHR could be offered by a software vendor as long as there is only one directly connected and integrated provider data source. Figure 2–2 provides a representation of the provider-tethered PHR.
Payer-Tethered

Payer-tethered PHRs represent healthcare insurance companies that offer a PHR to their members. Payer-tethered PHRs are internally connected to their administrative databases. Patients can communicate with providers and other payers via manual communication channels such as secure email but are unable to directly integrate external data. Similar to provider-tethered PHRs, payer-tethered PHRs reflect the source of the underlying data and not the political or business entities that ultimately supply the PHR. Figure 2-3 provides a representation of the payer-tethered PHR.
Third-Party
Third-party PHRs are aggregators of healthcare data for users. Third-party PHRs aggregate data through manual data exchanges, which import the data from external sources but are unable to feed the data into clinical or administrative systems in their native format. Users can only contact parties external to the PHR through manual communication channels. Figure 2-4 provides a representation of the third-party PHR.
Interoperable PHRs rely on regional aggregation of patient’s healthcare data to users. In this scenario, PHRs are populated with data from all regional data sources via standards-based automated data exchange. The connections with these sources would create a record that is more complete than any individual repository (e.g., EHRs, other PHRs, payer claims databases). Figure 2-5 provides a representation of the interoperable PHR.
Providers—There are three options for providers (from solo physician to large IDN) who want to provide a PHR to their patients. In the first option the provider can create a PHR that is based solely on its internal data systems, which is a provider-tethered PHR. This would benefit the provider by enabling patients to view lab results, edit and supplement their medication lists, and allow for automated appointment scheduling, but would not help patients track their healthcare expenditures or learn more about their levels of coverage. In the second option, the provider may want to include data from other providers, payers, or other organizations that have different data systems. This would function as a third-party PHR. This PHR option would provide a more robust set of functions and data sets but requires the construction of separate interfaces to each data source, which are costly without data standards. In the third option, the provider may want to connect with other organizations, where data standards would enable direct links to all data. This PHR option would act as an interoperable PHR. This option would save the provider the cost of building interfaces to the other data systems.

Payers—There are three options for payers that want to provide a PHR to their members. In the first option the payer can create a PHR that is based solely on its internal data systems, which is a payer-tethered PHR. This would benefit the payer by allowing patients to track their healthcare expenditures or learn more about their levels of coverage but would not enable patients to view lab results, edit and supplement their medication lists, and allow for automated appointment scheduling. In the second option the payer may want to include data from other payers, providers, or other organizations that have different data systems. This option would function as a third-party PHR. This PHR provides a more robust set of functions and data sets but requires the construction of separate interfaces to each data source, which are costly without data standards. In the third option the payer may want to connect with other organizations, where data standards would enable direct links to all data. This option would act as an interoperable PHR.

Evidence Synthesis

Value Clusters and Value Chains
CITL examined the literature to determine where evidence of PHR impacts clustered in conjunction with the taxonomy. Three such clusters were identified for PHRs, all having an impact on healthcare costs: 1) information sharing; 2) information self-management; and 3) information exchange. CITL distilled the evidence in these value
clusters into a series of value chains. A value chain is the representation of the process for transforming healthcare system statistics and technology impact data into projected value outcomes. The value chains in CITL’s PHR model project the value of eight functions in three function categories:

1. Information Sharing
   a. Sharing of complete test results: A function that enables the patient’s test results from laboratory tests and imaging studies to be shared with providers, with functionality differing by the type of data exchange. For manual data exchange, test results are available through the PHR as non-interpretable data files (e.g., Adobe Acrobat PDFs), requiring the provider to manually process the test results. With automated data exchange, test results ordered by different providers in different healthcare systems are automatically uploaded from the patient’s PHR into the EHR of the patient’s current provider.
   b. Sharing of complete medication lists: A function that enables the patients’ medication list to be shared with their provider’s EHR.

2. Information Self-Management
   a. Congestive heart failure (CHF) management: An interactive, web-based, closed loop application that will automatically receive data from a digital scale and monitor the patient’s weight and symptoms, provide automatic decision support to patients regarding the management of their disease, and, when appropriate, notify the patient’s healthcare team.
   b. Smoking cessation management: An interactive, web-based application that will have components similar to current online smoking cessation programs, including educational materials, goal setting, reminders, and peer-to-peer and peer-to-provider communication tools.

3. Information Exchange
   a. Appointment scheduling: An interactive, web-based application that provides patients with direct access scheduling to their provider (similar to on-line airplane flight booking), with functionality differing by the type of data exchange. CITL modeled both a manual processing application (i.e., one in which the medical secretary has to manually enter the appointment request into the scheduling program of the EHR) as well as an automated processing application (i.e., one in which the appointment can be scheduled directly into the provider’s scheduling program).
   b. Medication renewals: An interactive, web-based application that includes a drop-down list of the patient’s current medications and then automatically sends the structured renewal request information to the patient’s provider, with functionality differing by the type of data exchange. For manual data exchange, CITL modeled a manual processing of a medication renewal (i.e., one in which the medication renewal request is sent using the messaging service of the PHR). For automated data exchange, CITL modeled an automated processing (i.e., one in which the medication to be renewed is fed directly into the provider’s medication renewal workflow process).
   c. Pre-encounter questionnaires: An interactive, web-based application that includes
a templated questionnaire for entering demographic and insurance information that is then error checked and automatically routed to the provider’s intake administrative personnel, with functionality differing by the type of data exchange. For manual data exchange, CITL modeled a manual processing application (i.e., one in which the medical secretary has to manually enter the pre-encounter questionnaire data into the EHR from the messaging service of the PHR). For automated data exchange, CITL modeled an automated processing (i.e., one in which the pre-encounter questionnaire is uploaded directly into the provider’s PMS).

d. E-visits: A clinical encounter where patients pose questions to their clinician using secure messaging. The clinician then responds with a plan of action also via messaging through the PHR.

Model Development
CITL developed a computer simulation model to estimate the cost and benefits of PHRs. This section details the assumptions and analyses that are built into the model. Chapter 3 contains details on the inputs to the benefits model. Chapter 4 contains details on the inputs to the cost model. Appendix D contains the details on the construction and model components as implemented in Analytica.

Estimation of PHR Adoption
For the national rollout analysis, CITL needed to estimate the number of PHR installations that ensure 80% adoption by the US population at the end of the 10-year timeframe. This assumption represents a hypothetical adoption rate and is not meant to be a forecast of the US adoption rate in the next decade. The adoption rate used in this analysis is meant to serve as a benchmark to compare the different architectures. The choice of 80% serves as a goal to be reached by the healthcare industry, and the results show the potential benefits if that level is reached. Therefore, CITL defined an approach to estimate the number of PHRs based on a maximum adoption level of 80%. The following paragraphs describe the approach taken to determine the number of PHR installations for each of the four PHR architectures:

Provider-Tethered
CITL calculated the number of provider-tethered PHRs necessary to achieve 80% adoption based on the number of provider organizations. Since organizations provide different types of encounters, CITL used the number of ambulatory office visits as a proxy for total healthcare usage, recognizing that the majority of emergency room visits and hospitalizations occur at integrated healthcare delivery networks (IDNs) that also provide ambulatory care and thus would be captured by this method. CITL aggregated the provider groups based on a top-down approach that captures the largest organizations first and adds in progressively smaller groups until the desired threshold is reached, which in this case was 80% of provider office visits. First, CITL included the 1,453 IDNs,27 which account for approximately 50% of the 1 billion annual ambulatory visits in the United States.2, 3 CITL then assumed that the remaining 30% of patient visits would be covered by providers not in IDNs. However, there are no estimates of
the number of provider groups that are in IDNs. Therefore, CITL assumed that half of all provider organizations, which approximately total 295,000, would not be in IDNs. CITL estimated that the 25,025 largest provider groups would cover 30% of the remaining providers in the nation. CITL combined the two estimates to arrive at 26,478 provider installations that are necessary to achieve 80% PHR adoption by the US population and 149,000 installations to cover the entire US population.

**Payer-Tethered**

There are nearly 1,300 private payer organizations in the US and 56 government payer organizations (51 State Medicaid programs, Medicare, Civilian Health and Medical Program of the Uniformed Services—CHAMPUS, Civilian Health and Medical Program of the Department of Veterans Affairs—CHAMPVA, Veteran’s Health Administration, and the Indian Health Service). These 1,356 organizations cover roughly 84% of the US population. CITL reduced the number of private payer organizations by 50%, as the smallest 50% of insurance companies cover roughly 2.5% of the US population. CITL therefore estimated that 706 organizations (650 private payer organizations and 56 government payer organizations) would be necessary to achieve 80% PHR adoption by the US population.

**Third-Party**

There are currently approximately 89 third-party PHRs in the marketplace. CITL identified three main third-party initiatives in the PHR marketplace, each backed by major, national companies: Google Health, Microsoft’s HealthVault and Dossia. CITL believes these three third-party initiatives would be capable of supporting an 80% adoption rate for the US population, as each initiative is web-based and therefore easily accessible to everyone with Internet access.

**Interoperable**

There are 972 regions in the US with 10,000 or more people, accounting for nearly 100% of the US population. CITL estimated that 428 regions would be necessary to achieve 80% PHR adoption by the US population.

**Projection of Costs and Benefits**

CITL used three separate curves to project the costs and benefits over the 10-year span of the analysis: installation rollout, user adoption, and PHR usage. CITL’s projections start with zero installation, adoption, and use, ending at 100% installation, adoption, and usage for 80% of the US population.

**Installation Rollout**

Installation was considered to be the acquisition costs of the PHRs, which occurs over the course of a year, with annual costs occurring every year after the installation year. CITL assumed different organizations would install PHRs over a three-year period, with 25% installing in year one, reaching 100% installation in year three. CITL based
its installation curve on Roger’s Innovation Adoption Curve, which assumes installation occurs along a sigmoid curve,\textsuperscript{34} as shown in Figure 2-6.

\textbf{Three-Year PHR Installation Rollout Schedule}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure2-6}
\caption{Three-Year PHR Installation Rollout Schedule}
\end{figure}

\textit{Adoption Rollout}

Once a PHR is installed, it needs to be adopted by users (i.e., setting up accounts and assigning access rights). CITL assumed that adoption would occur over three years, starting with 25% adopting in the first year after installation and reaching 100% adoption within three years after installation, roughly following Roger’s Innovation Adoption Curve,\textsuperscript{34} as shown in Figure 2-7.

\textbf{Three-Year PHR Adoption Rollout Schedule}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure2-7}
\caption{Three-Year PHR Adoption Rollout Schedule}
\end{figure}
Usage Rollout
The final step after a PHR is installed and adopted is usage. CITL assumed that usage would occur over a five-year period, roughly following Roger’s Innovation Adoption Curve.\textsuperscript{34} CITL assumed 10\% use in the first year after installation and adoption and 100\% at the end of five years after installation and adoption is complete, as shown in Figure 2-8.

\textbf{Benefit Realization}
Upon installation, adoption, and use of a PHR system, the benefits occur immediately. Curves were sequentially superimposed upon each other to determine the benefit realization for the 10-year time frame of this analysis (Figure 2-9). None of the benefits of installing a PHR accrued until actual use began, which occurred after installation and adoption had occurred. All curves used were the same regardless of the type of PHR—payer-tethered, provider-tethered, third-party, or interoperable.
Sensitivity Analyses
CITL measured the sensitivity of its projections to uncertainties surrounding variables in the model that may significantly contribute to the model results. Actual variations in published literature or expert estimates were used to reflect the known uncertainty of these parameters. The variations in the parameters were then applied to the model in a univariate analysis to quantify the impact of each parameter’s uncertainty on CITL’s projected results. Table 2-2 contains a list of each variable examined in the sensitivity analysis as well as how its impact on overall model projections was estimated.
### Sensitivity Analysis Estimates

<table>
<thead>
<tr>
<th>Model Input</th>
<th>Sensitivity Analysis Method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Architecture Type (Number of Potential Installations)</strong></td>
<td></td>
</tr>
<tr>
<td>Provider-Tethered</td>
<td>Low = 1, High = 150,000</td>
</tr>
<tr>
<td>Payer-Tethered</td>
<td>Low = 1, High = 1,300</td>
</tr>
<tr>
<td>Third-Party</td>
<td>Low = 1, High = 89</td>
</tr>
<tr>
<td>Interoperable</td>
<td>Low = 1, High = 970</td>
</tr>
<tr>
<td><strong>Benefit Chains</strong></td>
<td></td>
</tr>
<tr>
<td>Sharing Complete Test Results Impact, Manual</td>
<td>Low/High Provided by Source</td>
</tr>
<tr>
<td>Sharing Complete Test Results Impact, Automatic</td>
<td>Low/High Provided by Source</td>
</tr>
<tr>
<td>CHF Remote Monitoring Impact</td>
<td>Low/High Provided by Source</td>
</tr>
<tr>
<td>Smoking Cessation Management Impact</td>
<td>Low/High Provided by Source</td>
</tr>
<tr>
<td>Appointment Scheduling Time Savings</td>
<td>Low/High by Type of Data Exchange, Provided by Source</td>
</tr>
<tr>
<td>Medication Renewal Time Savings</td>
<td>Low/High by Type of Data Exchange, Provided by Source</td>
</tr>
<tr>
<td>Pre-appointment Questionnaire Time Savings</td>
<td>Low/High by Type of Data Exchange, Provided by Source</td>
</tr>
<tr>
<td>Cost of E-visit</td>
<td>Low = $0, High = $25[35]</td>
</tr>
<tr>
<td>E-visit Face-to-Face Avoidance</td>
<td>Low/High Provided by Source</td>
</tr>
<tr>
<td><strong>Application Costs</strong></td>
<td></td>
</tr>
<tr>
<td>Application Development Costs</td>
<td>Low/High Provided by Source</td>
</tr>
<tr>
<td>Cost of CHF Digital Scale + Cable</td>
<td>Low/High Provided by Source</td>
</tr>
<tr>
<td><strong>Infrastructure Costs</strong></td>
<td></td>
</tr>
<tr>
<td>External Interface Costs</td>
<td>Low = $25,000, High = $100,000</td>
</tr>
<tr>
<td>Operations and Management Cost Ratio</td>
<td>Low = 15%, High = 25%</td>
</tr>
<tr>
<td>Number of Third-Party Interfaces</td>
<td>±25%</td>
</tr>
</tbody>
</table>

### Format of Reported Results

Sums in tables throughout this report may appear to be incorrect due to rounding. Numbers were rounded to two significant digits. The majority of amounts are in 2007 dollars. When 2007 figures are not available and where appropriate, prior year amounts were inflated to 2007 dollars based on US budgetary inflation figures[36] and indicated as such.
Chapter 3: Benefits of Personal Health Records

The benefits of PHRs are defined by the types of functions they support. As described in Chapter 2, there are a variety of potential PHR infrastructure and application functions. CITL chose to model eight PHR functions that demonstrate the potential effects of a range of infrastructure and application functions. The PHR infrastructure functions consisted of sharing of complete test results and sharing of complete medication lists. The PHR application functions were smoking cessation management, congestive heart failure (CHF) monitoring, appointment scheduling, medication renewals, pre-encounter questionnaires, and e-visits. The impact of these functions is derived from reducing administrative costs and direct healthcare utilization costs. The next section of this chapter describes how potential value was calculated, the inputs into each model, and the source(s) of the impact estimates.

Modeled Value Chains

Sharing of Complete Test Results
Providers may re-order tests when necessary results are not available at the time of the patient visit. Typically, this occurs because the current provider does not have the results of tests ordered by another provider. In a non-EHR world, the test results may be lost or unavailable and must be conducted again when results are imperative to clinical decision making, thus resulting in unnecessary spending by the healthcare system for the duplicate test. For providers with an EHR, there is a reduced chance of losing a test result, and clinical decision support systems (CDSS) can prompt the provider of the prior test result during the ordering of a test. This benefit can also be achieved through PHRs. The PHR infrastructure includes a data repository where test results, among other healthcare data, are stored. Unfortunately, there have been no studies to date that examine the impact of PHRs on the reduction in redundant tests.

Approach to Analysis

Savings Calculation
CITL modeled pre-PHR and post-PHR scenarios, calculating the pre-PHR minus the post-PHR costs to determine the savings. In the pre-PHR scenario, CITL multiplied the total annual cost of laboratory and radiology tests by the percentage of tests that are redundant.
In the post-PHR scenario, the calculation was virtually the same; however, CITL reduced the total cost of redundant tests by the percent reduction in redundant tests due to information available in a PHR.

Model Building Blocks
CITL estimated the baseline cost of redundant tests by using estimates of annual outpatient laboratory and radiology expenditures, $86.52 and $185.40, respectively, for an annual total of $271.92 per individual and $65.6 billion nationally. To estimate the total cost of redundant tests, CITL applied a redundant test estimate from prior research, 14.3%, for a total of $9.4 billion, serving as the pre-PHR baseline test costs.

There were no data available on the reduction in redundant tests due to sharing of test results through a PHR. Therefore, CITL conducted a modified Delphi to estimate the reduction in redundant tests. The type of data exchange determines impact estimates: automated data exchange has greater potential value than manual data exchange because the data found in the PHR can be uploaded directly to the provider’s EHR, as opposed to a viewing capability associated with the manual data exchange. The Advisory Board estimated the impact to be a 35% reduction in redundant tests for manual data exchange and an 84% reduction in redundant tests for automated data exchange.

