U.S. Department of Health and Human Services
Assistant Secretary for Planning and Evaluation
Office of Disability, Aging and Long-Term Care Policy

CASE STUDIES OF ELECTRONIC HEALTH RECORDS IN POST-ACUTE AND LONG-TERM CARE

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For additional information about this subject, you can visit the DALTCP home page at http://aspe.hhs.gov/_/office_specific/daltcp.cfm or contact the ASPE Project Officer, Jennie Harvell, at HHS/ASPE/DALTCP, Room 424E, H.H. Humphrey Building, 200 Independence Avenue, S.W., Washington, D.C. 20201. Her e-mail address is: Jennie.Harvell@hhs.gov.

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PREFACE

The Division of Health Care Policy and Research is a multi-disciplinary research organization in the Department of Medicine at the University of Colorado Health Sciences Center. The mission of the Division of Health Care Policy and Research is to improve health care services, organization, and policy through research and education. Division faculty conduct health services and health policy research in a range of areas, including: quality of care assessment, assurance, and improvement; Medicare reimbursement and regulations; clinical and system interventions aimed at improving nursing home care, home health care, transitions across sites of care, and end-of-life care; managed care alternatives; telemedicine and health informatics; cognition and behavior; and cross-cultural research to assess interventions aimed at improving health care services to ethnic minorities.

We would like to thank the four sites that allowed us to visit their health settings and gather information on their electronic health record systems. We also are grateful to the experts in electronic health record systems and post-acute/long-term care who provided their advice on the initial design of the project and recommendations for next steps. Finally, we would like to thank our ASPE Project Officer, Ms. Jennie Harvell, MEd, for her commitment to and valued guidance throughout the project, as well as Sam Shipley, ASPE Intern, for his contribution to site visits.

EXECUTIVE SUMMARY

Project Objectives

The following study, entitled "Electronic Health Records in Post-Acute and Long-Term Care," was sponsored by the Office of the Assistant Secretary for Planning and Evaluation (ASPE), United States Department of Health and Human Services (USDHHS). The objective of the project was to evaluate the status of interoperable electronic health records (EHRs) that extend into post-acute care (PAC) and long-term care (LTC) settings, and are capable of health information exchange with other care settings such as acute care hospitals, physician offices, pharmacies, or other PAC/LTC providers. This report summarizes case studies of four leading-edge sites, and reviews the findings and recommendations of a technical expert panel.

Context

Since 2001, the Department of Health and Human Services (HHS) has been actively promoting the development and use of electronic health records. In 2001, the National Committee for Vital and Health Statistics recommended a strategy to encourage efficient and secure exchange of health information through a common electronic health record (EHR) and through a National Health Information Infrastructure (NHII).[2] Recognizing that the NHII will require standards for (at least) messaging, terminology, and documents, other public and private initiatives also have contributed to this effort, including: (1) the Federal Government's acquisition of a license to freely distribute to healthcare entities in the United States the Systematized Nomenclature of Medicine Clinical Terms (SNOMED CT); (2) the Consolidated Health Informatics (CHI) initiative to review and endorse vocabulary and messaging standards for use in the federal healthcare enterprise; and (3) the Health Level 7 (HL7) effort to specify standards and a functional model for EHRs. More recently, establishment of a national health information system has become a major national priority backed by an Executive Order to create a national health information technology coordinator within HHS.[1] Thus, substantial momentum exists for rapid development and deployment of standardized EHRs that facilitate the exchange of health information when and where needed, across all healthcare settings.

One strategy for the exchange of information across the healthcare spectrum includes the use of Local Health Information Infrastructures (LHIIs) for the electronic exchange of patient-level health information among multiple providers in a community. Through the use of LHIIs, data could be shared and re-used without replication. However, development of most EHRs and the few LHIIs that exist in the U.S. today primarily has focused on acute hospitals and ambulatory care settings, with almost no attention to or implementation in nursing homes, home health agencies, and inpatient rehabilitation facilities (i.e., PAC and LTC). In total, these PAC/LTC settings include more than 26,000 Medicare-certified providers that treat more than one-half of

Americans during the course of their lifetimes.[3,4,5,6,7] Further, literature and surveys show that interoperable EHRs are not well developed in these settings.

From a patient care perspective, PAC and LTC have unique issues and requirements. First, transitions to and from these settings are a major source of medical errors in relation to medication administration, advanced care directives, allergies, and delivery of essential services. Second, the typical geographic separation of PAC/LTC providers from hospitals, diagnostic services, and physician offices creates communication barriers that contribute to medical errors. Third, persons treated in PAC/LTC settings suffer from impairments in physical, cognitive, and social functioning, as well as multiple chronic diseases, rendering them vulnerable to various threats to patient safety and quality. Fourth, PAC/LTC is provided by interdisciplinary teams with substantial family/informal caregiver involvement. Finally, government-mandated standardized assessments (i.e., MDS, OASIS, and IRF-PAI) exist in PAC/LTC settings and require information that is not comparable across settings and may not be clinically relevant, codeable with standardized, interoperable vocabularies, or readily able to interface with each patient's EHR. The use of standardized EHRs has potential to reduce many preventable errors, enhance the communication of needed information among providers, and provide needed tools to enhance and support more effective management of service delivery. Implementing standardized vocabularies adopted through the CHI initiative in future revisions to federally-required patient assessment forms would facilitate the exchange of information across settings.