Sharing of Complete Medication List
An adverse drug event (ADE) occurs when a patient has a negative reaction to an administered medication. ADEs can result in harm to the patient who may then require an office visit or hospitalization. Therefore, ADE avoidance is an important patient safety
issue and area of potential savings in healthcare. Many types of ADEs exist, and PHRs have the potential to enhance avoidance of some preventable ADEs: those ADEs that are not caught during the medication management process but are foreseeable. CITL modeled the impact of PHRs on preventable ADEs due to DDI.

When a provider prescribes a medication for a patient, there is a chance that it will interact with another drug that the patient is taking. Typically, the provider knows which medications he or she has prescribed for the patient. However, the patient may be on medications from another provider or taking over-the-counter medications that the provider is unaware of. Therefore, an accurate medication list is necessary to avoid preventable ADEs from outpatient medications. While no research has investigated the use of a PHR in this capacity, a patient-maintained medication list that can be shared with a provider through a PHR could be beneficial in reducing preventable DDI ADEs. Existing research shows that current medication lists are not 100% complete or accurate. For this analysis, CITL assumed that a PHR with a patient-maintained medication list would ensure a patient's medication list to be 100% complete, thereby eliminating all preventable ADEs and their associated costs due to outpatient, preventable drug-drug interactions, as detected by a provider's EHR error-checking capabilities. The analysis also assumes that all providers have an EHR with medication decision support capability.

**Approach to Analysis**

**Savings Calculation**

CITL modeled pre-PHR and post-PHR scenarios, calculating the pre-PHR minus the post-PHR costs to determine the savings. In the pre-PHR analysis, CITL multiplied the number of outpatient, preventable DDI ADEs resulting in hospitalizations by the average ADE-related hospitalization costs to calculate the total cost of ADE-related hospitalizations. CITL then multiplied the number of outpatient, preventable drug-drug interaction ADEs resulting in outpatient visits by the cost of a typical outpatient visit for the percentage of outpatient ADEs that typically require at least one outpatient follow-up visit. The total cost of preventable hospitalizations and outpatient visits was combined to calculate the total pre-PHR costs of preventable ADEs due to DDIs.
For the post-PHR scenario, CITL assumed that a PHR–enabled medication list would be 100% complete and therefore eliminate all outpatient, preventable DDI ADEs and corresponding costs.

**Model Building Blocks**

CITL estimated the rate of outpatient preventable ADEs at 3.7%\(^48\). The rate of preventable ADEs that are due to DDIs was 0.25%\(^49\). The rate of outpatient ADEs that result in hospitalization was 3%\(^43\). The cost of outpatient ADEs that result in hospitalization was estimated at $12,400, which was inflated to 2007 dollars from $10,583\(^50\). The rate of preventable ADEs that require additional outpatient encounters was estimated at 62.8%\(^48\). CITL used the Centers for Medicare and Medicaid Services (CMS) average reimbursement fees for the American Medical Association’s (AMA) Common Procedural Terminology (CPT) codes\(^51\) to estimate cost of an outpatient visit for an ADE. The cost of an office visit was estimated at $66.10, derived by averaging the Medicare reimbursement rates for the two most common CPT codes for a routine visit, 99213 & 99214\(^51\).

**Congestive Heart Failure Management**

Congestive heart failure (CHF) is a relatively prevalent and costly chronic disease. Patients suffering from this condition require daily monitoring of their blood pressure and weight to ensure that their symptoms are not worsening. The majority of costs associated with CHF are due to re-hospitalizations, which result from inadequate monitoring and management of CHF symptoms. However, routine monitoring requires patients to either know what to look for in changes in their vital statistics or to interact daily with a healthcare provider, typically a specialized nurse case manager. PHR systems could contain communication and remote monitoring functions—integration with blood pressure cuffs and weight scales—to support remote (home-based) management. This functionality would alleviate the demand on nursing services, which would be beneficial to the healthcare system.
Typical CHF self-management applications consist of patients monitoring their own blood pressure and weight on a daily basis. The manual method of CHF monitoring entails patients reporting their values to a care provider who then determines if further action is necessary. In an automated system through a PHR, data are electronically uploaded to providers, analyzed and acted upon as necessary. However, decision support functions could improve chronic disease management by decreasing the need for provider interaction to only those times when the patient needs immediate medical attention. Mancini et al. found that patients with severe CHF using a DayLink monitor, which combines an electronic scale with a display and communications device, could decrease hospital readmissions by 61%.52

Shah et al. found similar results.53 In this study, patients were given a digital sphygmomanometer, digital weight scale, and alphanumeric pager to transmit computer-generated reminders to patients to take their medications, weigh themselves, and measure their blood pressure and heart rate. Patients were contacted by phone once a week by a nurse to ascertain their clinical status and to collect their physiologic data, which was transferred to physicians once a month. Patients were also given 24-hour telephone access to a nurse to report changes in their medical condition, weight gain, or other medical emergencies. The nurses in turn notify the physicians if a patient had new or worsening symptoms, excessive weight gain, and/or significant changes in vital signs. This study found that hospitalizations for all causes fell 50% from 0.8 to 0.4 per patient per year.

**Approach to Analysis**

**Savings Calculation**

CITL modeled pre-PHR and post-PHR scenarios, calculating the pre-PHR minus the post-PHR costs to determine the savings. In the pre-PHR scenario, CITL determined the total number of CHF hospitalizations per year attributed to CHF complications. CITL then multiplied this number of hospitalizations by the average cost of a CHF hospitalization.

For the post-PHR scenario, the calculation was similar. However, CITL reduced the number of CHF hospitalizations by the PHR impact estimates.
Model Building Blocks

As described above, there were two impact estimates for CHF self-management through remote monitoring. While neither of these articles present research that was specific to PHRs, it is reasonable to assume that integrating these functionalities into a PHR would achieve the same impact on CHF hospitalizations. Since both estimates were valid, CITL averaged the two impact estimates, 50% and 61%, to arrive at 55.5% reduction. The number of hospitalizations due to CHF was estimated at 1.1 million. The cost of CHF hospitalizations was estimated at $10,300, which was inflated to 2007 dollars from $9,400 in 2004 dollars.

Smoking Cessation Management

Smoking is one of the leading causes of death in the US, contributing to or causing lung cancer, oral cancer, and chronic obstructive pulmonary disease (COPD), among many other conditions leading to increased morbidity and mortality, decreased life expectancy, and significant healthcare costs. There are many programs and products available to help people quit smoking, ranging from over-the-counter nicotine replacement therapies to support groups. Providers also counsel patients who want to quit smoking. However, other demands placed on provider’s time limit their ability to interact with a patient as often as needed.

Online tools are a relatively new method to help people quit smoking. Graham et al. evaluated the effectiveness of an Internet-based smoking cessation program. Quit rates after 12 months ranged from 13% using intention to treat analysis (non-responders counted as smokers) to 43% among survey responders. Higher website utilization was associated with better cessation outcomes, even after controlling for baseline motivation. Other studies have investigated the use of automated e-mail messaging as a tool for improving quit rates in a 30-day, Internet-based smoking cessation intervention, and use of a web-based, computer-tailored smoking cessation program as a supplement to nicotine patch therapy over a 12-week period.
**Approach to Analysis**

**Savings Calculation**

CITL modeled pre-PHR and post-PHR scenarios, calculating the pre-PHR minus the post-PHR costs to determine the savings. The endpoint for this value chain was a reduction in smoking-related healthcare expenditures in patients who smoke. In the pre-PHR scenario, CITL multiplied the total number of smokers in the US by the average annual healthcare expenditures for a smoker to determine the total healthcare costs of smoking.

For the post-PHR scenario, CITL determined the healthcare costs of those smokers who did not quit and added that to the healthcare costs of those smokers who did quit using a PHR that offered a smoking cessation application.

**Model Building Blocks**

While several studies investigated the use of online tools to quit smoking, none were integrated into a PHR. However, the Graham *et al.* study was deemed applicable as it was the only program that examined a web-based interface as the sole intervention and followed participants for a full year. This web-based interface could be easily integrated into a PHR with the same functionality. Thus, CITL used a quit rate of 13% estimated by Graham *et al.* The number of smokers, 45.1 million, was taken from the CDC.
The annual healthcare costs of smokers was estimated at $1,570, which was inflated to 2007 dollars from $1,161 in 1993 dollars. The reduction in healthcare costs was calculated at 14%, taken from a smoking cessation lag (i.e., the delay in achieving a full reduction in negative health effects after quitting smoking) model for the health benefits of avoiding lung cancer.

**Appointment Scheduling**

For established patients, appointments are typically made through phone calls to the provider office. The patient needs to talk with a medical secretary, who may be busy handling incoming patients and other tasks. Making appointments at one’s provider office is a natural fit for a PHR function, as found by researchers at Partners HealthCare System, where 36% of secure messages were for appointment requests. However, to date, no formal assessment of the benefits of automated appointment scheduling has been conducted.

**Approach to Analysis**

**Savings Calculation**

CITL modeled pre-PHR and post-PHR scenarios, calculating the pre-PHR minus the post-PHR costs to determine the savings. In the pre-PHR scenario, CITL derived the time (total minutes) taken to process an appointment request. CITL then multiplied the total time by the hourly wage of a medical secretary, the person most likely handling the appointment requests.

![Diagram of appointment scheduling calculation]

For the post-PHR scenario, the calculation was similar; however, only the time taken to process the appointment request was different.
Model Building Blocks

There were no data available on the average amount of time necessary to process appointment requests. Therefore, the amount of time to process an appointment scheduling request was estimated using a modified Delphi process for the pre-PHR scenario (2.7 minutes), the post-PHR scenario using a manual processing of the data (1.8 minutes), and the post-PHR scenario using automated processing of the data (0.5 minutes). CITL estimated the number of return visit appointments at 261 million.\textsuperscript{2,3} The hourly cost of a medical secretary is $18.03, which reflects both the addition of fringe benefits and inflation from 2006 dollars.\textsuperscript{60}

Medication Renewals

The majority of patients on continuous medications go to their provider during routine visits to obtain a prescription renewal. Obtaining a renewal outside of a patient visit requires patients to phone their providers to obtain a prescription renewal for their medications. It is important to note that a medication renewal is different from a medication refill. A refill occurs when a prescription has run out and the patient needs to get an additional amount that has been pre-determined by the prescriber. The majority of refills are handled by pharmacies. A renewal occurs when patients require a new prescription for a drug they are currently taking because it has run out of refills. In order to process a renewal, the medical secretary needs to examine the patient’s medical record to determine if the renewal is for a valid medication and then needs the registered nurse to write the prescription. This process requires locating the patient’s medical record and searching through it for the necessary information, which may be in multiple places in the record and not in a quick reference format.

A PHR application has the potential to streamline this task and save time for the medical secretary and registered nurse who process the requests. Researchers studying the Patient Gateway system for Partners HealthCare System found that 53% of PHR users submitted medication renewal requests.\textsuperscript{59} A PHR infrastructure typically includes some type of medication list, which is more robust when the PHR is connected to a provider’s EHR. This medication list can provide a validated list of medications, making the verification step much quicker. An automated system could provide access to the visit notes for the encounter in which the medication was previously prescribed, ensuring that all pertinent information is available. The patient would be able to request these renewals through the PHR rather than a phone call and be able to select from a predefined list of medications.

Approach to Analysis

Savings Calculation

CITL modeled pre-PHR and post-PHR scenarios, calculating the pre-PHR minus the post-PHR costs to determine the savings. In the pre-PHR scenario, CITL derived the time taken to process a phoned-in medication renewal in total minutes. CITL then needed to split the amount of time to process a medication renewal between the time...
spent by non-clinicians, such as the medical secretary, and time spent by clinicians, typically the registered nurse. CITL then multiplied the amount of time spent by both the non-clinician who receives the call and the clinician who processes the request by their respective hourly wages to estimate the pre-PHR cost of processing phoned-in medication renewals.

For the post-PHR scenario, the calculation was virtually the same. Only the time taken to process the renewal and the relative proportion of time spent by both the medical secretary who receives the call and the registered nurse who processes the request was different.

**Model Building Blocks**

There was no data available on the average amount of time taken to process a phoned-in medication renewal. Therefore, CITL conducted a modified Delphi to estimate the time it takes to process a phoned-in medication renewal for the pre-PHR scenario (9.1 minutes), the post-PHR scenario using manual processing of the data (6.1 minutes), and the post-PHR scenario using automated processing of the data (2.4 minutes). In addition, the total time spent processing the medication renewal requests was divided between the medical secretary and the registered nurse. CITL used a modified Delphi process to estimate the percentage of time spent by registered nurses processing medication renewal requests for the pre-PHR (27.8), the post-PHR with manual processing (40.0), and the post-PHR scenario using automated processing (82.8). The remainder of the time spent processing the medication renewal request was done by the medical secretary for each estimate. CITL estimated the number of phone-in medication renewals by multiplying the rate of annual calls to outpatient physician offices, estimated at
1.69 billion calls,\textsuperscript{61} by the percentage of those calls that were for medication renewals, estimated at 30.9%.\textsuperscript{62} The hourly cost of a medical secretary was estimated at $18.03, and the hourly cost of a registered nurse was estimated at $36.75, where both rates reflect the addition of fringe benefits and inflation from 2006 dollars.\textsuperscript{60}

**Pre-Encounter Questionnaire**

When patients go for their first visit to a new provider, they are always required to fill out background information questionnaires. There are two distinct types of background information that are typically collected at the start of a new patient encounter, administrative and clinical. This information is either entered into a paper record (in a non-EHR world) or is typed into the provider’s EHR. Typically, administrative office staff collect this information from the patient at the first visit, often resulting in a delayed visit.

With a PHR, these pre-encounter questionnaires could be handled electronically prior to the initial appointment. This would save the patient’s time in the office and free up administrative personnel in the office to conduct other business. In addition, it could potentially improve the process of insurance verification for the patient, by conducting verification prior to a visit as opposed to after a visit. Automated patient histories have been shown to be more accurate than paper histories, and for clinical information, they can allow for more detailed questions on specific conditions that would not be feasible with a paper questionnaire.\textsuperscript{63} This potential benefit has been mentioned in PHR literature,\textsuperscript{19} however, no studies have been conducted to date that assess the impact of a PHR on administrative or clinical information collection at or prior to the first new patient visit.

**Approach to Analysis**

**Savings Calculation**

CITL modeled pre-PHR and post-PHR scenarios, calculating the pre-PHR minus the post-PHR costs to determine the savings. In the pre-PHR scenario, CITL derived the time taken to process the pre-encounter questionnaires for all new patient visits in the US in total hours. CITL then multiplied the total hours by the hourly wage of a medical secretary, the person most likely to enter this information.
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<table>
<thead>
<tr>
<th>Time to Process Pre-Encounter Questionnaire</th>
<th>Hourly Cost for Medical Secretary</th>
<th>Total Time Processing Pre-Encounter Questionnaires</th>
<th>Pre-PHR Total Cost of Pre-Encounter Questionnaire Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of New Office Visits</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For the post-PHR scenario, the calculation was virtually the same, only the time taken to process the questionnaire was different.

<table>
<thead>
<tr>
<th>Time to Process Pre-Encounter Questionnaire with a PHR</th>
<th>Hourly Cost for Medical Secretary</th>
<th>Total Time Processing Pre-Encounter Questionnaires</th>
<th>Post-PHR Total Cost of Pre-Encounter Questionnaire Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of New Office Visits</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Model Building Blocks

There was limited data available on the average amount of time taken to process a pre-encounter questionnaire.\(^{64}\) CITL used available data to conduct a modified Delphi to estimate the time it takes to process a pre-encounter questionnaire for the pre-PHR scenario (3.2 minutes), the post-PHR scenario using a manual processing of the data (2.8 minutes), and the post-PHR scenario using automated processing of the data (1.0 minutes). For the number of new office visits, CITL used the CDC’s National Ambulatory Medical Care 2005 survey summary for ambulatory office and outpatient department visits, estimated at 108 million.\(^{2,3}\) An hourly cost of a medical secretary of $18.03 was taken from the Fall 2007 Bureau of Labor Statistics Annual Employment Statistics Report,\(^{60}\) which reflects both the addition of fringe benefits and inflation from 2006 dollars.

E-visits

In 2006, patients made over 1 billion visits to providers offices.\(^{2,3}\) Many of these visits are for routine care or questions that require minimal effort on the part of the provider. However, many providers are already overscheduled, and the ability to triage minor cases outside of the office setting would be beneficial. In addition, each appointment requires patients to leave work, making them less productive in the economy at large.

Perhaps the greatest promise of health IT is in helping to alleviate the burdens on the healthcare system. Numerous studies have examined the use of e-visits to eliminate the need for visits to provider offices. Bergmo et al. found that patients using a secure
messaging system with their providers had 23% fewer office visits than did the control group. Zhou et al. found a 9.7% reduction in the number of provider office visits from patients using a messaging system to communicate with their providers. Patients emailing their provider through messaging services provided by a PHR may avoid some face-to-face visits.

**Approach to Analysis**

**Savings Calculation**

CITL modeled pre-PHR and post-PHR scenarios, calculating the pre-PHR minus the post-PHR costs to determine the savings. In the pre-PHR scenario, CITL determined the total number of outpatient visits to providers. CITL then multiplied this total number of outpatient visits by a visit cost to estimate the total cost of outpatient visits.

For the post-PHR scenario, the calculation was similar; however, CITL assumed that there was no cost for the e-visit.

**Model Building Blocks**

While there were two available studies that measured the impact of e-visits on patient visit rates, neither of these were specific to PHRs. Therefore, a modified Delphi was conducted to estimate the reduction in face-to-face visits due to messaging within a PHR, which was estimated at 9.9%. The number of office visits to physician offices and hospital outpatient departments for established patients was estimated at 735 million, assuming that new patient visits would never be conducted via e-visits. The cost of an office visit was estimated at $66.10, derived by averaging the Medicare reimbursement rates for the two most common CPT codes for a routine visit, 99213 & 99214. CITL
assumed that there was no charge for the e-visit encounter to reflect the current reimbursement scheme for most payers. However, some payers are beginning to reimburse for these encounters. As reimbursement practices for e-visits change, the cost savings for patient-provider secure messaging will likely diminish.

Aggregate Benefits by Category

PHR Functions by Architecture
Depending on the type of architecture, each of the functions has different impacts as described in Chapter 2. These representative benefit functions have different value propositions based on PHR architecture (Table 3-1).

<table>
<thead>
<tr>
<th>PHR Function</th>
<th>Provider-Tethered</th>
<th>Payer-Tethered</th>
<th>Third-Party</th>
<th>Interoperable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharing of Complete Test Results</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Sharing of Complete Medication Lists</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>++</td>
</tr>
<tr>
<td>CHF Monitoring</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Smoking Cessation Management</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Appointment Scheduling</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Medication Renewal</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Pre-encounter Questionnaire</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>E-visits</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Key: - No Value Model; + Manual Data Processing; ++ Automated Data Processing

CITL defined the value proposition for each architecture by determining whether each function had both the data already available within that PHR architecture and the availability of automated data processing through the PHR. Below is a description of how each function varies by architecture.

Provider-Tethered
CITL assumed that provider-tethered PHRs would not have any benefits from information sharing functions since they are only connected to one, internal data source. CITL assumed that appointment scheduling, medication renewal, and pre-encounter questionnaires would be provided through automated data processing since there is an automated data exchange with the underlying provider data system. E-visits, CHF monitoring, and smoking cessation management all use manual data exchange for patient communication with their providers.
**Payer-Tethered**

CITL assumed that payer-tethered PHRs would not have any benefits from information sharing functions since they are only connected from one, internal data source. CITL assumed that appointment scheduling, medication renewal, and pre-encounter questionnaires would be provided through manual data processing since there is only manual data exchange (e.g., messaging) with the external provider data systems. E-visits, CHF monitoring, and smoking cessation management all use manual data exchange for patient communication with their providers.

**Third-Party**

CITL assumed that third-party PHRs would derive some benefits from sharing of complete test results but not for sharing of complete medication lists due to manual data exchange with external data sources. For sharing of complete test results, third-parties can only show test results, but they cannot be imported into the provider’s EHR. For sharing of complete medication lists, the manual data exchange prevents the medication list from being imported into the provider’s EHR, which is necessary for the provider’s EHR drug-drug interaction program to check this data. CITL assumed that appointment scheduling, medication renewal, and pre-encounter questionnaires would be provided through manual data processing since there is only manual data exchange (e.g., messaging) with the external provider data systems. E-visits, CHF monitoring, and smoking cessation management all use manual data exchange for patient communication with their providers.

**Interoperable**

CITL assumed that interoperable PHRs would have full benefits from sharing of complete test results and sharing of complete medication lists due to the automated data exchange with the external data sources enabled by standards, which allow the external data to be imported in the provider’s EHR. CITL assumed that appointment scheduling, medication renewal, and pre-encounter questionnaires would also be provided through automated data processing since there is automated data exchange with the external provider data systems. E-visits, CHF monitoring, and smoking cessation management all use manual data exchange for patient communication with their providers.

**Total Annual Benefits**

Based on this PHR value model, the annual benefits of the PHR functions CITL modeled ranged from $9 million for sharing of complete medication lists to $7.9 billion for sharing of test results (Table 3-2).
### Qualitative Benefits

Improved quality of care is perhaps the biggest benefit of increasing patient engagement through PHR use. Patients will be able to manage their own healthcare through alerts and reminders\(^\text{68}\) that help to improve medication adherence\(^\text{9}\) or make appointments to receive recommended screening (e.g., cancer) and immunizations (e.g., flu shots).\(^\text{69, 70}\) Patients are able to better manage their own chronic diseases\(^\text{9, 10}\) and may change their health behaviors, with nearly 20% of patients using a PHR having done so, according to one study.\(^\text{68}\) Patients are more satisfied with the care they receive due to their greater involvement and empowerment.\(^\text{68, 71}\)

In addition, PHRs enable providers to deliver better patient care. Pre-encounter questionnaires that capture clinical data can lead to a more complete and accurate patient information that can help providers make more informed clinical decisions.\(^\text{72}\) Post-encounter questionnaires help to monitor patients, especially after surgery, such as to detect the reoccurrence of head and neck cancer in patients after cancer surgery.\(^\text{73}\) PHRs can allow patients to return home earlier after traumatic events through remote monitoring and e-health encounters, such as for babies who have stayed in the neonatal intensive care unit.\(^\text{71}\) The data that patients provide during the review of their PHR data helps improve clinical decision making by supplementing and correcting the information providers already have in their EHRs\(^\text{9, 10}\) and by improving the delivery of care in emergency departments through continuity of care documents that providers can access electronically in case the patient is unconscious.\(^\text{10}\) Providers are also able to give patients customized content to help them manage their own care\(^\text{68}\) and achieve additional administrative benefits by being able to electronically handle referrals to specialists.\(^\text{59, 74-76}\)

PHRs also have the potential to positively affect the lives of patients beyond what is
modeled in this analysis. PHR-enabled e-visits can help to reduce the amount of travel patients need to make to attend doctor’s visits. Many times, this patient travel is during work hours; therefore, PHR users can keep better attendance at work. CITL’s PHR Advisory Board estimated that the average American would save 7.6 hours per year through e-visits. This equates to an annual savings of $20 billion in recovered wages, given a US workforce of 150 million people working for an average of $17.63 per hour.
CITL developed a model to estimate the cost of developing and installing a PHR system, which includes PHR infrastructure and applications. This model assumes that there is an underlying PHR infrastructure that can host any number of PHR applications. Each cost component is broken down by initial acquisition costs as well as annual costs (i.e., the costs to purchase and maintain these systems). CITL used this cost model to examine the costs of provider-tethered, payer-tethered, third-party, and interoperable PHRs.

**System Cost Components**

PHR systems costs consisted of two primary components, infrastructure and applications, as defined in Chapter 2.

**Infrastructure Cost**

Infrastructure functions facilitate information exchange and sharing. For a more thorough definition of a PHR infrastructure, see Chapter 2. A description of the infrastructure components that CITL modeled is provided below.

**Data Centers**

A data center is the physical space that houses the servers, network infrastructure, related hardware and all other application infrastructure required for a PHR. CITL estimated the cost of a data center for a single installation as $1.7 million in acquisition and $930,000 in annual costs.77

**User Authentication and Authorization**

Client user authentication and authorization include secure user logs in functionality and access controls that determine user access rights to a patient’s record. CITL estimated the single installation cost of user authentication and authorization at $95,000 in acquisition costs and $14,000 in annual costs.77

**Internet Connectivity**

Internet connectivity is the cost required for the PHR system to provide data exchange with healthcare stakeholders and web-based access to its users. CITL estimated that connectivity for a single PHR installation would have no installation cost and $1,000 as an annual cost.77
**User Interfaces**

The user interface is the front-end interface that users see when they log into the PHR and navigate the system. The cost for developing the PHR portal, the core shell that holds the various PHR applications and core user interface, is essentially equivalent to the cost of developing a web application (see the Application Costs section later in the chapter for further explanation). CITL estimated the cost of a single installation of the user interface at $450,000 in acquisition costs and $90,000 in annual costs. The user interface acquisition costs included development costs that encompass both the creation of the web-based user interface and the underlying data infrastructure.

**User Support**

User support consists of the help desk and ongoing training provided to PHR users. To determine the cost of user support, CITL obtained an estimate of the number of user support contacts per user in a pre-existing PHR system. The approximate contacts is equal to 0.13 per user per year. Next, the number of user support requests was multiplied by the average number of users per PHR architecture installation to calculate the average number of annual user support calls. Finally, CITL multiplied this estimate by the average cost per support call, estimated at $21. Since the $21 cost per support call already contains the amortized cost of the support center infrastructure, CITL did not separately model acquisition costs for user support.

**Record Matching Services**

Since PHRs may combine data from multiple sources, record-matching services are a requirement of different PHR architectures to facilitate record integration. There are five types of matching services included in this model: doctor matching, patient matching, medication matching, result name matching, and results answer matching.

- **Doctor matching** is needed to match provider records that may be located at multiple locations. CITL estimated the single installation annual cost of doctor matching at $57,000. No acquisition cost is associated with this matching service, because it is modeled strictly as a software subscription service.

- **Patient matching** is needed to match patient records located at multiple locations to ensure the PHR does not contain data that does not pertain to the individual user, and vice versa. CITL estimated the per-installation acquisition cost at $67,000 for the software to create a master patient index for local patients and annual cost of patient matching at $130,000.

- **Medication matching** is needed to match medications that are chemically similar but are named differently by various manufacturers, as well as by different data repositories. CITL estimated the annual cost of medication matching at $17,000 for a single installation. No acquisition cost is associated with this matching service because it is strictly a software subscription service.

- **Results name matching** is needed to match test results that are the same test yet coded differently by different data sources. For a single installation, CITL estimated the annual cost of result name matching at $460,000. No acquisition cost is associ-
ated with this matching service because it is strictly a software subscription service. Results answer matching is needed to ensure that the results provided by the test are captured and displayed in similar units for comparison without conversions or data keys for each source. Since this typically requires complex cross-linking of multiple possible representations to standardized results, CITL estimated the acquisition costs at $17,000 and annual cost at $15,000 for a single installation.77

Record matching services were not included for all of the PHR architectures. Since provider-tethered and payer-tethered PHRs draw information directly from their internal data warehouse where data are already normalized and fully matched, these PHRs do not require any matching services. In contrast, third-party and interoperable PHRs, which aggregate data from multiple data sources, require the use of matching services to reconcile data received from multiple external sources.

**Data Interfaces**

Any PHR will need data interfaces to external applications to retrieve patient data located across disparate ancillary systems. This analysis considered five types of data interfaces: provider, payer, lab, radiology, and pharmacy. For third-party and interoperable PHRs, CITL estimated the cost to build an external data interface at $50,000 in acquisition costs and $10,000 in annual costs.4,5 For provider-tethered and payer-tethered PHRs, data interfaces already exist in provider and payer systems and costs were estimated to be only 20% of the full cost of building a new interface because they are accessing their own internal data system, with greater familiarity minimizing the effort to convert the data for the PHR.

In addition, the number of interfaces for each of the five data types will vary depending on architecture. For third-party PHRs, many of each type of interface are required because these PHRs do not have access to clinical or administrative data without interfacing to a provider or payer system. The number of interfaces for payers, lab, radiology, and pharmacy were estimated by expert opinion.81 The number of provider interfaces for third-party PHRs was estimated to be the maximum number of provider groups (a full explanation of this number provided in Chapter 2). For payer PHRs, CITL estimated that there would be one internal interface for provider and pharmacy. Payer interfaces are not included as they would be part of the user interface, and lab and radiology data are not typically sent to payers. For provider PHRs, CITL estimated that there would be one internal interface for four of the data types: payer, lab, radiology, and pharmacy. Provider interfaces are not included as they would be part of the user interface. For an interoperable PHR, only one data interface would need to be created because all data and transactions are standardized for each data type.

**Data Storage**

This cost model considers the PHR data repository as the primary data storage for the PHR system. The PHR data repository consists of all data entered by users, data from
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messaging, and pointers to the all primary data sources. The storage cost was estimated on a per-user basis, assuming 14 MB per user at a cost of $1.80 per GB in annual costs.82 There is no acquisition cost included because remote storage was used for this estimate. All four PHR architectures require a PHR data repository.

Additionally, third-party and interoperable PHRs require additional storage capacity for clinical and administrative data. This repository is necessary since neither type of PHR is assumed to have access to healthcare data, unlike provider and payer PHRs, which have existing data warehouses. The data storage consists of the actual data as opposed to pointers to ensure constant access to the data. The cost was estimated at $400,000 in acquisition costs and $100,000 in annual costs.77

Secure Messaging

Secure messaging is another core component of any PHR system, and there are several types of electronic messaging. For the purposes of this model, CITL envisioned messaging as a two-part process. For incoming messages, users would first receive a message notification in their personal e-mail notifying them that they have a message in their PHR “inbox.” After receiving this notification, users would log in to their PHR over secured channels to retrieve and respond to the actual message. Similarly, users would need to be logged into their PHR in order to send messages to their providers over secured channels. The security embedded in the infrastructure provides the privacy and security for the messages. The infrastructure component required for this type of messaging is a message server. CITL assumed a message server would meet the following requirements:

• Accepts a user name and a message
• Looks up the user’s public e-mail address using the PHR’s user management functions
• Sends the user a notification that a message is waiting and asks the user to log into the PHR portal
• Stores the message in the user’s PHR mailbox
• Allows the portal to check if there is any message waiting for the user (when user logs into the portal)
• Displays the message as requested by the user
• Allows the user to send messages to other users on this PHR system

For a single installation, CITL estimated $50,000 in acquisition costs and $10,000 in annual costs.78

Application Costs

CITL defined a PHR application as any function within a PHR system that allows patients to learn about, monitor, manage their own health and the health of others, and to engage in automated data exchange transactions with others regarding their health and well-being. PHR applications add additional functionality and services to the PHR
Chapter 4: Costs of Personal Health Records

infrastructure. CITL has defined the six applications for the purpose of this model, as described in Chapter 2: smoking cessation management, congestive heart failure (CHF) monitoring, appointment scheduling, medication renewals, pre-encounter questionnaire, and e-visits.

Purchasing costs of commercial PHR applications are not generally available, typically because of proprietary pricing models, differences in scalability, and volume pricing. Therefore, CITL estimated the cost of a prototypical, web-based PHR application using the development cost of five representative clinical and administrative PHR applications. CITL interviewed a software development expert to estimate the number of person-months (shown in Table 4-1) that would be required to build each application and computed the average. These estimates were further validated by other experts in the field. The average development effort was then multiplied by the annual average salary for a computer programmer, estimated at $100,000, including benefits and validated by other sources.

<table>
<thead>
<tr>
<th>Application</th>
<th>Person Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking Cessation Management</td>
<td>26</td>
</tr>
<tr>
<td>Congestive Heart Failure (CHF) Monitoring</td>
<td>18</td>
</tr>
<tr>
<td>Pre-Encounter Questionnaire</td>
<td>18</td>
</tr>
<tr>
<td>Medication Renewal</td>
<td>8</td>
</tr>
<tr>
<td>Appointment Scheduling</td>
<td>20</td>
</tr>
</tbody>
</table>

The development costs only included the cost to design, develop, build, and test the PHR application. CITL estimated the management and support costs as equivalent to 100% of the development cost. In addition, core knowledge management costs were also 100% of the development costs. Thus, total costs for an application were a combination of the three cost categories, or three times the development cost. In addition, the CHF PHR application costs included the hardware cost of digital scales. Certain disease management applications could feasibly require additional hardware. In the case of CHF, a digital scale is required to track patient changes in weight, and CITL estimated this cost at $290 per patient.

CITL’s application cost model addresses the costs of building applications and services in which data from the application can be automatically processed through data standards, as well as applications that require some degree of manual data processing. An analogy would be the process by which individuals schedule their airline reservation. Standards-based scheduling is comparable to a self-service e-ticket site, where an individual can select a flight directly and receive immediate confirmation because the system is directly interfaced to the airline’s databases. Unstructured messaging is comparable to emailing.
a travel agent your individual preferences, where the information will have to be processed manually and then a confirmation e-mailed back to the individual at a later date. The former requires little or no administrative personnel time because the information can be automatically read by the scheduling system, while the latter still requires significant administrative personnel time in re-keying the scheduling message into the scheduling system. CITL has made the assumption that the differences in development costs between these two types of applications are negligible based on the idea that developing to a standard does not incur significant additional costs if the standard is known at the time of development.

Results

CITL developed one-time acquisition and annual costs for each PHR architecture at the national level (Table 4-2), which is derived from the per-installation and per-user level (Table 4-3). In addition, detailed costs for each component of a PHR is presented in Table 4-4.

### Table 4-2 National Installation Total Cost

<table>
<thead>
<tr>
<th>PHR Architecture</th>
<th>Acquisition ($)</th>
<th>Annual ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provider-Tethered</td>
<td>$130,000,000,000</td>
<td>$43,000,000,000</td>
</tr>
<tr>
<td>Payer-Tethered</td>
<td>$4,700,000,000</td>
<td>$2,000,000,000</td>
</tr>
<tr>
<td>Third-Party</td>
<td>$21,000,000,000</td>
<td>$4,900,000,000</td>
</tr>
<tr>
<td>Interoperable</td>
<td>$3,700,000,000</td>
<td>$1,900,000,000</td>
</tr>
</tbody>
</table>

### Table 4-3 Typical Users and Cost per User per Installation

<table>
<thead>
<tr>
<th>PHR Architecture</th>
<th>Average Users per Installation</th>
<th>Cost per User ($)</th>
<th>Cost per User ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Acquisition</td>
<td>Annual</td>
</tr>
<tr>
<td>Provider-Tethered</td>
<td>9,100</td>
<td>$550</td>
<td>$180</td>
</tr>
<tr>
<td>Payer-Tethered</td>
<td>340,000</td>
<td>$20</td>
<td>$8</td>
</tr>
<tr>
<td>Third-Party</td>
<td>80,000,000</td>
<td>$88</td>
<td>$20</td>
</tr>
<tr>
<td>Interoperable</td>
<td>560,000</td>
<td>$15</td>
<td>$8</td>
</tr>
</tbody>
</table>
Chapter 4: Costs of Personal Health Records

Discussion of PHR Cost Model

This PHR cost model provides an in-depth description of PHR costs. It addresses application and infrastructure costs, as well as initial acquisition and annual costs, for third-party, payer, provider, and interoperable PHR architectures. The components of this cost model can be combined in numerous ways to estimate the costs of various PHR business models.