Benefits of Leading-Edge PAC/LTC Systems

Four leading-edge sites were chosen for their implementation of interoperable EHRs in PAC/LTC and other parts of the healthcare continuum. Each of these sites was visited for two to three days using a structured site visit protocol. The four sites included a VA Medical Center (Bay Pines), North Mississippi Health Services, PeaceHealth, and Deaconess Billings Clinic. Each site had been established for at least 35 years, and each was a pioneer in the development of EHRs through strong local leadership and an organizational and cultural commitment to enhancing quality of care and increasing efficiencies. All four of the health systems visited were composed of an urban referral medical center in a medium-sized city and the surrounding environment, with outreach into rural areas and sometimes smaller communities and hospitals. The visited sites "owned" most of the providers and employed most of the physicians in their systems, but were branching into relationships with previously unaffiliated providers. Because the selected health systems are pioneers in the field and are "early adopters" of EHR systems used to exchange information across the continuum of care, the systems were deployed before widespread agreement existed regarding the use of standards for terminology and messaging. Nevertheless, these four sites represent the most advanced EHRs that have and use the capability for interoperable information exchange across the healthcare delivery spectrum, including PAC and LTC.

At each of the selected sites, clinicians reported that the most highly valued function of the EHR in PAC/LTC settings was the provision of care transition information from the previous provider, (predominantly an acute care hospital) and from pharmacists and physicians. All four of the visited sites exchanged health information among their owned providers, with reported benefits in terms of patient safety, quality of care, and efficiency. The information was available in real time and followed the same medical record architecture as provided in the hospital, without abstraction of core content most relevant to PAC/LTC. Nevertheless, the information was useful in evaluating patients for admission from geographically removed settings, which frequently is required by PAC/LTC providers, and to initiate care, enhancing continuity.

Medication management is a major function in PAC/LTC settings because of the large number of medications received by these patients and the high proportion of medical errors that are related to medication prescribing and administration. Medication list management upon admission to PAC/LTC -- ensuring that the appropriate medications are prescribed -- is complex. It requires the reconciliation of lists from before a hospital stay and during an acute care stay with any new discharge medications. Although only the VA had a single medication list (and only for prescriptions filled at VA pharmacies), all sites were moving toward a single medication list and a system for reconciliation. Sites also had systems for tracking medication administration in PAC/LTC settings. More expensive technologies reportedly were difficult to support under current Medicare PAC and Medicaid payment rates, but were used in the VA (e.g., bar coding). However, lower cost solutions, including unit dosing or multiple day packaging and an automated medication administration record, were in place at all sites. Drug alert systems also were used to review dosages, drug interactions, and sometimes necessary laboratory data.

At some sites, systems for electronic physician/geriatric nurse practitioner orders and progress notes from all PAC/LTC providers were structured partially and were part of the EHR. Where orders were entered electronically in IRF units or nursing homes, staff reported a reduction in ordering time and error rates, and these systematized processes were received favorably. Where nursing progress notes were fully electronic, considerable reduction in documentation time was noted and clarity of documentation for shift changes was enhanced. Despite limited structure for progress notes (except for vital signs) in the sites where an EHR was used, both RNs and CNAs endorsed the potential of EHRs for care management and documentation of nursing care activities in PAC/LTC settings. At some sites, physical and occupational therapists also utilized the system for progress notes, leading to better communication among different disciplines treating the same patient. Thus, even relatively rudimentary systems in terms of structure and standardization demonstrated some of the potential benefits of interoperable EHRs for PAC/LTC.

Limitations of Leading-Edge Systems

The same characteristics that enabled these sites to become leaders in interoperable EHR systems -- local control and strong leadership -- also are limitations to further development. Through the local clinical, organizational, and information technology culture, each system has flourished, but in a unique manner that is not replicable. With the exception of the VA, no economies of scale exist because each system had to develop its own applications. The VA is part of a larger national network, but individual sites customize components and lack interoperability with other VA Medical Centers (VAMCs) and non-VA health systems. Thus, the ability to "go it alone," and the success of this method, now places these state-of-the-art health systems in the difficult position of needing to retool and adapt to enable wider connectivity.

In no area is this more apparent than in the lack of standards for messaging, vocabularies, and documents. As reflected in the President's Executive Order, and in various public and private initiatives, the use of healthcare information technology standards is an essential part of an infrastructure that ensures the availability of real-time clinical information to support clinical decision making, reduce errors, and promote efficiencies. For the most part, each of the four sites will face challenges as it conforms its "homegrown" clinical content with CHI-endorsed standards and works to ensure its information technology infrastructure interoperates with the national health information technology infrastructure. As an example, these health systems will be challenged when there is agreement on core clinical content that should be transmitted at times of patient transfers from hospitals to PAC/LTC settings, the standardization of that clinical content, and the use of a standardized clinical document architecture for the efficient communication of this information across settings. Standards development is only in the early stages, and the PAC/LTC systems that were visited did not use standardized terminologies, messaging standards, or documents for the electronic recording and exchange of any information. In fact, standardization was not high on the agenda at most sites because each was functioning adequately within the confines of the EHR system.

Lack of standards contributes to another limitation: difficulty in extending electronic health information systems into provider settings that are not owned and operated by the site or its employees. Although all sites were experimenting with business affiliations that addressed technological, legal, privacy, and communication issues, no sites had been able to overcome the barriers to being interoperable with unaffiliated PAC/LTC providers using staff who were not employees of the larger system. Although these barriers existed with extension into all unaffiliated providers, linkages with PAC/LTC facilities generally lagged behind physician offices and other hospitals for several possible reasons. Health enterprises that include PAC/LTC facilities still are focused on improving EHR functions in the acute care operations, where greater value and return on investment are anticipated. As PAC/LTC settings utilize EHR technology to a greater extent, interoperability will become more essential so that external parties can use and contribute to the record.

A final limitation to interoperability that also could be improved by standards development is the integration between the EHR maintained in the various PAC/LTC sites and the government-mandated data sets: MDS, OASIS, and IRF-PAI. In every case, the information systems for the mandated data set were completely distinct from the EHR. None of the sites was able to import information from the comprehensive clinical assessments contained in the EHR and populate mandated data sets. In most cases, the process for completing the mandated data sets was separate from the process used to maintain the EHR. Thus, the lack of integration between mandated assessments and the clinical information recorded in the EHR was a major impediment to integrated care delivery. Further, the EHR was dominated by orders and assessments written by the physician and/or nurse practitioner, and by nursing and therapy reports of medical care issues such as medications, vital signs, and treatments. However, linkage of mandated data sets and the EHR requires standardized content and messaging not only for the EHR, but also for the federally mandated data sets. Furthermore, enhancing the clinical utility of content in the mandated data sets will be necessary to avoid the documentation burden of two distinct sets of information for PAC/LTC patients.