CITL’s analysis of costs demonstrates that specific infrastructure components are the
major drivers of costs for different architectures. Data interface costs vary the most across PHR architectures. These costs are minimized for providers and payers since they have access to pre-existing data warehouses. This is not true for third-party PHRs, which have no internal patient information and must invest heavily in interfaces to obtain data.

For ongoing costs, user support accounts for the single highest uniform cost across all PHR architectures. User support is highest among third-party and interoperable PHRs, for a single installation because of the larger number of patients that each installation of these systems is assumed to support. Additionally, the need to maintain numerous interfaces creates the significantly higher interface costs for third-party PHRs.
Chapter 5: Net Value of Personal Health Records

Thus far, CITL has considered PHR benefits and their associated system costs separately, as summarized in Table 5-1. To assess the net value, this chapter combines the benefits from Chapter 3 with the costs from Chapter 4 over a 10-year period and at steady state thereafter.

### Total National Annual Benefits, Costs, and Net Value by Value Chain Functions and PHR Architecture

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Provider-Tethered ($, million)</th>
<th>Payer-Tethered ($, million)</th>
<th>Third-Party ($, million)</th>
<th>Interoperable ($, million)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PHR Benefits</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sharing of Complete Test Results</td>
<td>N/A</td>
<td>N/A</td>
<td>$3,300</td>
<td>$7,900</td>
</tr>
<tr>
<td>Sharing of Complete Medication List</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>$9</td>
</tr>
<tr>
<td>Congestive Heart Failure Management</td>
<td>$6,300</td>
<td>$6,300</td>
<td>$6,300</td>
<td>$6,300</td>
</tr>
<tr>
<td>Smoking Cessation Management</td>
<td>$1,000</td>
<td>$1,000</td>
<td>$1,000</td>
<td>$1,000</td>
</tr>
<tr>
<td>Appointment Scheduling</td>
<td>$170</td>
<td>$71</td>
<td>$71</td>
<td>$170</td>
</tr>
<tr>
<td>Medication Renewals</td>
<td>$1,100</td>
<td>$490</td>
<td>$490</td>
<td>$1,100</td>
</tr>
<tr>
<td>Pre-Encounter Questionnaires</td>
<td>$71</td>
<td>$13</td>
<td>$13</td>
<td>$71</td>
</tr>
<tr>
<td>E-visits</td>
<td>$4,800</td>
<td>$4,800</td>
<td>$4,800</td>
<td>$4,800</td>
</tr>
<tr>
<td>Annual (Steady State) Benefit</td>
<td>$14,000</td>
<td>$13,000</td>
<td>$16,000</td>
<td>$21,000</td>
</tr>
<tr>
<td><strong>PHR Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acquisition Costs</td>
<td>$134,000</td>
<td>$4,700</td>
<td>$21,000</td>
<td>$3,700</td>
</tr>
<tr>
<td>Annual (Steady State) Costs</td>
<td>$43,000</td>
<td>$2,000</td>
<td>$4,900</td>
<td>$1,900</td>
</tr>
<tr>
<td><strong>PHR Net Value</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net (Steady State) Value</td>
<td>-$29,000</td>
<td>$11,000</td>
<td>$11,000</td>
<td>$19,000</td>
</tr>
</tbody>
</table>

N/A – not applicable in this PHR architecture, given function description.
National Net Value of Provider-Tethered PHRs

Using the approach to analysis articulated in Chapter 2, and projecting PHR costs and benefits presented in earlier chapters of this report, the net value of provider-tethered PHRs, as modeled, shows a negative outcome. Provider-tethered PHRs show a total steady state net value of -$29 billion. The net value is never positive during the 10-year rollout period with the net value in year 1 of -$44 billion (Figure 5-1).

Table 5-2 depicts the national cost, benefit, and net value of provider-tethered PHRs per user and per installation at steady state.
Chapter 5: Net Value of Personal Health Records

National Net Value of Payer-Tethered PHRs

Unlike provider-tethered PHRs, payer-tethered PHRs, as well as third-party, and interoperable PHRs, generally show net positive value. Payer-tethered PHRs had a steady state net value of $11 billion annually. They had a net value of -$1.6 billion during the first year of the roll-out with the net value turning positive by year 4 (Figure 5-2).

Table 5-3 depicts the national cost, benefit, and net value of payer-tethered PHRs per user and per installation.

| Year | National Net Value for Payer-Tethered PHRs During Roll-out
|-----|-----------------------------------------------
| 1   | $-6                                           |
| 2   | $-4                                           |
| 3   | $-2                                           |
| 4   | $0                                            |
| 5   | $2                                            |
| 6   | $4                                            |
| 7   | $6                                            |
| 8   | $8                                            |
| 9   | $10                                           |
| 10  | $12                                           |

| Year | National Net Value for Payer-Tethered PHRs at Steady-State per User and per Installation
|-----|------------------------------------------------------------------------------------------------
<table>
<thead>
<tr>
<th></th>
<th><strong>Category</strong></th>
<th><strong>Annual Cost</strong> ($)</th>
<th><strong>Annual Benefit</strong> ($)</th>
<th><strong>Ten-Year Net</strong> ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per User</td>
<td>$8.40</td>
<td>$53</td>
<td><strong>$44,000</strong></td>
<td></td>
</tr>
<tr>
<td>Per Installation</td>
<td>$2,900,000</td>
<td>$18,000,000</td>
<td><strong>$15,000,000</strong></td>
<td></td>
</tr>
</tbody>
</table>
National Net Value of Third-Party PHRs

Similar to payer-tethered PHRs, third-party PHRs show a steady-state net value of $11 billion annually. The net value in the first year of the 10-year rollout is -$6.4 billion, turning positive by year 4 (Figure 5-3).

Table 5-4 depicts the national cost, benefit, and net value of third-party PHRs per user and per installation at steady state.

<table>
<thead>
<tr>
<th>Year</th>
<th>National Net Value for Third-Party PHRs During Rollout</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-15</td>
</tr>
<tr>
<td>2</td>
<td>-10</td>
</tr>
<tr>
<td>3</td>
<td>-5</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 5-4

| National Net Value for Third-Party PHRs at Steady State per User and per Installation |
|-----------------------------------------------|-----------------|-----------------|-----------------|
| Category                        | Annual Cost ($) | Annual Benefit ($) | Ten-Year Net ($) |
| Per User                        | $20             | $66              | $46             |
| Per Installation                | $1,600,000,000  | $5,300,000,000   | $3,700,000,000  |
National Net Value of Interoperable PHRs

As with third-party and payer-tethered PHRs, interoperable PHRs may achieve a positive net value. Interoperable PHRs show a total steady state net value of $19 billion annually. In year 1, the net value is -$1.3 billion, turning positive by year 3 (Figure 5-4).

Table 5-5 depicts the national net value of interoperable PHRs by examining the cost, benefit, and net per user and per installation at steady state.
Comparison of Annual Net Value between PHR Architectures

Figure 5-5 compares the annual net value for each of the four PHR architectures. Provider-tethered PHRs do not produce positive financial returns for the nation. Comparatively, the payer-tethered, third-party, and interoperable PHRs produce positive returns in different ways. All have initial negative returns because of relatively high acquisition costs, yet all three architectures turn net positive within a four-year period, with interoperable PHRs having the earliest net positive value by year 3, followed closely by third-party PHRs and payer-tethered PHRs by year 4.

[Diagram of National Annual Net Value by PHR Architecture]
**Steady State Annual Cost, Benefits, and Net per User and per Installation by PHR Architecture**

<table>
<thead>
<tr>
<th>Category</th>
<th>Provider-Tethered ($)</th>
<th>Payer-Tethered ($)</th>
<th>Third-Party ($)</th>
<th>Interoperable ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit Per User</td>
<td>$56</td>
<td>$53</td>
<td>$66</td>
<td>$89</td>
</tr>
<tr>
<td>Cost Per User</td>
<td>$180</td>
<td>$5</td>
<td>$20</td>
<td>$8</td>
</tr>
<tr>
<td>Net Per User</td>
<td>-$120</td>
<td>$48</td>
<td>$46</td>
<td>$81</td>
</tr>
<tr>
<td>Benefit Per Installation</td>
<td>$510,000</td>
<td>$18,000,000</td>
<td>$5,300,000,000</td>
<td>$50,000,000</td>
</tr>
<tr>
<td>Cost Per Installation</td>
<td>$1,600,000</td>
<td>$2,900,000</td>
<td>$1,600,000,000</td>
<td>$4,500,000</td>
</tr>
<tr>
<td>Net Value Per Installation</td>
<td>-$1,100,000</td>
<td>$15,000,000</td>
<td>$3,700,000,000</td>
<td>$46,000,000</td>
</tr>
</tbody>
</table>

**Comparison of Net Value within PHR Architectures**

CITL’s analysis considers the net value of a single architecture to cover 80% of the nation. This was done to compare the various architectural approaches in a similar manner. While there are multiple competing PHR architectures in the market today, it is unclear which architecture is the most beneficial to the various stakeholders. Therefore, the purpose of modeling a national single architecture is to derive an estimate of impact should policy changes and market dynamics favor a single architecture.

CITL investigated the size of installers for both provider-tethered and payer-tethered PHRs. Provider-tethered PHRs were broken into four categories: IDNs, large provider groups (groups with 16 MDs or greater), medium-sized provider groups (groups with 7 to 15 MDs), and small provider groups (groups with 2 to 6 MDs*). Payer-tethered PHRs were broken into 4 categories: public payers (e.g., Medicare, Medicaid), the largest non-public payer in each state, the second largest payer in each state, and the remaining largest 50% of all payers.

The primary purpose of this analysis is to explore the relationship between population coverage, number of installations, and cost-benefit. In order to cover 80% of the US, CITL determined that even small organizations (i.e., small providers and small payers) would need to offer their own PHR. Thus, the large number of installations required significantly impacts the cost-benefit of the provider-tethered PHR. Because the cost is greatly increased when the thousands of small provider organizations are included, and the benefit increased only marginally from their small patient population, the net value for provider-tethered PHRs decreases significantly when these small practices are included.

* See Chapter 2 for a discussion of the provider office sizes used to reach 80% coverage.
Table 5-7 and Table 5-8 examine this dynamic in more detail. These tables show the number of installations, the cumulative percent coverage, and the cumulative steady-state net value. Each table starts with the largest provider/payer and incorporates groups as necessary to reach 80% coverage.**

**Provider-Tethered PHR: Steady-State Net Value by Size**

<table>
<thead>
<tr>
<th>Provider</th>
<th>Number of Installations</th>
<th>Cumulative Coverage</th>
<th>Cumulative Net Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDN</td>
<td>1,453</td>
<td>50%</td>
<td>$8 Billion</td>
</tr>
<tr>
<td>IDN + Large</td>
<td>1,718</td>
<td>65%</td>
<td>$6.4 Billion</td>
</tr>
<tr>
<td>IDN + Large + Medium</td>
<td>3,742</td>
<td>70%</td>
<td>$0.84 Billion</td>
</tr>
<tr>
<td>IDN + Large + Medium + Small</td>
<td>19,566</td>
<td>80%</td>
<td>$-29 Billion</td>
</tr>
</tbody>
</table>

**Payer-Tethered PHR: Steady-State Net Value by Size**

<table>
<thead>
<tr>
<th>Payer</th>
<th>Number of Installations</th>
<th>Cumulative Coverage</th>
<th>Cumulative Net Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public</td>
<td>56</td>
<td>27%</td>
<td>$8 Billion</td>
</tr>
<tr>
<td>Public + 1st Largest</td>
<td>56</td>
<td>52%</td>
<td>$9.7 Billion</td>
</tr>
<tr>
<td>Public + 1st Largest + 2nd Largest</td>
<td>51</td>
<td>62%</td>
<td>$10 Billion</td>
</tr>
<tr>
<td>Public + 1st Largest + 2nd Largest + Remaining Largest 50%</td>
<td>548</td>
<td>80%</td>
<td>$11 Billion</td>
</tr>
</tbody>
</table>

The trends are evident for both provider-tethered and payer-tethered PHRs, as shown in Table 5-7 and Table 5-8, although more dramatically for provider-tethered PHRs. For provider-tethered PHRs, the net value decreases from IDNs to large and medium provider groups but does not become negative until the inclusion of the small providers. The marginal cost of non-IDNs offering PHRs is not offset by the marginal benefit, suggesting the need for policy provisions, such as access to capital to support the adoption of PHRs by small providers. For payer-tethered PHRs, the net value increases with the addition of each of the smaller categories. While the incremental value per installation may be decreasing, it never goes below zero, thus incurring benefits to all payer groups.

Although the payer-tethered PHR never reaches a net negative value, a dynamic similar to provider-tethered PHRs is apparent when closely examining the net PHR value when based on large public payers versus when smaller payers are included. The net value for the large public payers is $8 billion; however, to cover 80% of the nation, the first, second, and remaining largest commercial payers must be included. Although the total number of installations greatly increases when adding in these payers, the net value increases only slightly, going from $8 billion to $11 billion.

** See Chapter 2 for a discussion of the provider office sizes used to reach 80% coverage.
Comparison of Net Benefit by PHR Function Category

Among the different PHR function categories, the steady-state net value by PHR architecture varies from $0 annually across all PHR architectures for Information Collection functions to $7.4 billion annually across all PHR architectures for Information Self-Management. Of the functions modeled, the Information Self-Management function category was the most beneficial, followed by Information Exchange, Information Sharing, and Information Collection. Table 5-9 shows a complete breakdown of benefits by PHR function category.

<table>
<thead>
<tr>
<th>Function Category</th>
<th>Provider-Tethered ($, billions)</th>
<th>Payer-Tethered ($, billions)</th>
<th>Third-Party ($, billions)</th>
<th>Interoperable ($, billions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Collection</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Information Sharing</td>
<td>$0</td>
<td>$0</td>
<td>$3.3</td>
<td>$7.9</td>
</tr>
<tr>
<td>Information Self-Management</td>
<td>$7.4</td>
<td>$7.4</td>
<td>$7.4</td>
<td>$7.4</td>
</tr>
<tr>
<td>Information Exchange</td>
<td>$6.2</td>
<td>$5.4</td>
<td>$5.4</td>
<td>$6.2</td>
</tr>
</tbody>
</table>

Comparison of Net Benefit by Stakeholder

Regardless of the PHR architecture, the financial benefits of the PHRs modeled accrue to one of two stakeholders, providers or payers. Table 5-10 shows the distribution of PHR benefits by stakeholder for each of the four architectures at a steady-state after the 10-year adoption period. Overall, the benefits to payers far exceed the benefit to providers by more than an order of magnitude across all PHR architectures. Payers receive the benefits of sharing complete test results, sharing of complete medication lists, e-visits, CHF management, and smoking cessation management equal to their share of encounter costs, which are equal to one minus the national average provider capitation rates of 7.3%. Providers receive the benefits of sharing of complete test results, sharing of complete medication lists, e-visits, CHF management, and smoking cessation management equal to their share of encounter costs, which is equal to the national average provider capitation rate of 7.3%, plus the full benefits of appointment scheduling, medication renewals, and pre-encounter questionnaires. The bulk of the benefits go to payers, regardless of the type of PHR; for each dollar that the provider saves, the payer saves five to eight dollars.
PHR Benefits by Stakeholder

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Provider-Tethered ($, billion)</th>
<th>Payer-Tethered ($, billion)</th>
<th>Third-Party ($, billion)</th>
<th>Interoperable ($, billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provider</td>
<td>$2.3</td>
<td>$1.5</td>
<td>$1.7</td>
<td>$2.8</td>
</tr>
<tr>
<td>Payer</td>
<td>$11</td>
<td>$11</td>
<td>$14</td>
<td>$19</td>
</tr>
</tbody>
</table>

Sensitivity Analysis

Overview of Sensitivity Analysis
A sensitivity analysis examines the effect of the value of certain variables on the model results and can help determine the most important variables in a model. For this sensitivity analysis, CITL separately varied each model input that was thought to significantly contribute to the overall model results (see Table 2-2 for a list of the variables and sensitivity ranges). The effect of these variations on the overall model steady-state net results was examined. CITL conducted sensitivity analyses for each of the four PHR architectures, and we present the results in the tornado diagrams that follow. Each tornado diagram below displays the percent change in the steady-state net value if the given input factors were increased and decreased by a pre-determined amount, or by actual variations in published literature or expert estimates.

In general, only the top 10 variables, based on the magnitude of the percent change in the steady-state net value, are depicted in the tornado diagrams. The only exception to this is the analysis of the impact of the number of instances of each type of PHR architecture to cover 80% of the US population, which correlates directly with the number of typical users for each type of PHR architecture in the CITL model—that is, it is directly correlated with net value of each PHR architecture. The number of PHR implementations for each architecture caused the greatest percentage change in steady-state net value for provider-tethered and third-party PHRs and caused the third highest percentage change in steady-state net value for payer-tethered and interoperable PHRs. Because of the magnitude of the impact of this variable in the sensitivity analysis, especially for provider-tethered PHRs but also for third-party PHRs, as well as the potential policy implications of varying this variable, this variable was not included in any of the tornado diagrams. Instead, a separate analysis of the impact of varying the number of typical users for each PHR architecture is presented in the breakeven analysis at the end of this chapter.

Provider-Tethered PHRs Sensitivity Analysis
For provider-tethered PHRs (Figure 5-6) the application development costs are the most important variable in determining provider-tethered PHR steady-state net value. The second and third top variables in the provider-tethered PHR sensitivity analysis are the operations and management cost ratio and the costs of the e-visits.
Payer-Tethered PHRs Sensitivity Analysis
For payer-tethered PHRs (Figure 5-7), varying the cost of e-visit caused the biggest change in the steady-state net value, followed closely by the percentage of face-to-face visits avoided by e-visits and the impact of CHF remote monitoring.
Third-Party PHRs Sensitivity Analysis

Third-party PHRs (Figure 5-8) are most sensitive to external interface costs. Variations in this number cause the most dramatic changes in value. The next two significant factors are the cost of the e-visit and the number of third-party interfaces needed.
Interoperable PHRs Sensitivity Analysis
Finally, for interoperable PHRs (Figure 5-9), the cost of the e-visit, the percentage of face-to-face visits avoided by e-visits, and the impact of automatic sharing of complete test results all have significant impact on the overall steady-state net value of the interoperable PHR.
Breakeven Analysis

One of the key aspects in CITL’s PHR value model is the typical number of users of a single PHR architecture. Also, from a business case perspective, knowing the approximate minimum number of PHR users required to make a given type of PHR self-sustaining is very important. Therefore, CITL conducted a separate breakeven analysis investigating the number of patients covered by a single installation of a PHR and the resulting net value (Figure 5-10 through Figure 5-13). This approach allows CITL to estimate the number of users required to equal the financial costs of installing a single PHR. This analysis predicts that the breakeven population size for a single installation of a third-party PHR is about 47 million active users, for a single installation of a payer-tethered PHR is about 64,000 active users, for a single installation of a provider-tethered PHR is about 59,000 active users, and for a single installation of an interoperable PHR is 52,000 active users. If CITL assumes that the average provider panel is approximately 2,000 providers²⁴ this would equate to roughly 30 providers needed for a provider-tethered PHR to have net positive value at the end of the 10-year rollout period. Third-party PHRs break even with a number of active users almost three orders of magnitude greater than any other architecture of PHR in this analysis.
Chapter 5: Net Value of Personal Health Records

10-Year Breakeven Analysis of Provider-Tethered PHRs

Figure 5-10

10-Year Breakeven Analysis of Payer-Tethered PHRs

Figure 5-11
10-Year Breakeven Analysis of Third-Party PHRs

Break even at roughly 47,000,000

10-Year Breakeven Analysis of Interoperable PHRs

Break even at roughly 52,000
Chapter 6: Limitations

Given that the field of PHRs is rapidly evolving and that relatively little available research in real-world PHR experience exists, this report has several limitations. Limitations relate to the PHR taxonomy and assumptions in the benefit and cost components of the PHR value model, as well as CITL’s overall approach. These limitations are outlined below.

**Taxonomy Limitations**

CITL’s PHR taxonomy does not include the communications medium used for accessing a PHR; it only considers web-based approaches. The portable device medium was excluded from this analysis, because research has found security issues with using USB drive-based PHRs. The desktop-only based PHR would require patients to store their own data locally; yet to share that information electronically, they would have to either host a personal PHR server on the Internet or carry around their data on a portable device. The personal PHR server approach would require an “always-on” Internet connection to ensure around-the-clock accessibility and significant data management overhead to prevent data corruption or loss, neither of which are cost effective nor necessarily desirable for an individual patient. The portable device transport of this data has essentially the same limitations as USB-based PHRs. Therefore, CITL believes the web-based approach to PHRs is and will be the preferred modality.

This taxonomy does not consider hybrids of the four PHR architectures that are described in this report. For example, a PHR offered by a staff-model HMO could provide both clinical and claims data. In this type of organization, the types of the data are mixed, because the staff-model HMO holds both the administrative and clinical data within its data warehouse. However, CITL believes that the basic functions of the PHR, as they have been defined here, will not change substantially during the creation of such a hybrid.

**Benefit Limitations**

One of the challenges in modeling the value of PHRs, which this model clearly demonstrates, is to consider all of the constituencies involved in a PHR. CITL’s analysis helps identify costs and benefits to payers and providers who currently bear direct healthcare costs. CITL recognizes that many others, including patients, employers, and non-healthcare related corporations, may derive significant benefits from PHRs.
Benefits may include improved healthcare satisfaction, healthcare quality and healthcare efficiency through the use of PHRs, to name a few. However, the evidence for hard cost savings to these other groups, including patients, has not been demonstrated, and therefore was not included in this model.

The PHR value analysis relied on an activity-based costing approach for some savings projections, especially related to appointment scheduling, medication renewals, and pre-encounter questionnaires. Therefore, some of the quantitative administrative savings may be difficult to realize. For an individual group of providers, these savings would typically encompass less than one full-time equivalent administrative staff person. Although these administrative savings are real, they may be hard to capture.

The projected savings in each area modeled also assume that the PHR functions modeled are causing all of the savings when other health IT could also cause these savings. For example, interoperable EHRs or telehealth technology could also reduce costs associated with incomplete medication lists or incomplete test results.4, 5, 26, 90 Similarly, a congestive heart failure (CHF) management system outside of a PHR could provide much of the benefit of a PHR CHF remote monitoring function.52, 53 In such an environment, the added value of the PHR CHF remote monitoring function would be much less. Therefore, many of the benefits could be achieved by other health technologies in which case PHR functions that achieve the same benefit would be less valuable.

This analysis assumes that all providers have an EHR. However, 100% EHR adoption has not yet been reached in the US, nor is it anticipated in the timeframe of this analysis. This may result in an overestimate of the benefits of PHR functions, particularly functions that utilize functionality provided by the EHR, such as utilizing the complete medication lists from PHRs for more robust drug-drug interaction checking. However, this overestimation only has a negligible impact on the total net benefits through the Sharing of Complete Medication Lists chain.

This model also does not take into account all of the potential functions that a PHR may provide, or that are even currently available. Additionally, this model does not consider the qualitative benefits of a PHR.

**Cost Limitations**

There are several approaches to modeling the cost of messaging within a PHR system. One approach that CITL considered was the cost of secure Internet e-mail. However, this approach was costly because it required that users have encryption software to protect their health information. CITL instead modeled unsecured e-mail notification for patients that instructs them to log into a secure portal—an approach to secure mes-
Chapter 6: Limitations

If the costs of encryption software can be addressed, the solution of sending personal health information to a user’s email is viable.

A PHR infrastructure needs to be designed and built to support nearly infinite variations of PHR applications and to provide them with the various personal health data the applications require. For example, a variety of chronic disease management applications could connect to and share the same infrastructure. Therefore, the infrastructure costs presented here are conservative because a PHR with much more functionality could be built with relatively little additional costs, thereby providing greater net value.

Another limitation related to the number of applications is that CITL only modeled the development costs for six applications; however, CITL recognizes that PHR systems will have multiple applications to support clinical and administrative functions. In theory, any number of applications can be developed and connect to an underlying infrastructure. Additionally, the development cost of an application can vary greatly from the estimated $450,000 used in this model. The complexity of an application can greatly increase the average development cost, and the knowledge repository for specific applications can be complex and varied. CITL attempted to address this limitation in the sensitivity analysis by varying application costs and assessing this variance on total net value. Some applications can be very complicated, containing a wide range of detailed functionality and costing much more then the estimated application cost, and vice versa.

CITL made the assumption that the differences in development costs between a standards based versus a non-standards based application are negligible. Given that the data communication protocols are typically part of the application specification development, CITL assumed that the application development costs to build to a standard data structure versus a proprietary data structure would be roughly equivalent. The differences in building to a data standard versus not doing so will impact the exchange and reusability of the data but not the cost of developing the PHR function itself. Improved processing of data and information exchange is a result of using data standards in system design. Building to data standards enables data interoperability. Data interoperability facilitates the free exchange of data and eases data processing.

Another limitation of CITL’s cost model relates to data conversion costs. The model’s interface costs only encompass the basic cost to create an interface but not the costs associated with data conversion that may be needed for the data to be fed into or taken out of the interface. Depending on the current form of the data used by the input or output systems and the availability or lack thereof of data standards, the costs for data conversion could range from minimal to significant (Table 6-1).
Table 6-1

<table>
<thead>
<tr>
<th>Input System</th>
<th>Output System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standards-Based Data Format</td>
</tr>
<tr>
<td>Standards-based data format</td>
<td>Low Cost</td>
</tr>
<tr>
<td>Propriety data format</td>
<td>Medium Cost</td>
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</tbody>
</table>

In addition, CITL did not attempt to model transient costs associated with workflow change or other indirect implementation costs. These costs are difficult to quantify and will vary greatly from organization to organization, even for the same PHR function, because of differences in existing processing and people. Additionally, CITL did not model the marketing costs of recruiting and retaining PHR users.

CITL also recognizes that for third-party and interoperable PHRs, data sharing and use agreements would need to be created to enable data exchange. CITL did not model the costs associated with creating data sharing and use agreements. Competitive issues for data sharing and storage may also exist for third-party and interoperable PHRs, which may affect cost and adoption but were not modeled. For provider-tethered PHRs, CITL did not include the cost of the EHRs needed to enable provider-tethered PHRs.

Finally, software development and annual costs are subject to significant economies of scale, which has important implications. For example, one smoking cessation application could be used for the entire country, or hundreds of different smoking cessation applications could be developed independently at hundreds of times the cost. However, the benefits derived from broad use of either a single or multiple smoking cessation applications would arguably be the same.

### Overall Limitations

CITL’s results are based on outputs from a simulation model, which are predictive and may not mirror findings from a field study. Models are built as closed systems and cannot account for all factors experienced in the real-world. CITL only modeled quantifiable impacts where data could be found to support them and did not model qualitative impacts. CITL also did not model or account for any possible unintended consequences from PHR use. Some stakeholders may find these un-modeled impacts critical to their own decision making regarding the pursuit of PHR implementations.

To date, the nation has not fully embraced PHRs. In order for benefits to be realized, these systems have to be implemented, adopted, and used. If implementation, adoption, and use occur on a schedule slower than the one outlined in this report, benefits will likewise be realized more slowly. For all types of PHRs, CITL modeled implementation, adoption, and use over a 10-year period, starting with 0% implementation, adoption,
and use and moving to 80% of the US population being PHR users at the end of the 10-year period. A small percentage of people use a PHR today, so that 0% assumption is not entirely true. Also, many factors may affect the actual implementation, adoption, and use, and these may differ significantly by architecture. For payer-tethered PHRs, the insured population only accounted for 84% of US population. Therefore, for 80% of the US population to be covered by payer-tethered PHRs assumes that close to 100% of the insured US population will be using payer-tethered PHRs by the end of the 10-year period.

Because PHRs are a relatively immature and rapidly evolving area of health IT, relatively little data about their impact exists. CITL, therefore, was forced to turn to estimates where data was lacking. The process for determining estimates was rigorous, utilizing a modified Delphi process (see Appendix A for details) with a group of renowned experts in the field. However, these are estimates and may not be reflective of the real world. Additionally, CITL extrapolates data and modified Delphi results to estimate PHR value at a national level. This extrapolation may introduce some error.

Finally, technology is changing rapidly. CITL could not account for future technology changes that might significantly affect PHR functions, benefits, and costs. Likewise, CITL did not account for future advances in the field of medicine itself, which may affect PHRs. In addition, there are legal implications for each type of PHR. Health Information Portability and Accountability Act (HIPAA) restrictions apply to data stored and provided by a healthcare entity and its business associates, but it is unclear how they apply to a third party or other aggregator models. CITL does not address these issues in this analysis, though the separate classifications used here could serve as a framework for drafting patient privacy legislation for PHRs.
In this report, CITL presents an assessment of the potential economic value of PHRs in the US. For this analysis, CITL assessed the value proposition for provider-tethered, payer-tethered, third-party, and interoperable PHRs. This analysis found that to implement any type of PHR throughout the US, the cost can range from approximately $3.7 billion to $134 billion in acquisition expenses and $1.9 billion to $43 billion in annual expenses. However, in the third-party, payer-tethered, and interoperable PHR architectures, these acquisition expenses are dwarfed by the estimated potential benefits ranging from $13 billion to $21 billion annually. The provider-tethered PHR, however, has a poor return on investment, with a net value of -$29 billion. Although CITL has modeled the value of each individual architecture, several competing architectures could potentially exist. However, the development of data standards as demonstrated in the interoperable PHR could diminish costs and facilitate health information exchange.

PHRs are an emerging healthcare technology, and a clear value proposition will help guide the development of and the investment into this technology. PHRs are envisioned to help enhance the storage and use of health information across an individual’s lifetime. The current fragmentation of patient health information and lack of data liquidity between disparate healthcare information technologies has contributed to rising healthcare costs and diminished quality of care. The ability to enhance exchange of patient information within the healthcare system affects the delivery and quality of healthcare.

Recently, more than ever, the need for portable health information has been crucial. In 2005, Hurricane Katrina demonstrated the need and importance of consolidated electronic patient information. Many news reports indicated the dire situation associated with water-damaged patient records. Some physicians were drying paper records to decipher the medications that their patients required. Recently, several government agencies have made PHRs a top priority, thus emphasizing the importance of a thorough analysis regarding the differing value propositions for this technology.

**Costs**

In the cost analysis, each PHR architecture has the same set of core components: a data center, user authentication and authorization, connectivity, and interfaces to sources of clinical data. Differences in costs exist in user support and data storage, which differ for a single installation, due to the variable number of users for a single installation in each architecture. However, at the national level, these are equivalent since all PHR architectures are estimated to serve the same national population. Differences in costs also exist with patient-matching services, which are only required by third-party and interoper-
able PHRs, given that provider-tethered and payer-tethered PHRs are connected to other health IT systems. Differences also exist in the cost of interfaces required to access data sources because more are required for the interoperable and third-party PHR architectures. These differences stem from the assumption that these PHRs are not a source of healthcare data and therefore must interface with primary sources of data. In this model, the cost of additional interfaces for third-party PHRs is borne by only three third-party PHR installations, which CITL envisions could achieve 80% adoption by the US population (see Chapter 2).

The third-party PHR has a higher single installation cost primarily because of the need to build numerous data interfaces to the multiple data sources needed to populate the PHR. However, the costs for a single third-party PHR installation are superseded in a national PHR rollout because a larger number of provider-tethered and payer-tethered PHRs must be installed to achieve 80% adoption by the US population. Therefore, on the national level, third-party PHRs have the best economies of scale, although on a per-installation basis, they are the most costly because of the larger number of PHR users that a single third-party PHR is expected to be able to service.

This difference between the costs to build a single installation of a PHR system and the costs to roll out these systems nationally is also demonstrated through interoperable PHRs. These PHR systems are built around the assumption of interoperability standards for healthcare information exchange. The initial costs for interoperable PHRs are much lower than third-party PHRs due to the relatively smaller number of interfaces that need to be developed and implemented to obtain access to a wide range of data. Also, this PHR architecture is designed to be a regional aggregator. The number of installations to achieve 80% adoption by the US population is less for interoperable PHRs than for provider-tethered and payer-tethered PHRs. As with other analyses, this PHR study underscores the significant value of data standards.

This analysis considers PHR infrastructure and applications as two distinct components in a PHR system, with the acquisition and annual infrastructure costs being significantly greater than the application costs. This analysis demonstrates the value of developing a common PHR infrastructure based on interoperability standards upon which numerous PHR applications could be built. This approach would greatly reduce the costs of PHRs.

**Benefits**

**Infrastructure Functions**

On the benefits side, CITL recognizes that the PHR infrastructure itself could be designed to create direct financial benefits. The idea of PHR infrastructure value comes from the notion of using the PHR as a patient-centered network similar to a regional health information organization (RHIO) or national health information network.
(NHIN), with the PHR acting as the hub of patient-controlled information exchange.\textsuperscript{1} Although many PHRs today may not have envisioned infrastructure functions providing direct value, these functions could provide significant value in the future. CITL’s model predicts that the sharing of complete test results, enabled by a PHR, could save almost $8 billion annually. These savings would more than cover the entire acquisition ($3.7 billion) and annual ($1.9 billion) costs of all of the core components of a PHR. In fact, infrastructure benefits facilitating healthcare information exchange may be the most valuable benefits of all PHR functions.