Recommended Next Steps

Following completion of the draft report, a technical expert panel (TEP) was convened on April 14, 2004, to recommend next steps in research relating to EHR in PAC and LTC settings (see Appendix E for panel membership). Several major themes emerged from this discussion that, when taken together, suggest a strategy for further research.

A major barrier to widespread implementation of EHRs in PAC/LTC seemed to be the inability of these health settings to recognize the potential for interoperable EHRs to benefit patient care, efficiency, and clinicians. Thus, demonstration, dissemination, and education regarding these benefits relative to the associated costs were considered imperative if providers and vendors were going to invest more heavily in EHRs for PAC and LTC. Consideration is needed of options to promote the value of and return on investment for using interoperable EHRs in PAC/LTC, particularly for those PAC/LTC providers that are unaffiliated (i.e., not owned or managed by) larger health systems. Absent implementation of complete and interoperable EHRs across the health continuum, including PAC/LTC providers, quality, safety, and continuity of care will be comprised. Panel members recognized that the visited sites had the most advanced IT infrastructure in PAC/LTC, but argued that further investment at the federal level should be in the development and implementation of EHR functions that could be translated to sites beyond these legacy systems. These leading sites in PAC/LTC could serve as laboratories for further development to rapidly deploy and test EHR functions.

The panel fully supported and endorsed the use of health information technology standards in any future federal research and policy activities directed toward specifying clinical content and the use of EHRs in PAC and LTC settings. The most efficient and

cost-effective way to extend systems to sites that are not owned and providers that are not employees of a health system is through the use of standardized vocabularies, messaging formats, and document architecture. In addition, work is needed to enhance the clinical content in federally mandated data sets to avoid the documentation burden of two distinct sets of information for PAC/LTC patients -- documentation needed in the course of providing care and documentation to meet federal reporting requirements. In addition, the expert panel concluded that, given the limited state of EHR implementation in PAC and LTC, the development of a single needed application (rather than a comprehensive EHR system) would be the most effective strategy for increasing the awareness of and demand for EHRs by PAC and LTC providers. The expert panel recommended the Federal Government follow a "design-build" strategy and invest in the development of a needed cutting-edge technology that could be demonstrated rapidly in at least a couple of PAC/LTC sites. The technical experts recommended developing a standards-based, electronic transfer document that would meet the business and clinical needs of PAC and LTC providers to receive timely information when a patient is to be admitted into these settings. The approach should allow rapid deployment of an application that could be supported in environments that use standardized EHRs, as well as those that do not have this technology.

Such an approach would take advantage of available content, messaging, and document architecture standards; identify gaps in these standards; and allow for future refinements to the application as additional standards become available. The approach would support the design of the best possible initial electronic transfer document based on what is presently known, and allow the electronic document to be engineered, implemented, and refined in practice. Through a series of iterations, the content and application would be refined, and the impact on continuity and quality of care and costs would be evaluated. An advantage of this approach is that a prototype would be available in a short timeframe (preferably within a year) for widespread implementation. The expert panel recommended engineering, implementing, and refining the application at a VA Medical Center and in a private-sector health provider.

In summary, as a result of the expert panel discussion and information learned as a result of the literature review and site visits activities conducted as part of this study, the following activities are recommended:

1. Ensure the content of federally-required patient assessments instruments data sets is information that would otherwise be routinely collected in the course of providing care and integrate health information technology standards into the development and modification of federally mandated data sets. This would facilitate the linkage of required data sets with standardized EHRs and reduce the administrative burden for PAC/LTC providers by supporting and maximizing the re-use of information collected and entered into a standardized EHR for the completion of administrative data requirements.

2. Work to fill the gaps in the disability content in existing standardized, codeable terminologies. Previous research has found gaps in the physical and cognitive

disability content of standardized vocabularies and terminologies. Terms and concepts regarding the disability status of individuals' residing in nursing homes are critically important in this setting.

3. Engineer, implement, refine, and disseminate to the public, the specifications for an electronic care transfer document that would embed, using health information technology standards, the clinical content needed at times of transfers from acute care hospitals to nursing homes and develop a method for the timely exchange of this information in environments with or without interoperable EHRs. Development of an electronic, standardized transfer document would permit the timely exchange of information from acute care systems with EHRs to nursing homes with or without EHRs. In addition, such a transfer document could serve as a template for EHRs for nursing homes.

4. Examine the costs and benefits to nursing home patients, providers, the health system, and payers of implementing interoperable electronic medication management and administration systems in nursing homes and develop options for promoting the use of these systems. Given the high proportion of medical errors that are related to medications, the large number of medications taken by persons in PAC/LTC, and the relatively advanced state of terminology standards for medications, electronic medication management and administration systems are a high and immediately viable priority for development in the PAC/LTC EHR.

I. INTRODUCTION

The potential for electronic health records (EHRs) to improve clinical decision making, increase adherence to best practice guidelines, enhance compliance with preventive services, improve communication during healthcare transitions, reduce redundancy, and prevent errors and adverse events has been increasingly documented.[2,8,9] The goal of an EHR is to fully replace the paper record so that patient information is available anytime and anywhere. To the extent that an EHR uses standardized terminology and messaging formats, electronic exchange of information across healthcare settings is greatly enhanced. Such electronic interoperability is essential to realize the maximum clinical utility and savings potential of EHRs. However, progress has been slow during the last decade in the development of EHRs that are interoperable across health care settings, with the exception of some exemplary healthcare systems.