**Application Functions**

On the benefits side, the six sample PHR application functions in this model demonstrate tremendous potential value, and PHRs could have many more similar functions. The value of an application to the healthcare system depends on both the prevalence of the condition and the savings per individual case. In this model, with CHF management and smoking cessation management as examples, the paradigm of volume of impact versus cost of impact is demonstrated. The CHF management application achieves savings via reduced hospitalizations for CHF patients. CHF affects a smaller number of people than smoking; however, the cost of CHF hospitalizations to the healthcare system is large, as is the magnitude of savings. On the other hand, although many people smoke, the quantifiable first-year savings of reducing the incidence of smoking is relatively low; thus, the magnitude of savings is not quite as great as that of CHF management. The important inference here is that the value of all interventions depends on the prevalence of the condition, as well as the benefit incurred by each individual. Generalizations and conclusions from this model do not necessarily suggest that chronic disease management functions will have more of an impact than lifestyle modification functions. The impact of a function is a combination of the prevalence of a condition and the effect per person. It is important for developers to consider both of these factors in application development and marketing strategy.

**E-visits**

E-visits, replacing face-to-face visits, have the potential to address a wide range of chronic and acute (non-emergent) healthcare issues, and they therefore represent a large area of potential PHR benefit. This PHR function addresses a diversity of healthcare needs. Therefore, using e-visits to replace face-to-face visits could be the source of significant benefits. However, the value of e-visits is highly dependent on the costs associated with these visits. In this model, CITL assumed the current practice standard: that providers are not reimbursed for e-visits. CITL recognizes that to provide value, providers need to offer e-visits, payers need to reimburse them on some level, and the e-visits themselves need to use the provider’s time more efficiently and effectively. E-visits can also provide value to patients and employers by diminishing travel time and decreasing time lost from work; these sources of value, however, are not direct costs to the healthcare system and thus were not factored into this analysis. CITL assumed that if PHRs were available, many providers would exchange email with their patients and
improve service. However, most providers would prefer to be reimbursed for this time, and lack of reimbursement could impact provider adoption of PHRs. Additionally, the size of the patient panel and level of e-traffic can affect provider use of messaging, even if reimbursed.

Changing the assumption about e-visit reimbursement changes the net value. For example, even charging $25 per e-visit would decrease the benefit of e-visits by about $5 billion annually at steady state for each PHR architecture. Even if e-visits remain uncompensated, if they result in a net increase in face-to-face healthcare encounters, they will have a net direct cost increase to the healthcare system. If e-visits cost less than face-to-face encounters and/or allow for fewer face-to-face visits, e-visits will provide a net savings to the healthcare system. Given the predominance of fee-for-service reimbursement in the current healthcare system, most PHR value will accrue to payers. However, even if the payment model changes and e-visits still cost as much as face-to-face visits, e-visits could result in clinical benefits such as reduced hospitalizations.

Net Value

CITL’s analysis presents a conservative estimate of overall PHR value for several reasons. First and foremost, this model only considers a relatively limited, but representative, number of PHR functions, thus underestimating the direct potential benefits of PHRs. Also, modeling the direct impact of PHRs only on the healthcare system neglects their potential direct financial impact on people and organizations outside of the healthcare system. Additionally, PHRs could also provide substantial benefits—such as time and travel savings and improved satisfaction, to patients and others—which were not modeled.

As described in Chapter 5 (Table 5-1), interoperable PHRs have the greatest net value to the nation, with a potential annual savings of $19 billion. Payer-tethered PHRs and third-party PHRs have the next highest net value, both estimated at $11 billion in annual savings. Finally, due to the numerous amount of small providers required to cover 80% of the US, the provider-tethered PHRs are projected to have a negative net value at steady state of -$29 billion per year.

The implication that provider-tethered PHRs could have a net loss is important for stakeholders to consider. This estimate was reached because the number of installations of provider-tethered PHRs is extremely high. Therefore, the costs are not scalable, and it does not make sense for small provider organizations to develop their own PHRs because the number of estimated users will be low. CITL’s analysis indicates that for provider-tethered PHRs, the breakeven point is about 60,000 patients, or 30 providers, assuming a typical full-time primary care provider panel of approximately 2,000 patients. The value proposition for small providers is so poor that it has a significant
negative impact on the value proposition for providers as a whole. Large provider institutions such as the Veterans Health Administration have enough patients to address the issue of scalability; however, the value proposition for large provider organizations is significantly different from that of small provider organizations. Therefore, this analysis suggests that small group practices should find more cost-effective means to offer PHRs to their patients. Third-party PHRs, or those offered through an IDN or large provider organization, will offer better economies of scale and enable small providers to support PHRs in their practices more realistically.

Additionally, regardless of PHR architecture type, the net value is highly dependent on the number of people covered by a single PHR installation. Economies of scale greatly affect the value proposition of a PHR and depend significantly on the number of people covered by one PHR installation. The fewer people covered by a single PHR installation, the more PHRs are needed to cover the population, resulting in significantly higher costs with only marginally higher benefits. This factor is the primary reason provider-tethered PHRs appear to have net-negative value in this model.

In this model, even small provider organizations need to develop and install their own PHR to achieve 80% adoption by the US population. Thus, scalability works significantly against provider-tethered PHRs compared to the other types of PHRs. Although CITL’s model assumes that small provider organizations are developing their own PHRs, this dynamic will most likely not occur in the real world. Many small organizations will not have the resources to develop and maintain a PHR system as described in this model; thus, they will need other means to acquire these systems. In this model, CITL does not consider how some small providers might acquire information systems through large provider groups, even though such partnerships are increasingly feasible. The safe harbor provision in the Stark statute protects “certain arrangements involving the donation of some forms of electronic health information technology and services to doctors and other designated healthcare providers.”94 Provisions such as this could feasibly facilitate a PHR partnership. An alternative to these partnerships could be that small providers will first adopt an EHR and then buy a PHR module. If provider-tethered PHRs were only installed in larger provider organizations, the net value of provider-tethered PHRs could be much different. This lack of economies of scale also operates in the general health IT marketplace for providers and is a contributing factor to delayed health IT adoption.24

The interoperable PHR represents the anticipated future model of PHRs where standards and seamless healthcare information exchange (HIE) exist. Adoption of HIE standards could facilitate the transformation of provider-tethered, payer-tethered, and third-party PHRs into interoperable PHRs. Interoperable PHRs represent the most valuable type of PHRs because they leverage the combined advantages of scale and standardized interfaces. They also have the greatest access to data and therefore the greatest potential value from PHR functions.
Financial Motivations to Enter into the PHR Market

Regardless of the type of PHR, direct healthcare savings would accrue to both payers and providers, with payers realizing the majority of the cost savings. Depending on the type of PHR, savings to payers could be five to 10 times greater than the savings to providers. Third-party PHRs present a unique case in which entities not controlling or not responsible for direct medical costs (e.g., Microsoft, Google) are providing PHR technology that could entail significant net savings to payers and providers, with minimal or no cost to the payers or providers to date.

The financial motivations to offer a PHR to patients differ based on who is paying for the PHR. Providers and payers are already spending substantial dollars in the healthcare system. Research has shown that health IT could produce significant financial benefits, thus incentivizing providers and payers to adopt these technologies. Payers stand to realize enormous cost savings if their covered populations use PHR applications to manage their health issues. Increased prevalence of chronic conditions is one factor that drives rising healthcare costs, and increased patient monitoring of these conditions can prevent costly hospitalizations and other costs.

For third-party entrants into the PHR marketplace, the value proposition differs. Third-party entrants such as Microsoft and Google are not currently invested in the healthcare marketplace with respect to responsibility for direct medical costs in the same ways as providers and payers. To third parties, the value derived from health technologies such as PHRs does not accrue from clinical or financial savings from the healthcare marketplace; it accures from selling PHR-related products and services. For instance, some third-party PHR vendors may provide the PHR “free of charge,” but then may rely on advertising or selling access to the health information obtained from the PHR. A recent article states that “the rise of consumerism, compels a response focused more on revenue and strategic advantage than on pure cost savings.” Third-party PHRs could be attractive because they could potentially defray a large amount of PHR system acquisition and maintenance costs to sources outside of the healthcare system. Since third-party entrants are sponsoring the technology, providers will not bear much of the costs, which could potentially increase provider adoption and quality of service. A third-party PHR also benefits the payer by decreasing healthcare costs. Challenges to third-party PHRs are data sharing among competitors and maintaining privacy and security. The most important point here is that these entrants need the participation of the clinical stakeholders in the healthcare system for the feasibility and viability of a third-party PHR.

Unlike many healthcare technologies, PHRs do not necessarily have a misalignment of incentives. All four architectures may include providers and payers, the two parties that receive the benefit of the technology. Thus, those installing and providing the PHR are the ones receiving the benefit. The exceptions to this premise are the sponsors of PHRs
that are neither payers nor providers. In order for those PHRs to survive, an appropriate business model needs to be developed that provides payment to these sponsors.

Additional Motivations

In addition to financial motivations, other entities are entering into the PHR marketplace as a means to improve quality, safety, and convenience for patients and their families. Existing literature indicates that provider adoption and motivation to enter the health IT market is low because providers do not view health IT as a cost-savings measure; rather, they view health IT as a mechanism to improve processes, outcomes, and quality of care. Providers to date have been resistant to health IT in part because of the misalignment of incentives.96

Similarly, payers have additional, non-financial motivations to offer PHRs to their members. While decreased healthcare expenditures are a great incentive for payers to enter the PHR market, improved customer service and automation (i.e., eligibility requirements) are also important. Purchaser requirements might also affect payer entrance into this market (i.e., employer revision of a request for proposal could require that a payer provide a PHR to its employees).

Installation, Adoption, and Use

Currently, adoption and use of PHRs among providers, patients, and payers are low. An estimated 70 million people in the US have access to some form of a PHR, generally through their health insurer. America’s Health Insurance Plans (AHIP) is planning to offer a PHR product to their more than 200 million covered members by the end of 2008.22 In addition, there are multiple third-party efforts underway to provide a PHR to all Americans with Internet access.23 Although access is high, adoption and use is still low.14 This may be caused by many factors. In the development of these technologies, it is important for PHR sponsors to understand the potential user requirements associated with this technology. A recent study states that “[w]idespread adoption and use of PHRs will not occur unless they provide perceptible value to users, are easy to learn and easy to use, and have associated costs (both financial and effort) that are easily justified related to the PHR’s perceived value.”9 Across all stakeholders, there exists a variety of barriers to adoption. In 2006, Tang et. al. identified two main mechanisms for breaking down barriers to adoption: education and research.9

Provider Adoption

Regardless of PHR architecture, most PHR functions involve interactions between patients and providers. Therefore, patient use and provider adoption are equally critical to the success of a PHR. Functions such as e-visits or Internet-based appointment
scheduling have no functional use to patients unless their providers adopt these functions as well. Provider adoption of PHRs is affected by the value generated to providers. Some examples of value to providers could include providers being reimbursed for PHR usage, providers having direct costs savings through the use of the PHR, or possibly providers having improved satisfaction in responding to patient demands through a PHR. New incentives may be put into place to encourage provider adoption. For example, draft legislation has been proposed in the US Congress to mandate reimbursing providers an annual fixed amount per patient for adopting a PHR.97 Physician pay for performance incentives as measured via a PHR are another mechanism being discussed as a stimulus to provider adoption.16

**Payer and Employer Adoption**

Currently, there are a variety of payer-tethered PHRs in the market. Payers have long understood the value of increased patient-provider communication. Many payer organizations employ health coaches or case managers to check on patients. Such communication can help control costs by identifying problems and issues earlier to reduce overall costs. Some payers have begun accepting CPT code 0074T to reimburse clinicians who provide online consultation for patients.98 Because e-visits are critical to a PHR system and also greatly affect the net value, it is important for payers to recognize and address this functionality as an essential component of a PHR system. Given that payers are typically not directly involved in patient care, it is unclear how readily payer-tethered PHRs will be adopted by providers or be used by patients.

Similarly, employers who are one of the biggest purchasers of healthcare in the US see potential value in PHRs. Dossia is an important initiative in this regard because it “is a consortium of large employers united in their goal of providing employees, their dependents, retirees and others in their communities with an independent, lifelong health record.”99 Employer motives for investing in, adopting, and encouraging use of PHRs among their employees will generally be for items such as healthcare cost containment or for distinguishing themselves with this employee benefit among employers.

**Patient Use**

Ultimately, PHRs will only be effective if patients use them. There are many factors that can affect patient adoption of a health technology. One factor that may influence patient adoption is that the targeted population of users may have low computer literacy. Frequent users of the healthcare system are often those who are chronically ill, young, or elderly. One article found that the majority of PHR users had significant issues with computer literacy and thus experienced resulting anxiety.100 Another article found that provider recommendations played a strong role in patient use of the PHR.91

Additionally, user design is a critical factor in patient adoption and use of PHRs. One objective of the Robert Wood Johnson Foundation’s Project Health Design initiative is to “stimulate the health information technology industry to develop consumer-focused
personal health records system products and services that use the common platform approach, and to generate insight into the needs, preferences and design challenges associated with diverse populations. PHR use has the potential to become widespread among patients if the PHR is accessible and usable to patients and they find value in its functionality. User-centric design increases accessibility and usability for the user.

Patient use of PHRs may vary depending on the architecture, even with the same or similar functionality because of different perceptions of third parties, payers, and providers among patients and other PHR users. Patients may be less likely to use third-party or payer-tethered PHRs, versus provider-tethered PHRs, because they already have a trusted, established healthcare relationship with their provider. This relationship does not exist, or at least does not exist on the same level, with payer and third-party organizations.

**Security and Privacy**

As with the exchange of financial data, significant security and privacy concerns are associated with the exchange of personal health information. Security and privacy are one of the top concerns cited by patients when interviewed about PHRs. It is important for any PHR to carefully consider security and privacy issues. The CITL PHR model maintains the underlying assumption that robust security will be built into the infrastructure.

Security and privacy concerns related to PHRs are complicated by several issues. First and foremost, some groups sponsoring PHRs are not traditional healthcare organizations and therefore are not subject to the security and privacy rules and regulation of the Health Insurance Portability and Accountability Act (HIPAA). Accordingly, Google has provided the following disclaimer for its PHR: “Google is not a ‘covered entity’ under the Health Insurance Portability and Accountability Act of 1996 and the regulations promulgated there under. As a result, HIPAA does not apply to the transmission of health information by Google to any third party.” Secondly, as with EHRs, PHRs have the potential to aggregate patient health information so that a privacy and security breach within a PHR has the potential to compromise many thousands or even millions of patients’ health information. Finally, many researchers, public health officials, and others see great potential in PHR data for population-based purposes not directly related to the care of a specific patient from whom the data was collected. While the potential societal gain of these uses may be great, significant security and privacy issues have yet to be resolved.

Although there are some costs and no direct financial benefits from PHR security and privacy, without these elements, PHRs will not be adopted and used and will therefore fail.
The Value of Other Types of PHRs

The Markle Foundation’s PHR description as an Internet-based PHR, which is the basis that CITL used for this PHR value analysis, excludes some PHR products in the current marketplace (e.g., USB-based PHRs and desktop-based PHRs). Although these products may possess some of the functionality described in this report, these other products will ultimately not be able to provide the range of functionality that Internet-based PHRs could provide because of their relative lack of access to health information and relative lack of health information interoperability. In addition, some of these products present security issues that will probably limit their adoption and use.89

The Value of PHRs to Patients

The epicenter of any PHR discussion involves patients because at its core, PHRs involve patient control of and access to information about their health. Ultimately, PHRs will succeed or fail because of their perceived value to patients, even if their value to other stakeholders is high. In this PHR value analysis, CITL did not attempt to quantify the value of PHRs to patients because most patients do not directly bear the risks for the costs of care. Therefore, the direct financial benefit of PHRs to most patients will be minimal.

This does not imply that patients will not directly benefit from PHRs. In fact, if PHRs do not have some direct benefit to patients, patients will not use them, and they will not succeed. Rather, the benefits of PHRs to patients will be more qualitative and not directly linked to personal cost savings. Potential benefits to patients include more efficient access to healthcare resources, access to healthcare information throughout a patient’s lifetime, and enhanced networking among patients with similar healthcare issues. Some leaders in the field even envision a paradigm shift to a patient-centered healthcare system enabled by PHRs.

The PHR value analysis presented here demonstrates that just looking at direct health costs and benefits, PHRs have the potential to save the US healthcare system billions of dollars per year, even without considering the value to patients. CITL recognizes that this direct financial net value may only be the beginning of understanding and realizing the value of PHRs to patients.

Conclusion

CITL believes there is a financial case for supporting PHR development and adoption in the US. The analysis presented in this report provides a framework for PHRs as well as the quantifiable financial value of this technology. To date, the emerging field of PHRs
lacks a clear value proposition. This value proposition is important because if PHRs are implemented intelligently and appropriate policy decisions are made, the healthcare system will reap significant financial benefits. The results from this model suggest that interoperable PHRs are the most financially viable and produce the greatest net benefit, clearly illustrating the need for data standards within the US healthcare system.
The CITL methodology consists of five primary components:
• Convene an Advisory Board
• Conduct a literature review
• Develop taxonomy
• Synthesize the evidence synthesis to form a conceptual model
• Develop a software simulation model to project clinical utilization, access, financial, and organizational value

Convene an Advisory Board

CITL’s first step in analyzing the potential value of health IT is to convene an Advisory Board. The board reviews and provides feedback to CITL on the analytic framework, taxonomy, model estimates, preliminary findings, and final report. The board is made up of experts who have implemented or researched the technology. The members come from provider organizations, payer organizations, research institutions, and government entities to ensure a wide range of expertise. During the project, the board has one day-long, face-to-face meeting and monthly teleconferences.

Conduct a Literature Review

Next, CITL conducts a systematic review of the literature. The goal is to identify literature in the US academic and trade journals that are most likely to contain data relevant to the analysis. CITL uses systematic review methodologies and standard techniques to find, review, and analyze disparate literature. The methodology is adapted from leading academic sources, including the Harvard School of Public Health, the American College of Physicians, and Stanford University’s Evidence-based Practice Center. A search strategy is then defined and vetted with experts in the field as well as with a medical librarian. The main search is typically completed using MEDLINE via OVID as well as other databases, such as CINAHL and EMBASE.

Each article abstract is reviewed by two reviewers to determine relevance. A deep abstraction is performed on every article unless both reviewers reject the article for lack of relevance to the subject. The deep abstraction is used to identify primary articles that might contain data relevant to this model as well as to the writing of the final report. Discrepancies in interpretation are resolved through team discussion to reach a consensus.
Develop Taxonomy

Based on the preliminary evidence gathered about the health IT being evaluated, a taxonomy for the various forms and functionalities of these technologies is developed. The initial work on the taxonomy involved reviewing existing taxonomies for the studied technology. If CITL determines that current taxonomies are not comprehensive, a new taxonomy is developed to reflect these technologies. The goal of the taxonomy is to represent the breadth of the technology in its application in the real world.

Synthesize the Evidence

The synthesis of the evidence combines the results of the literature review with the development of the taxonomy. The goal is to determine where impacts are clustered in the literature, which are referred to as “value clusters.” The identification of these value clusters has allowed CITL to begin a framework for the model. From these value clusters, CITL created a series of “value chains.” A value chain is the representation of the process for transforming healthcare system statistics and impact data into projected value outcomes. These value chains are used to inform the model construction and identify the parameters needed.

For each value chain, parameters are defined in order to determine the resultant outcome and subsequent financial value for each chain. For each parameter needed, data from the literature are identified and tagged in CITL’s database to that particular input. Parameters lacking data, “data gaps,” are then identified, and a targeted search is conducted to fill those gaps. For chains that lack the necessary data to inform the chains, CITL consults the Advisory Board. Data sources are reviewed with Advisory Board members, who are then asked to provide additional resources to potentially fill the data gaps from published literature, unpublished evidence, or advice from other experts in the field. If this process does not yield appropriate data, CITL asks the board members to participate in a Modified Delphi process, as detailed below. If the board judges that a missing data element could not be estimated with confidence, the chain is excluded from the model.

As opposed to a traditional Delphi method, available evidence is presented to Advisory Board members with the reasoning as to why CITL believes existing data cannot be used in the model. The best evidence available is provided as a reference point for Advisory Board members in making their own estimates. Based on this reference point, all members provide their own estimates for the data point, and estimates are then shared anonymously with all members via e-mail. Participants are allowed to leave their estimates unchanged or provide new estimates if they so choose. This process is repeated a second and final time. Final estimates are then aggregated to compute an average and standard deviation for inclusion into the model.
Develop a Simulation Model

CITL’s last step is to develop a software simulation model using Analytica™ modeling software. Analytica™ is a visual tool for creating, analyzing, and communicating decision models. It combines graphical presentation of influence diagrams with integrated uncertainty calculations and propagation, transparent multi-dimensional array manipulations, and multiple probabilistic simulation capabilities. The model uses sensitivity analysis to identify pivotal variables. Sensitivity analyses are performed to determine the behavior of the model in response to variations in input variables and key assumptions. Numerical results and implications of the model are reviewed with the Advisory Board to ensure model validity. For those parameters where there were no published measures or expert estimates of uncertainty, CITL uses a factor of ±25% to reflect potential uncertainty in the parameter.
Appendix B: Advisory Board Biographies

Jane Barlow
*Medco Health Solutions, Incorporated*

Jane Barlow, MD, serves as Vice President, Medical Strategy and Clinical Quality for Medco Health Solutions, Inc. She is responsible for the medical evaluation of new strategic opportunities and provides comprehensive medical leadership and oversight of Medco’s quality and accreditation activities. As Medical Director for Medco’s National and Government Accounts, she provides clinical consultation and guidance designed to enhance client relationships, promote Medco’s business, and showcase the company’s clinical capabilities to internal and external customers.

Dr. Barlow attended medical school at Creighton University and completed her residency training in occupational medicine at Johns Hopkins University. She holds Masters’ degrees in business administration and public health and is a Certified Physician Executive. Dr. Barlow is board certified in occupational medicine and holds the rank of fellow in both the American College of Occupational and Environmental Medicine and the American College of Preventive Medicine.

Dr. Barlow’s prior experience includes expertise in employer benefits, employee well-being, and occupational and environmental health and safety. Her diverse background includes positions with the US military, federal government, industry, private practice, and consulting.

Dr. Barlow is a member of the National Advisory Committee for the Agency for Healthcare Research and Quality. She is a board member of the National Business Group on Health Institute on Health Care Costs and Solutions and recently served as Co-chair, National Committee on Evidence-Based Benefit Design.

William Crawford
*Children’s Hospital Boston*

William Crawford is the Director of the Informatics Solutions Group (ISG) at the Children’s Hospital Informatics Program (CHIP) in Boston. In this role he is responsible for the development of the core version of the Indivo open source Personally Controlled Health Record platform, as well as collaboration between Children’s Hospital and the Dossia PCHR Consortium. Before the creation of ISG, Mr. Crawford was the Director...
The Value of Personal Health Records

Robert Heyl
Aetna, Inc.

Robert Heyl is Managing Director, eHealth Strategy and Innovation for Aetna, Inc. He is head of strategy and innovation for Aetna’s eHealth business, which includes oversight, research and development, design and implementation of online consumer products and strategies. Mr. Heyl is also responsible for the business and editorial operations for Aetna InteliHealth®, a public consumer health portal in collaboration with Harvard Medical School. Prior to taking this role in January 2006, Mr. Heyl served as Technical Solution Manager in Aetna Information Services organization, responsible for the architecture, design, and delivery of Aetna’s web, self-service, customer service, and fulfillment solutions.

Mr. Heyl joined Aetna in July 2001 as a lead for emerging technology research and IT strategy development. He came from Computer Science Corporation, Consulting Group, where he served as a Senior Consultant and Senior Architecture Specialist. There he provided breakthrough solutions across a number of industries, including Consumer and Industrial Products, Retail, Financial Services, and Government.

Mr. Heyl holds a Bachelor of Science degree in Mathematics from Temple University. He is the Head of eHealth Product Strategy and Delivery at Aetna, Inc. and oversees the strategic research, development, and implementation of consumer, online products, and programs in addition to running the Aetna InteliHealth business operations. Most recently, Mr. Heyl has focused on the Aetna Personal Health Record product and the Enterprise Health Information Technology strategy.

Prior to this role, he directed the IT solution design of all self-service products, tools, and technologies across all lines of Aetna’s business, as well as customer service and fulfillment.
Before joining Aetna in 2001, he was a Senior Consultant at CSC Consulting, where he focused on large-scale systems integration and consumer online solutions.

**David Lansky**

*Pacific Business Group on Health*

David Lansky, PhD, joined the Markle Foundation as Senior Director of the Health Program in 2004. His work focuses on accelerating the adoption of interoperable health information technology throughout US healthcare, with a particular emphasis on ensuring that patients and consumers have access to and control over their information and can participate fully in the redesign of the healthcare system. He also serves as Executive Director of the Personal Health Technologies Initiative. For more than 20 years, Dr. Lansky has been a proponent of a more responsive and accountable healthcare system. He previously served as President of the Foundation for Accountability (FACCT) from 1995 to 2004.

A nationally recognized expert in accountability and quality measurement, Dr. Lansky has served as a board member or advisor to numerous healthcare projects and programs, including the National Quality Forum, the Joint Commission on Accreditation of Healthcare Organizations, the National Patient Safety Foundation, the Leapfrog Group, and President Bush’s 2002 Economic Summit.

Before heading to FACCT, Dr. Lansky was a senior policy analyst for the Jackson Hole Group during the national healthcare reform debate of 1993–94. He also led the Center for Outcomes Research and Education at Oregon-based Providence Health System. His responsibilities included outcomes research, measurement of consumer satisfaction, health risk and health status assessment, development of electronic member records, and communicating with purchasers and the larger community about healthcare quality.

Since February 2008, he has been President and CEO of Pacific Business Group on Health.

**Omid Moghadam**

*Intel Genomics*

Omid Moghadam is the Worldwide Director of marketing for Intel Genomics, focused on providing computing solutions and services to the genomics market. Prior to joining Intel Genomics, he founded Dossia Corporation (www.dossia.org), a not-for-profit corporation that has created a national platform for storing independent consumer-owned health records. Mr. Moghadam served as Dossia Executive Director until recently. Prior to Dossia, Mr. Moghadam was the head of microprocessor strategy at Intel, where he led the transition of the corporation from single to multiple-core processors.
Prior to joining Intel, Mr. Moghadam was a Principal of the American Management Systems, a management consultancy based in Washington, D.C. At AMS, he focused his efforts on serving clients’ strategy needs in healthcare, finance, and government.

Prior to AMS, Mr. Moghadam spent seven years with Eastman Kodak Company in various technical and general management roles. His assignments ranged from creation of the Digital Angiography business, to managing regional sales and marketing for the newly created Digital Imaging business and leading mergers and acquisition deals in the printing and semiconductor sectors.

An expert in medical imaging, Mr. Moghadam holds bachelor and master degrees in electrical and computer engineering, with concentration in bio-physics. He also holds an MBA in finance.

Mr. Moghadam also holds an appointment with Harvard Medical School, where he focuses on creation of programs in Personal Genomics. He also serves on Markle Foundation’s Personal Health Technology council, Children Hospital Boston’s Gene Partnership Program, and Robert Wood Johnson’s Project Health Design National Advisory Boards. A prolific inventor, he holds 46 patents and has received the honor of being named an Eastman distinguished inventor.

Kim M. Nazi
Veteran’s Health Administration

Kim Nazi is a Management Analyst for the Department of Veterans Affairs, working in the Veterans/Consumer Informatics Resource Office of the Veterans Health Administration. Kim is a Board-Certified Healthcare Executive and a Fellow in the American College of Healthcare Executives. She holds a Master’s degree in Strategic Communication from Seton Hall University, New Jersey, and is a doctoral student in the Joint Sociology/Communication program at the University of Albany.

Ms. Nazi’s research interests include technology and personal health records, health communication, and behavioral interventions. Prior to taking on her current role in July 2006, Ms. Nazi served as the Director of eHealth for the VA Healthcare Network Upstate New York, focusing on the use of technology to improve and expand the delivery of healthcare services. She is a graduate of the VA’s Executive Career Field Candidate program and a member of the American Health Information Community (AHIC) Consumer Empowerment Workgroup.
Daniel Z. Sands  
*Cisco Systems*

Daniel Z. Sands, MD, MPH, is senior medical informatics director of Cisco Systems. He brings solid industry knowledge and broad experience to these roles, providing both internal and external health IT leadership and helping partners with business and clinical transformation using IT.

Prior to joining Cisco, Dr. Sands was vice president and chief medical officer of Zix Corporation, where he helped the company become a leader in e-prescribing. Before that, he was clinical systems integration architect at Beth Israel Deaconess Medical Center in Boston, where he developed and implemented numerous systems to improve clinical care delivery and patient engagement.

Dr. Sands earned his baccalaureate at Brown University, medical degree at Ohio State University, and a master’s degree at Harvard School of Public Health. He did residency training at Boston City Hospital and an informatics fellowship at Beth Israel Deaconess Medical Center. Dr. Sands is an assistant clinical professor of medicine at Harvard Medical School and maintains a primary care practice in which he makes extensive use of health information technology.

Dr. Sands is the recipient of numerous health IT awards, sits on the board of the American Medical Informatics Association, and has been elected to fellowship in both the American College of Physicians and the American College of Medical Informatics.

Paul Tang  
*Palo Alto Medical Foundation*

Paul C. Tang, MD, MS, is an internist and Vice President, Chief Medical Information Officer at the Palo Alto Medical Foundation (PAMF). He is also Consulting Associate Professor of Medicine (Biomedical Informatics) at Stanford University. At PAMF, Dr. Tang is responsible for the electronic health record (EHR) system and an integrated personal health record (PHR) system. PAMF has been using an EHR system since 1999 and deployed its PHR system in 2001. Over 90,000 patients (representing over 45% of PAMF’s primary care patients) are actively using the online PHR system.

Dr. Tang received his BS and MS in Electrical Engineering from Stanford University and MD from the University of California, San Francisco. He is Chairman of the Board for the American Medical Informatics Association and is a member of the National Committee on Vital and Health Statistics (NCVHS). Dr. Tang serves on the IOM’s HealthCare Services Board and chaired an IOM patient safety committee whose reports were published in 2003–4: *Patient Safety: A New Standard for Care*, and *Key Capabilities of*
an Electronic Health Record System. He is a member of the American Health Information Community Consumer Empowerment Workgroup and is also a member of Markle Foundation’s Connecting for Health Steering Committee and its Consumer Access Work Group. He chairs the Robert Wood Johnson Foundation’s National Advisory Council for ProjectHealth Design (dealing with PHRs). Dr. Tang chairs the National Quality Forum’s Health Information Technology Expert Panel and is a member of the NQF Consensus Standards Approval Committee.

Jonathan S. Wald  
*Partners HealthCare*

Jonathan S. Wald serves as Associate Director of Clinical Informatics at Partners Healthcare, Boston, where he oversees development and research of *Patient Gateway*, a secure patient portal developed at Partners that connects thousands of patients with their physicians in over 30 practices for secure online communication and patient access to their own medical records since 2002.

Dr. Wald is a member of the faculty of Harvard Medical School, has served as Co-Principal Investigator for a large study of quality of care using patient portals funded by the Agency for Healthcare Research and Quality, serves on the National Advisory Committee for the Robert Wood Johnson’s Health e-Technologies Initiative, and has served on several workgroups for the Markle Foundation’s *Connecting for Health* initiative. His main focus is advancing the use of electronic medical records, including patient-physician electronic communication and patient access to information and decision support in real-world settings.
To review the relevant literature on PHRs, CITL designed a search strategy aimed at identifying applicable articles in peer-reviewed academic periodicals and trade journals, written in English from 1997 to 2007. The search strategy, outlined below, utilized a multi-tiered approach to filter germane articles from the medical literature; such an approach was vetted with experts in the field, as well as a medical librarian. In conducting its literature review, CITL began with the Markle Foundation’s broad description of personal health records:

“The Personal Health Record (PHR) is an Internet-based set of tools that allows people to access and coordinate their lifelong health information and make appropriate parts of it available to those who need it. PHRs offer an integrated and comprehensive view of health information, including information people generate themselves such as symptoms and medication use, information from doctors such as diagnoses and test results, and information from their pharmacies and insurance companies. Individuals access their PHRs via the Internet, using state-of-the-art security and privacy controls, at any time and from any location. Family members, doctors or school nurses can see portions of a PHR when necessary and emergency room staff can retrieve vital information from it in a crisis. People can use their PHR as a communications hub: to send e-mail to doctors, transfer information to specialists, receive test results, and access online self-help tools. PHR connects each of us to the incredible potential of modern healthcare and gives us control over our own information.”

A team of researchers distilled this definition into a series of search terms. Each term is listed below in Figure C-1. The results from each search were assessed, and ones that seemed to be too broad or narrow were excluded.
### Initial Search Terms for Literature Search

<table>
<thead>
<tr>
<th>Search Terms</th>
<th>Number of Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Health Records</td>
<td>54645</td>
</tr>
<tr>
<td>“Personal health records”</td>
<td>62</td>
</tr>
<tr>
<td>PHR</td>
<td>422</td>
</tr>
<tr>
<td>PHR and “Personal Health Records”</td>
<td>16</td>
</tr>
<tr>
<td>Personal Health Records AND “Patient Empowerment”</td>
<td>18</td>
</tr>
<tr>
<td>Personal Records</td>
<td>3402</td>
</tr>
<tr>
<td>Online Health Record</td>
<td>286</td>
</tr>
<tr>
<td>Online “personal records”</td>
<td>4</td>
</tr>
<tr>
<td>Patient provider “online record”</td>
<td>12</td>
</tr>
<tr>
<td>Online Record</td>
<td>894</td>
</tr>
<tr>
<td>“Personal Electronic Health Record”</td>
<td>5</td>
</tr>
<tr>
<td>Personal “Electronic Health Record”</td>
<td>22</td>
</tr>
<tr>
<td>Electronic health record and “patient participation”</td>
<td>35</td>
</tr>
<tr>
<td>Patient Provider Web Portal</td>
<td>8</td>
</tr>
<tr>
<td>Patient Provider AND electronic record</td>
<td>127</td>
</tr>
<tr>
<td>Patient Provider AND personal records</td>
<td>33</td>
</tr>
<tr>
<td>Insurance Web portal</td>
<td>4</td>
</tr>
<tr>
<td>Web Portal</td>
<td>220</td>
</tr>
<tr>
<td>Electronic “patient information systems”</td>
<td>6</td>
</tr>
<tr>
<td>Shared “health records”</td>
<td>34</td>
</tr>
<tr>
<td>Patient accessible records</td>
<td>234</td>
</tr>
<tr>
<td>“Web-based” “personal health record”</td>
<td>247</td>
</tr>
<tr>
<td>“Web-based” “personal health record”</td>
<td>4</td>
</tr>
<tr>
<td>“Web based” “health record”</td>
<td>32</td>
</tr>
<tr>
<td>Patient-held records</td>
<td>50</td>
</tr>
<tr>
<td>Grand Total (Deduplicated Total)</td>
<td>259 (204)</td>
</tr>
</tbody>
</table>

Note: Strikethrough indicates terms ultimately excluded.