A strategy for building a National Health Information Infrastructure (NHII) was recommended by the National Committee for Vital and Health Statistics and adopted by Health and Human Services (HHS) to encourage efficient and secure exchange of health information through a common EHR.[2] An NHII will require messaging, terminology and document standards, communication and networking systems, decision-support and education applications, and confidentiality protections. Several major public and private initiatives are contributing to this effort, including: (1) the Federal Government's acquisition of a license to freely distribute to entities in the United States, through the UMLS, the Systematized Nomenclature of Medicine Clinical Terms (SNOMED CT); (2) the Consolidated Health Informatics (CHI) initiative to review and endorse vocabulary and messaging standards; (3) Health Level 7 (HL7) efforts to specify standards for EHR; and (4) the Institute of Medicine's Committee on Data Standards for Patient Safety.[10] NHII advocates are encouraging the development of Local Health Information Infrastructure (LHII) that builds on existing systems and local needs and incentives, but with standards that will allow connectivity between LHIIs and the NHII.

If LHIIs, and ultimately the NHII, are going to be interoperable across all healthcare settings, EHRs must include post-acute care (PAC) and long-term care (LTC). For the purpose of this project, the major PAC and LTC settings are nursing homes (NHs), home health agencies (HHAs), and inpatient rehabilitation facility/units (IRFs). Under nursing homes, we include Medicare skilled nursing facilities (SNFs), transitional care units (TCUs), and both hospital-based and freestanding nursing homes. HHAs include Medicare-certified agencies, and rehabilitation hospitals include PPS-exempt hospital units. With more than 18,000 nursing homes, more than 7,000 Medicare-certified home-health agencies, and more than 1,300 rehabilitation facilities, these providers represent a substantial part of the healthcare system.[3,4] More than 40% of Americans who live to age 65 will spend some time living in a nursing home, with more than one-half spending at least one year there. HHAs provide more than 90 million visits per year.[5,6,7] Thus,

with the shifting emphasis from acute to chronic care, interoperability of EHRs with PAC/LTC settings is critical.

In addition, PAC/LTC settings have unique characteristics requiring specialized EHR capabilities. Frequently, individuals treated in these settings have multiple comorbidities in the context of any acute problems, resulting in numerous medications and more complex medication management. They often have significant functional and/or cognitive impairment requiring different types of assessments and record keeping, and they may have care issues relating to diet, activity, and mental stimulation, for example, that do not fit under diagnostic classification systems. A balance between aggressive care and chronic care management is critical, and these individuals are particularly vulnerable at times of transitions across settings.

In most PAC/LTC settings, care is delivered primarily by nurses, nurse's aides, and therapists with limited physician oversight. Turnover is often higher, staffing shortages are more prevalent, and salaries are lower compared to other healthcare settings. The care delivery process often requires communication among members of an interdisciplinary team and greater involvement of the family/informal caregiver. Frequently, diagnostic services are less available at the point of care, and there are greater geographic distances requiring enhanced communication. Finally, government-mandated assessments exist (i.e., MDS, OASIS, and IRF-PAI) that require staff, training, and a system for submitting information that may not readily interface with an EHR.

The purpose of this project was to evaluate interoperable EHR systems in PAC/LTC. Based on an extensive literature review and discussions with stakeholders from healthcare systems, vendors, and government agencies, PAC/LTC EHR systems were found to be less well developed than acute care and ambulatory care systems.[10,11,12,13] There are a number of clinical information systems that are utilized in PAC/LTC settings. This study was focused on electronic health records (EHRs) and information systems that are used to exchange clinical information across providers. However, the only clinical information systems that we were able to identify that exchanged information across settings that include PAC/LTC providers were health delivery systems that were highly integrated either because of their geographic location (large, rural health systems) or financial structure. The sites selected for this study were sites that used EHRs in the course of providing care and also used their EHRs to exchange clinical information with other health care providers. To learn more about the most advanced EHR systems in PAC/LTC, case studies were conducted at four sites with connectivity to acute hospitals, pharmacies, and/or ambulatory care. The goal was to emphasize sites representing the various PAC/LTC settings, types of affiliations, and both organizational and payment arrangements.

II. FINDINGS

A. Sites

Sites were screened based on the following criteria:

1. Interoperability of the EHR system across two or more care settings (e.g., home health and physicians' offices), at least one of which was in the PAC/LTC environment. PAC and LTC providers that were not using electronic health information systems to exchange information from their EHR with other health providers (e.g., physicians, hospitals, labs, pharmacies, etc.) were not included in this study.

2. A robust electronic health record (EHR) system with multiple features, such as computer-based provider order entry (CPOE), computerized progress notes, decision-support tools, "auto alerts," medication/allergy lists, utilization of bar codes, pharmacy linkage, image handling, problem lists, laboratory tests, therapy, patient history/demographics, vitals, pain scale, etc.

3. One or more post-acute care (PAC) or long-term care (LTC) facilities (home health agency, inpatient rehabilitation facility, skilled nursing facility, or nursing home) that were part of a health system (a legal relationship exists between facilities) and in which the EHR was operational at some level.

A potential site list (Table II.1) was developed from the stakeholder interview process, recommendations of the Technical Advisory Group, and Web searches. As information on each potential site was gathered, the site was either removed from the potential list or further information on the site was gathered using Web site evaluation and/or telephone interviews until it was determined that the site met all three of the required criteria. Only sites in the United States or Canada were considered.

TABLE II.1: Potential Sites Evaluated for a Visit

• Baycrest Health System • Bayshore Healthcare • Brigham and Women's Hospital • Columbia Presbyterian Medical Center • Deaconess Billings Clinic • Good Shepherd Services • Group Health • Harvard Vanguard Medical Associates • Henry Ford • Heritage Behavioral Health Center Inc.	• Intermountain Health Care • Kaiser-Permanente • Maimonides Medical Center • Maine General Health • Manor Care of America • Marianjoy Rehab Hospital • Mayo Clinic, Rochester • MyGroupHealth • North Mississippi Health Services • Ohio State University • PeaceHealth • Queens Health Network	• Regenstrief Institute • Sun Health Care • The Queen's Medical Center • University of Illinois Medical Center, Chicago • University of Pittsburgh • VA, Bay Pines VAMC • VA, Canandaigua VAMC • VA, Maryland VAMC • VA, Portland VAMC • VA, Puget Sound VAMC • VA, Washington DC VAMC

One site visit was reserved for visiting a veterans affairs medical center (VAMC). After evaluating a number of VAMCs, a short list of four VAMCs was provided to VA management, who then selected the Bay Pines VAMC (BP) as the preferred VAMC to visit. Beyond the three criteria, sites were selected so that the various PAC/LTC settings with different types of affiliations and in different environments (urban vs. rural) would be visited. After evaluating all potential sites, eight sites were chosen for a short list and contacted to inquire about the feasibility of a site visit. Various factors such as project timing, the site's ability or willingness to host a site visit, and the settings available at each site, resulted in the final selection of three additional sites: North Mississippi Health Services (NMHS), PeaceHealth (PH), and Deaconess Billings Clinic (DBC). Basic characteristics of the four health systems are provided in Table II.2.

TABLE II.2: Health System Characteristics for Visited Sites

	BP	NMHS	PH Oregon Region	DBC
Location	St. Petersburg, Florida	Tupelo, Mississippi	Eugene, Oregon	Billings, Montana
Area Served (e.g., rural)	Urban	Rural	Urban/Rural	Urban/Rural
Year Established	1933	1937	1936	1927 (Deaconess Hospital) 1939 (Billings Clinic) 1993 (integrated)
Ownership	Government (VA)	Non-Profit	Non-Profit	Non-Profit
FT Employees	700	6,000	4,000	1,879 (main campus)
Nursing Homes	3 units	4	0 - owned 4 - affiliated	1 - owned 1 - affiliated
Home Health Agencies	3 programs	2 agencies 9 offices	1	0
Inpatient Rehabilitation	1	2	1	0
Pharmacies	1	6	1 - inpatient 2 - outpatient	3
Laboratory	1	6	1	4
Radiology	1	6	1	5
Acute Care Hospitals	1	6	6 (across 5 regions, 3 states, PHOR has 2 hospitals)	1
Physician Practices	9	40	PHOR has 100 multidisciplinary practices	7

Bay Pines

Bay Pines is one of 138 medical centers that is owned and operated by the VA. It is built around an acute care hospital that contains an integrated rehabilitation unit, and with a VA-owned pharmacy, laboratory, and radiology service. The geriatrics and extended care program includes a geriatrics evaluation and management unit (GEM), a transitional care unit (TCU), and a nursing home care unit (NHCU). It also manages three home health programs, including hospital-based primary care, a contract program for Medicare services outside a 50-mile radius, and a private homemaker program.

These services plus outpatient physician clinics are all located on a 337-acre campus. Bay Pines also has affiliated physician clinics in other geographic locations and a community care coordination service that provides remote monitoring for patients in the home (a pilot program).

As in all VAMCs, veterans health information system and technology architecture/ omputer-based patient record system (VistA/CPRS) is used, in which a subset of standardized data is transmitted to a central national data repository allowing downloading of information from other VA medical centers. However, each VAMC has flexibility in locally customizing VistA/CPRS at each health setting within specific operational parameters.

North Mississippi Health Services

North Mississippi Health Services is a private, non-profit corporation with an integrated delivery network and more than 6,000 employees, including physicians. While NMHS directly employs some physicians, most physicians have their own practices and are affiliated with NMHS. NMHS serves the majority of the population (487,000 out of 700,000) in a rural area that is roughly within a 100-mile radius of Tupelo, Mississippi, providing services to 33 communities in two states. The main campus at Tupelo (North Mississippi Medical Center) consists of more than 50 buildings on a 125-acre campus that includes a comprehensive acute care center and multi-specialty physician groups. About 50 more offices are located in the Tupelo municipality, as well as five additional smaller campuses in the NMHS catchment area with acute care, pharmacy, radiology, laboratory services, and PAC/LTC providers.

PeaceHealth

PeaceHealth is a non-profit healthcare delivery organization that serves communities in Oregon, Washington, and Alaska. It serves six medium-sized communities with acute care hospitals, medical groups, regional laboratories, pharmacies, and HHAs. The site visit was conducted in the region referred to as the PeaceHealth Oregon Region (PHOR). Based in Eugene, Oregon, and the surrounding area, it has the Sacred Heart Medical Center including an acute inpatient rehabilitation unit. In the Eugene area, contracted PeaceHealth-employed practitioners provide care in several local nursing homes. PeaceHealth owns one HHA in Eugene, Sacred Heart Home Health, Hospice, and Home Infusion. PeaceHealth also owns the Senior Health and Wellness Center, a geriatric specialty clinic providing both primary and consultative care for seniors in the area as well as a 100-physician multi-specialty group located in 14 community clinics.

Deaconess Billings Clinic

Deaconess Billings Clinic is a community-owned, not-for-profit medical foundation, with a 272-bed hospital and 210-physician multi-specialty group practice. DBC is a physician-led organization located in Billings, Montana. With more than 200 physicians,

DBC is the region's largest multi-specialty group practice. The campus includes not only the Billings Clinic and Deaconess Hospital, but also specialty departments such as a psychiatric center, heart center, occupational health center, wellness center, orthopedics, and sports medicine. Several miles from the main campus is the Aspen Meadows Retirement Community, which also contains a 90-bed nursing home and two satellite primary care practices. Seven additional DBC-owned regional clinics are located in Central and Eastern Montana and in Northern Wyoming, serving the rural population of these two states as well as Western North Dakota residents. DBC also provides management, information systems, and ancillary support services to eight area hospitals and clinics, including seven hospital-based nursing homes, which are considered to be affiliated entities.