These 204 unique articles composed a base set of literature for the PHR search; however, CITL sought to be more expansive in its exploration of the literature and employed a medical librarian to conduct a more targeted search. The search strategies used are outlined below.
Database: PubMed

The librarian conducted iterative searching in PubMed in order to try for the most comprehensive retrieval.

Date: 7/11/07


**Limits:** Last 10 years, English, and review articles.

**Results:** This search produced 1,806 results, of which 97 were included in CITL’s results.

Date: 7/12/07


**Results:** 172 citations, 114 of which were unique and included in the final literature review.
Database: Business Source Complete

Use of similar subject headings as in the PubMed database in this database caused the relevancy of results to drop precipitously. Accordingly, a medical librarian used a single phrase searching this database.

**Strategy:** keyword phrase “personal health record.”

**Results:** This produced 72 citations, of which 43 were recognized as unique and relevant to the project.

Database: ABI Inform

It was difficult to perform a focused search in this database. Searching “personal health record” AND “value analysis” produced no results. Instead, a medical librarian developed a search strategy for electronic health record-related sources.

**Strategy:** electronic medical records AND value AND personal.

**Results:** This produced 323 results, of which 34 were unique and deemed relevant and added to the results.

Additional Materials


These search strategies identified a grand total of 493 articles. CITL then filtered these articles using exclusionary criteria and an initial scan of the abstracts; 137 were determined relevant and underwent a full abstraction (Figure C-2).

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**Summary of Literature Search**

- **493 Initial Articles**
  - From CITL search terms and medical librarian advice

- **228 Articles Rejected**
  - (due to exclusionary criteria)

- **265 Article Abstracts Reviewed**

- **128 Articles Rejected**
  - (due to abstract review)

- **137 Articles Abstracted**

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The Value of Personal Health Records
Appendix D: PHR Model Reference

Introduction

A computer model is a key component of CITL’s research methodology. The computer model, typically written on Lumina Decision System’s Analytica platform,110 allows CITL to represent both the features of the computerized interventions and the characteristics of the underlying healthcare system. In addition, by explicitly capturing the assumptions and the logical progression of the analysis, CITL can quickly and effectively review every detail of the analysis with domain experts to validate the model. This appendix will highlight key aspects of CITL’s PHR software model using graphical representations of the model.

PHR Software Model

CITL’s PHR model is an influence diagram using the Analytica™ decision analysis software from Lumina Decision Systems, Inc.110 This software allows CITL to consider many factors simultaneously and to incorporate probability distributions in the PHR model to be explicit about uncertainties in the data used in the model. The results in this report are outputs from the model, and underlying calculations are summarized in tables and text throughout the report. An overview of the model can be seen here in Figure D-1. Each of these modules interacts with one another via a user interface in order to project PHR benefits. These modules are summarized in Table D-1 below.
**Figure D-1**

**PHR Model Top-level View**

<table>
<thead>
<tr>
<th>Module Name</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background Statistics</td>
<td>General statistics about the US healthcare environment such as the US population</td>
</tr>
<tr>
<td>Indices and Constants</td>
<td>General definitions for constants and indices not specific to PHR, such as physician practice sizes</td>
</tr>
<tr>
<td>Information Self Management</td>
<td>Value chains for Information Self Management</td>
</tr>
<tr>
<td>Information Collection</td>
<td>Value chains for Information Collection</td>
</tr>
<tr>
<td>Information Exchange</td>
<td>Value chains for Information Exchange</td>
</tr>
<tr>
<td>Information Sharing</td>
<td>Value chains for Information Sharing</td>
</tr>
<tr>
<td>PHR Benefits</td>
<td>The module summarizing results from the value chains</td>
</tr>
<tr>
<td>PHR Definition</td>
<td>Definitions specific to PHR such as PHR architecture types</td>
</tr>
<tr>
<td>PHR Net Value</td>
<td>Combining results from PHR Benefits module and the System Cost module</td>
</tr>
<tr>
<td>System Cost</td>
<td>The module capturing cost estimation for PHR systems</td>
</tr>
<tr>
<td>User Interface</td>
<td>The module for the PHR model user interface</td>
</tr>
<tr>
<td>Utility Function</td>
<td>Commonly used functions in model simulation</td>
</tr>
</tbody>
</table>
User Interface Module

For most users, the only module they would use is the user interface module. Within this module, every result presented in this report could be calculated at the touch of a button. On opening the module, the user would see what is shown below in Figure D-2.

As can be seen in Figure D-2 above, the control buttons are arranged into three columns. The left column contains 20 buttons for calculating most numerical results from the CITL PHR model such as net steady-state benefits for the nation, per installation, or per person. The right column contains buttons for performing breakeven analysis for single PHR installation based on number of users, and the buttons for generating the provider and payer pyramidal analysis. The center column contains two control buttons and 18 buttons for sensitivity analysis. The 18 sensitivity analysis result buttons can be further subdivided into two types: those that presented the raw sensitivity analysis results versus those that further translated the results into High-Low number pairs that are suitable for creating tornado diagrams. The latter group is denoted in the user interface with a suffix of “HL.” Finally, the control buttons at the top of the sensitivity analysis column are used to generate the 1 million-user architectural comparison analysis, and to control whether the High-Low results are presented as absolute numbers or as a percentage of their deviation from the main estimate.
The majority of the results presented in the User Interface Module is calculated inside the PHR Net Value Module. This module brings together all the results projected in the other modules of the PHR model to estimate the net impact of PHR systems. On opening the module, the user would see what is shown below in Figure D-3.

The primary inputs of the PHR Net Value module are the variables “Yearly Benefits of PHR” (eq. 1) and “Yearly Cost of PHR” (eq. 2).
Equation 1: \( PHR\_YB = \text{Max}(B_{arch}) \times \text{Benefit}\_\text{curve}, \) where
\[
PHR\_YB = \text{Yearly Benefits of PHR}
\]
\[
\text{max}(B_{arch}) = \text{Maximum annual benefits of PHR by architecture (eq. 1)}
\]
Benefit\_\text{curve} = PHR Benefit accrual curve

Equation 2: \( PHR\_YC = PHR\_\text{Cost}\_\text{US} \times \text{Cost}\_\text{curve}, \) where
\[
PHR\_YC = \text{Yearly Cost of PHR}
\]
\[
PHR\_\text{Cost}\_\text{US} = \text{Acquisition and annual cost to implement PHR for US}
\]
Cost\_\text{curve} = PHR Cost accrual curve

Once the variables “Yearly Benefits of PHR” and “Yearly Cost of PHR” are calculated, then the annual cash flow of PHR (“Yearly Cashflow of PHR”) can be trivially calculated by subtracting the yearly cost of PHR from the yearly benefit of PHR (eq. 3).

Equation 3: \( PHR\_\text{Cashflow} = PHR\_\text{YB} - PHR\_\text{YC}, \) where
\[
PHR\_\text{Cashflow} = \text{Annual cashflow of PHR (non-cumulative)}
\]
\[
PHR\_\text{YB} = \text{Yearly Benefit of PHR (eq. 1)}
\]
\[
PHR\_\text{YC} = \text{Yearly Cost of PHR (eq. 2)}
\]

The annual cashflow of PHR is then used to calculate both cumulative net and steady-state value of PHR. Calculation of cumulative net value of PHR (“Cumulative net for PHR,” eq. 4) and final net value of PHR (“Final Net for PHR,” eq. 5) involve only simple arithmetic cumulating and summing of annual cashflow. Once the final net value of PHR for the nation is calculated, final net, per-installation estimates (“Final Net per Installation,” eq. 6) and final net, per-person estimates (“Final Net per Person” eq. 7) can be extrapolated by dividing by the number of PHR installation in the US and total PHR population in the US.
Equation 4: \( PHR_{CN} = \sum_i PHR_{Cashflow} \), where

- \( PHR_{CN} = \) PHR cumulative net
- \( PHR_{Cashflow} = \) Annual cashflow of PHR (eq. 3)

Equation 5: \( PHR_{FN} = \sum_i PHR_{Cashflow} \), where

- \( PHR_{FN} = \) PHR final net
- \( PHR_{Cashflow} = \) Annual cashflow of PHR (eq. 3)
- \( N = \) Number of years in simulation

Equation 6: \( PHR_{FN}_{PS} = \frac{PHR_{FN}}{PHR_{Sites}} \), where

- \( PHR_{FN}_{PS} = \) PHR final net per site
- \( PHR_{FN} = \) PHR final net (eq. 5)
- \( PHR_{Sites} = \) Number of sites for each PHR architecture in US

Equation 7: \( PHR_{FN}_{PP} = \frac{PHR_{FN}}{PHR_{Population}} \), where

- \( PHR_{FN}_{PP} = \) PHR final net per person
- \( PHR_{FN} = \) PHR final net (eq. 5)
- \( PHR_{Sites} = \) Total number of PHR users in US

In the CITL PHR model setup, the total simulation time, referred to as \( N \) in equation 5, is chosen to ensure that the benefit accrual, cost accrual, and cashflow of PHR have reached equilibrium, or steady state. Therefore, CITL was able to define the steady-state, annual net value of PHR for the US simply by choosing the last year of the simulation (eq. 8). Per-installation and per-person estimates of steady-state, annual net value (eq's
9,10) are calculated similar to the corresponding calculations for final net estimates.

**Equation 8:** \[ PHR\_SS = PHR\_Cashflow, \]

where

- \( PHR\_SS \) = Steady-state, annual net value of PHR for US
- \( PHR\_Cashflow \) = Annual cashflow of PHR (eq. 3)
- \( N \) = Number of years in simulation

**Equation 9:** \[ PHR\_SS\_PS = \frac{PHR\_SS}{PHR\_Sites}, \]

where

- \( PHR\_SS\_PS \) = PHR steady-state, annual net value per site
- \( PHR\_SS \) = PHR steady-state, annual net (eq.8)
- \( PHR\_Sites \) = Number of sites for each PHR architecture in US

**Equation 10:** \[ PHR\_SS\_PP = \frac{PHR\_SS}{PHR\_Population}, \]

where

- \( PHR\_SS\_PP \) = PHR steady-state, annual net per person
- \( PHR\_SS \) = PHR steady state annual net (eq.8)
- \( PHR\_Sites \) = Total number of PHR users in US

The site level breakeven analysis submodule is inside the PHR net value module (see Figure D-4). The logic flow of the breakeven analysis is very similar to the parent PHR net value module. The key inputs to the submodule are “Single-Site Annual Benefit” and “Single-Site Annual Cost” (eq’s 11,12). In calculating single-site annual benefit and cost, different accrual curves needed to be used because the national benefit and cost accrual curves accounted for phased installation across the country, whereas single-site installations generally proceed at much faster pace. Annual cashflow, cumulative net, final net, and steady-state, net values are derived from single-site annual benefit and single-site annual cost similar to the US-level calculations (see eq’s 3,4,5, and 8). Using the Smart Array function of Analytica, CITL is able to iteratively determine the relevant range and resolution of the population sizes that are tested for the breakeven analysis. The model then transforms the population ranges into ranges of PHR sites due to the
logic flow of the model. Using the what-if function of Analytica, CITL then produced the breakeven analysis for single-site, final net and single-site, steady-state net.

**Equation 11:** $SS\_AB = Max(Benefit\_per\_site) \times SS\_Benefit\_curve$, where

- $SS\_AB = \text{Single-site annual benefit}$
- $Max(Benefit\_per\_site) = \text{Maximum annual benefit per site}$
- $SS\_Benefit\_curve = \text{Single-site benefit accrual curve}$

**Equation 12:** $SS\_AC = PHR\_Cost\_per\_site \times SS\_Cost\_curve$, where

- $SS\_AC = \text{Single-site, annual cost}$
- $PHR\_Cost\_per\_site = \text{Acquisition and annual cost per site}$
- $SS\_Cost\_curve = \text{Single-site, cost accrual curve}$

The sensitivity analysis variables are produced using specialized what-if-all functions of Analytica, which is similar to the what-if function used for the breakeven analysis, except that while what-if only varies one parameter, what-if-all performs one-way sensitivity analysis over an array of variables. The tornado diagram submodule contains
additional variables used to produce tornado diagrams using Analytica’s array-sorting and re-indexing functions.

**PHR Benefits Module**

On opening the module, the user would see what is shown below in Figure D-5. It contains one primary input, the “Benefit by Chains” variable, which is simply an array of summary benefit estimates from the PHR value chain modules. It is combined with a mapping assigned value chain levels to architectures and a benefit distribution to stakeholders to produce total benefit estimate by architecture (eq. 13). Benefits per installation and per person are estimated using similar techniques as in PHR net value module calculations (see eq’s 6 and 7).

![Figure D-5](image)

**Equation 13:**

\[
B_{arch} = \sum_{stakeholder} \sum_{chain} B_{chain} \times App\_Matrix \times B\_dist,
\]

where

- \(B_{arch}\) = Benefit by Architecture
- \(B_{chain}\) = Benefit by Chains
- App\_Matrix = Mapping from value chain levels to architecture
- B\_dist = Benefit distribution to stakeholder by chains
- Chain = Index of value chains
- Stakeholder = Index of stakeholders
**Information Collection Module**

The Information Collection Module is a conceptual module and does not contain any actual value chains that project values specific to information collection functionalities.

**Information Sharing Module**

On opening the module, the user would see what is shown below in Figure D-6, which only serves as a place holder for two submodules shown in Figure D-7 and Figure D-8.
The logic for the Avoided Redundant Test value chain and Avoided ADE value chain are described fully in earlier chapters and will not be repeated here.

**Information Self-Management Module**

Similarly, the Information Self-Management Module (Figure D-9) is also mainly a shell for two value chains, Smoking Cessation (Figure D-10) and CHF Management (Figure D-11), whose logic have been fully described in the main text of this report.
Information Self-Management Module

Smoke Cessation Submodule

CHF Management Submodule

Information Exchange Module

Information Exchange is the richest value cluster (Figure D-12). The module contains four value chain submodules: Appointment Schedule (Figure D-13), Medication Renewals (Figure D-14), Pre-Encounter Questionnaires (Figure D-15), and E-visits (Figure D-16).
Appendix D: PHR Model Reference

Information Exchange Module

Appointment Scheduling
Medication Renewals
e-Visits
Pre-Encounter Questionnaires

Appointment Scheduling Submodule

Figure D-12

Figure D-13
System Cost Module

The PHR System Cost module (Figure D-17) is mostly contained in two submodules: Application Cost (Figure D-18) and Infrastructure (Figure D-19). The cost for US, cost per installation and cost per person are then calculated as a function of the outputs of these two submodules.
While the application cost logics are well described in Chapter 4, it is worth noting that the submodule structure contains two primary branches. One branch determined the development cost and estimated development cost per chain. A separate branch then determined the typical cost of CHF scales, which is combined with estimates of CHF patients per site to determine the total CHF scale cost per site and for the nation.
In the infrastructure submodule, the information is about individual component costs first assembled in a massive array (“System Component Costs”), which include interface costs, storage costs, support costs, and other components. A “Component Cost Grid” is then used to map varying components in each category to the applicable PHR architectures.

**PHR Definition Module**

The PHR Definition Module, as shown in Figure D-20, allows the extrapolation of relevant values such as total outpatient visits for new patients, established patients, and established patients who schedule appointments from the estimated PHR population. It also generates estimates for the number of PHR users per site and total number of smokers using PHRs.
Background Statistics Module

The Background Statistics module contains epidemiological figures and general descriptive statistics concerning the US healthcare system, such as population, smoking prevalence, provider panel size, or average provider clinical encounter costs. This module provides the context to interpret PHR-specific value chains, and also allows for future customized analysis for specific geographic regions.

On opening the module, the user would see what is shown below in Figure D-21.
Utility Function Module

The Utility Function module contains various routines written by CITL to simplify modeling and enforce consistent management of common issues such as inflation. This module does not contain information specific to the PHR analysis.

Indices and Constants Module

The Indices and Constants module contains definitions for various common concepts such as sensitivity analysis labels, physician group sizes, and hospital sizes that are used in but not specific to the PHR analysis.


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This research was supported through unrestricted funding from the following organizations:

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Adam Vincent, MPP, Research Analyst

CITL is generously supported by:
About the Book
The Center for Information Technology Leadership’s (CITL) Value of Personal Health Records report examines the value proposition for implementing personal health records (PHRs) throughout the US. This analysis quantifies the cost-benefit of a variety of infrastructure, administrative, and clinical PHR functions including:

- Sharing of complete medication lists
- Sharing of complete test results
- Appointment scheduling
- Medication renewals
- Pre-encounter questionnaires
- E-visits
- Congestive heart failure (CHF) remote monitoring
- Smoking cessation management

CITL modeled these eight functions for provider-tethered, payer-tethered, third-party, and interoperable PHRs, examining differing deployment strategies to achieving 80 percent adoption by the US population. The report includes a detailed cost model for each type of PHR system.

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The Center for Information Technology Leadership (CITL) in Boston is a not-for-profit research organization chartered by Partners Healthcare System and supported by a strategic alliance with Healthcare Information and Management Systems Society (HIMSS). Using a rigorous analytic approach, CITL assesses clinical information technologies and disseminates its findings to help provider organizations maximize the value of their IT investments, help technology firms understand how to improve the value proposition of their healthcare products, and inform national healthcare IT policy discussions. For more information, visit www.citl.org.