B. Site Visit Preparation and Data Collection

Each site visit was conducted by a three-member study team, including a site visit manager with knowledge about health systems and EHR, a physician knowledgeable about EHR and post-acute/LTC, and an IT expert. At three sites, one or more representatives from the Office of the Assistant Secretary for Planning and Evaluation (ASPE) participated in the visit. The site visit manager worked with a site liaison to obtain the necessary baseline information to determine specific settings to be visited and to develop a site visit schedule for each member of the team. The intent was to visit predominately the post-acute and long-term care settings, but also to learn about the general IT system. Specific settings to be visited were determined in part by geography, because each site visit had to be completed in two to three days, and some sites had provider settings that were distant from the main campus.

In order to structure the site visit, discussion guides were developed to cover three broad areas: clinical processes, information technology, and management issues (Table II.3). Each site visit team member was assigned specific discussion guides to complete. The physician was responsible for all clinical record and information flow guides, the IT expert for all technical aspects guides, and the site manager for all management guides. However, all team members gathered information in general areas and made observations if there was an opportunity.

The clinical process information guides for each of the four health settings were similar; however, each guide was based on a fictitious patient that was customized for the particular health setting (the pharmacy discussion guide also had fictitious patient information). The intent was to better understand how information flowed (electronic, paper, phone, etc.) among health settings as a patient was treated. The technical aspects and impact on patient care operations discussion guides for each health setting were identical. Discussion guides were only completed for those settings that were present in the system (connected by the EHR).

TABLE II.3: Discussion Guides Used During Site Visits		
Clinical Processes (Clinical Record/Info Flow)	**Information Technology**	**Management**
• Acute care* • Home health* • Nursing Home* • Inpatient Rehab Facility* • Attending MD • Pharmacy • Laboratory • Radiology	• EHR ns Health Network	• Health System Information • Health Setting Information • Medical Records • Impact on Patient Care and Operations** • Impact on Organization and EHR History
* These forms contained the unique portion of the fictitious patient scenario for each setting. The questions were mostly the same for each setting except for the data entry observations regarding the scenario. ** Used in all four healthcare settings: Acute care hospital, inpatient rehab, nursing home, and home health.		

The discussion guides provided focus for discussion at each health setting; however, unique conditions at each site made it impossible for the discussion guides to be implemented in a uniform manner. Various factors, such as schedules, policies that prevented a fictitious patient's data from being entered, and other site policies limited discussions in different ways. Although the discussion guides were designed to cover a range of material that was exhaustive and detailed, some information was not able to be obtained during all the site visits. Individuals who were interviewed were not able to address some issues, or physical and operational characteristics of each site were not compatible with the discussion guide in some cases. In order to ensure the accuracy of information and complete missing information, each site was provided an opportunity to review its site-specific information contained in this report.

C. Analysis

Analysis of the case study results involved consolidation of notes obtained by all site visitors and synthesizing these into three major categories of results: (a) clinical care; (b) organization, culture, and impact; and (c) information technology. To the extent feasible, comparable information collected in multiple sites was tabulated.

Within clinical care, results were organized by PAC/LTC setting: nursing home, home health, and inpatient rehabilitation units. Pharmacy operations were included as a separate section. The organization/cultural/impact issues were categorized into five major categories: business plan, organizational structure, staffing/training, communications, and workflow processes. The emphasis of the analysis was to demonstrate how each site has evolved and dealt with the complexities of the EHR system and its impact on PAC/LTC. Because all sites had different resources available to them and different organizational structures within which to function, we did not expect them to be at similar stages of development. However, we sought themes that were consistent across sites. Themes relating to information technology were identified and became topics for cross-site examination.

III. COMPARING STATE MODELS

A. Clinical Functions

This section provides a synthesis of clinical care observations pertaining to nursing homes, home health agencies, inpatient rehabilitation units, and pharmacy services. In all sites, the referenced staff were employees and the providers were "owned" by the healthcare system unless otherwise indicated. Thus, the findings represent the best case scenario for accessibility and connectivity.

1. Nursing Homes

Each of the four case studies included one or two nursing homes (Table III.1). The term nursing home is used to refer to Medicare skilled nursing facilities (SNFs), transitional care units (TCUs), or nursing facilities (NF), recognizing that some of the providers may have a post-acute care orientation while others provide more chronic care. At BP, the units included a 22-bed, transitional care unit, specializing in intravenous care and pulmonary care requiring short stays, and a 206-bed, hospital-based nursing home care unit (NHCU) that was detached from the hospital. The NMHS nursing homes included a 107-bed freestanding facility, and a hospital-based facility attached to a critical access hospital with 10 subacute beds, 44 long-term care beds, and 19 swing beds. Both are located in medically-underserved communities and owned by NMHS. The NH visited as part of the PeaceHealth (PH) visit was a 112-bed private, for-profit NH that recently contracted with PH, allowing PH physicians and the geriatric nurse practitioner (GNP) the opportunity to access the PH EHR. Two NHs were visited during the DBC site visit: one was a DBC-owned, 90-bed, freestanding, non-profit facility that was five miles from the main downtown DBC campus (Aspen Meadows); and the other was an affiliated hospital-based rural NH located 60 miles from Billings, that had very limited electronic access to the DBC EHR (Beartooth). The EHR capabilities in the NHs at the four sites are described in Table III.1.

Two of the four sites (BP and NMHS) had an EHR to which all NH staff could read/write. At PH, the contracted MDs/GNPs have read/write capabilities in the NH, can use the medication ordering software (RxPad®), can type or template their notes, and can dictate progress or transfer notes if needed. The other SNF clinical staff had read-only access to LastWord® (i.e., PH's main EHR system for clinical information). DBC had a read-only system that was accessible only to MDs and NP/physician assistants (PAs). The EHR was only accessible to employees of the respective organizations. Reading prior hospital information during the transfer to NH was considered one of the most critical functions of the EHR, even though clinicians always conducted an independent assessment upon admission to the NH. The information accessed from the prior hospital stay included history and physical (H&P), transfer medications, medication administration record (MAR), course of the patient's stay, allergies, laboratory and radiology data, problem list, and notes from physicians, nursing, and therapy staff (at most sites). The value of this information was emphasized at all sites both to evaluate

patients for admission when not in proximity to the hospital, and because discharge summaries were frequently not available for 24 hours or more. In the DBC-affiliated nursing home (Beartooth), where only DBC physicians had access to the EHR, the staff indicated there could have been considerably greater efficiencies if staff had access to the information because they had to rely on reams of faxed paper. At the DBC-owned facility, the admission process still relied heavily on faxed data, although staff had the capability to access the EHR and used this to fill information gaps as needed. Interestingly, workflow processes at the DBC-owned NH continued to be driven almost solely by the paper chart; the Director of Nursing indicated that although staff had *permission* to use the DBC EHR, most did not use it.

The similarity among the systems stopped with reading prior hospital information. In BP, the admission assessment began with the physician who had seen the patient in the hospital and decided to admit to the NHCU. The MD then updated the problem list and wrote the basic admission orders electronically (using a template or dictation), including orders for medications and laboratory tests. The physician also ordered any consults for medical services and therapies. Templates were used for the problem list, medication ordering, and ordering each consult. Although the problem list distinguished active and inactive problems, the list was not well maintained; problems were not eliminated or moved to inactive when appropriate. Because the system was fully electronic, the physician intake was available instantaneously, and medication orders were filled. The physician also could update advanced directives, allergies, or any other aspect of the record. A GNP then completed the H&P, directly entering the information into CPRS or dictating for later transcription and electronic downloading into CPRS for the admission assessment, and developed a complete plan of care. The GNP also could write orders that were then co-signed by the physician.

At NMHS, the social worker reviewed the acute hospital information in the EHR to determine the appropriateness of the admission, avoiding a time-consuming visit to the hospital that was more than 60 miles away. The admission decision could be made in 30 minutes. Upon arrival, intake information was entered by a nurse in the EHR using a mobile laptop on a cart that could be brought to the bedside. The nurse developed a care plan using a template. The physician wrote an admission note and orders on paper. Orders then were entered into the EHR by a clerk and verified by the nurse. At both nursing homes, a small number of physicians saw all the patients (one at one facility and three at the other), but they still wrote notes rather than enter them into the computer.

Following receipt of prior hospital information, all further record keeping at PH was conducted using a paper record. This included the H&P conducted by the GNP, problem list, nursing intake, physician, nursing, therapy, and case management notes and physician/GNP orders. Orders that were written by a physician or GNP were taken off by the ward clerk and delivered to the respective service centers.

TABLE III.1: Nursing Home Clinical Record[a]				
	BP	**NMHS**	**PH**	**DBC**
NUMBER OF NHS STUDIED	2	2	1	2
Hospital-based	2	1	0	1
Freestanding	0	1	1	1
EHR CAPABILITY	Read/Write	Read/Write	Read/Write (MD, GNP) Read-only for other clinical staff	Read-only
ADMISSION ASSESSMENT				
Prior Hospital	Read (all)	Read (all)	Read (MD/GNP)	Read (MD/NP)
History & Physical	Read/Write (GNP)	P[b] (MD)/E (GNP)	P (GNP)	P (MD)
Problem List	Read/Write (MD)	Read/Write (GNP)	P (GNP)	P (MD)
Nursing Intake	Read/Write (RN)	Read/Write (RN)	P (RN)	P (MD)
MDS	Stand-alone (RN)	Stand-alone (SW)	Stand-alone	Stand-alone
ORDERS				
Written	E (MD/GNP)	P (MD/GNP)	P (MD/GNP)	P (MD/NP)
Entered	N/A	E (RN/clerk)	N/A	E (LPN/RN/Pharm)
Transferred	N/A	E	P (clerk)	E
Medication Tracking	E	E/P	P	P
Laboratory Results	E/P	E/P	E	P/E
Radiology Results	E	Ph/E	E	P/Fax/Ph/E
PROGRESS NOTES				
MD	E (templates/ dictation)	P (scanned)	E (dictation)	P (dictation)
GNP	E (templates/ dictation)	N/A	P	P
Therapy	E (templates/ dictation)	P (scanned)	P	P
Nurses	E (templates/ dictation)	E (templates) CNA (templates)	P	P
SW	E (templates/ dictation)	P (scanned)	P	P
CLINICAL DECISION MAKING				
Alerts/Flags	Drug interactions Drug Dosage Advanced Directives	Drug interactions (Report generated showing if lab result is outside boundaries)	Drug interactions (by pharmacist)	Drug interactions (by pharmacist)
Guidelines	Templates for different clinical problems	Guidelines for wound care, pain, falls, restraints	Access to clinical databases for drug and evidence-based guidelines	Database for drug interaction and dosing information
Quality Monitoring	MDS-based	MDS-based	MDS-based	MDS-based

a. Staff were employees and providers were "owned" by system.
b. P = Paper; E = Electronic; Ph = Phone; Fax = facsimile; D = Dictation

DBC used a paper record for the complete admission. The physician wrote orders on paper, which were picked up by the pharmacist daily and then entered into the medication order system in order to maintain a current medication list at the owned facility. This was an online system that could be used to print a MAR. At the affiliated NH, paper orders were delivered, but nurses entered the orders into a stand-alone (non-integrated) software system for tracking, and reviewed for accuracy. This ensured that orders were legible and allowed for reprinting recurring orders every 60 days.

Ordering medications, laboratory, radiology, and consults was fully electronic at BP including entry, transfer, tracking, and notification of results. The only exception was phone calls for abnormal laboratory values so they were not lost in the numerous action items received each day on the system. Physicians reported additional time to complete orders electronically rather than by hand, but urgent medication orders were filled in approximately 25 minutes in the nursing home and all pharmacy orders were filled within hours. Radiology and laboratory results were transmitted electronically.

At NMHS, after clerks entered the orders and nurses confirmed them, orders were electronically transmitted to the relevant departments (pharmacy, laboratory, radiology) in real time and interpreted there. Laboratory results and radiology results were all printed for the chart. An MAR was generated from the EHR based on physician orders that were entered by the clerk to conduct rounds and dispense medications. At PH, orders followed a paper system, except for the reporting of laboratory and radiology results if they were processed by a PH-owned or operated facility. In this case, the results were available electronically to PH physicians/GNPs. At DBC, all orders were handwritten by the MD, then entered into the EHR and transmitted electronically to the relevant departments. The results were received on paper, but were also available online.

The MDS assessment was conducted using a stand-alone software system at all four sites. The MDS was sometimes completed by an RN, a social worker, MDS coordinator, or a team completing different portions of the form. However, none of the sites was able to use relevant clinical data from its EHR to electronically populate the MDS system. This resulted in duplicate work for the staff. At BP, nurses used the MDS and RAPs to prepare a plan of care, and they tracked activities of daily living (ADLs) all on paper and separate from the EHR.

Progress notes were the least well-structured component of the record, but they were fully electronic at BP using templates and dictation. Nurses, for example, used a desktop on the unit to enter progress notes during their shift. Vital signs, including pain and weight, were tracked using specified fields and could be displayed graphically. Although NMHS physicians wrote their clinical narrative on paper, nurses, non-licensed staff, and social workers all used the EHR directly for progress notes. In some cases they had text templates to accommodate their needs, while at times they used free text. Certified Nurses Assistants (CNAs) entered vital signs directly into the system, for example, which made them more accessible to all members of the team. Staff could review the EHR and use printouts from the EHR during and between shifts; the printouts were thrown away after their notes were entered. Nurses found considerable reduction in documentation time by using the EHR (down from six to four hours in a 12-hour shift), and time also was reduced for their change in shift because documentation was easier to read. Thus, the EHR had a positive impact on work management and was received favorably by nursing staff.

At PH, physicians dictated their notes, which were transcribed into EHR and also printed and inserted into the paper record. However, when a patient was being

transferred to the hospital, a physician/GNP note could be dictated and entered into the EHR within one to two hours of the hospital transfer. In the nursing home, the PH EHR was available to the Director of Nursing or her/his designee (read-only); however, line clinical staff primarily used a paper record. At DBC, physicians could elect to write notes or dictate them. These notes were included in the paper chart, but they did not consistently make it into the EHR. Only DBC-employed providers' dictation was included in the EHR.

At both sites that had a complete EHR in the NH, they were alerted to drug-drug and drug-food interactions during the process of entering medication orders. At BP, physicians encountered these alerts when entering medication data; at NMHS, nurses and clerical staff encountered the information alerts because physicians did not enter their own orders. The challenge with such alerts was not to make them too simplistic so that flags occurred too often. On the floors, BP nurses used laptops on a medication cart and a bar code system for tracking all medication administrations, including identifying medications for each resident and tracking missed doses. BP physicians encountered a difficult problem with alerts in that they received up to 200 action items in a day on their computers, and in the midst of those action items they could lose track of the more critical alerts. Telephone calls were used to bypass the system for urgent alerts. PH-employed GNPs and geriatricians have access to decision-support databases to check for interactions. If they prescribe using RxPad® functionality in LastWord®, there is a built-in allergy and drug interaction alert system. At the NHs visited for DBC, staff had access to software for checking drug interactions, dosing, and patient education.

At the NHs with electronic records, templates were built into the system as guidelines for clinical problems. These guidelines were used by nursing home staff as care pathways for problems such as wound care, pain, falls, and restraints. All NHs used MDS data to generate quality reports on a stand-alone system.

2. Home Health Agencies

A home health agency (HHA) was studied at three of the four sites (Table III.2). At BP, this consisted of home-based primary care (HBPC), which is the VA-based home health care conducted by a multidisciplinary team for both short- and long-term care. Nurse practitioners provide oversight within a 50-mile radius. Outside the 50-mile radius, BP contracted with HHAs, particularly for IV care, in which case all communications were by fax. Outside agencies had no direct electronic connection to the EHR. However, VA staff had the opportunity to enter information from the agencies into CPRS if needed. HHAs also were owned by NMHS and PH. BP and NMHS HHAs had the capabilities to read from and write to the EHR. Home health was not fully integrated into the PH EHR, but staff had read-only access to the PH system.

Admission information required from the prior hospital stay was obtained electronically in all systems and then confirmed by the agency. At all three sites, the system was accessed by a desktop; however, at NMHS laptops were sometimes used

to access information from the patient's home. At BP, the GNP downloaded relevant information, completed the H&P and problem list, and wrote the admission orders. The GNP orders were co-signed by the physician at which time they became active. The staff could not view the orders until the physician signed off on them.

TABLE III.2: Home Health Agency Clinical Record[a]				
	BP	**NMHS**	**PH**	**DBC**
NUMBER OF HHAS STUDIED	1 (owned)	1 (owned)	1 (owned)	0 (none owned)
EHR CAPABILITY	Read/Write	Read/Write	Read-only	N/A
ADMISSION ASSESSMENT				
Prior Hospital	Read (GNP)	Read/Write (RN)	Read (RN managers)	N/A
History & Physical	Read/Write (GNP)	Read	P[b] (RN)	N/A
Problem List	Read/Write (GNP)	Read	P (RN)	N/A
OASIS	Not required	Stand-alone	Stand-alone (RN)	N/A
ORDERS				
Written	E (GNP/MD)	E (data entered by RN/clerical staff)	P	N/A
Transferred	E	Fax	Fax	N/A
Medication Tracking	E	E	P	N/A
Laboratory Results	E/Ph	E (lab tech)	E	N/A
Radiology Results	E	E (radiology)	E	N/A
PROGRESS NOTES				
MD	E (templates/ dictation)	P	P	N/A
GNP	E (templates/ dictation)	P	P	N/A
Therapy	E (templates/ dictation)	E	P	N/A
SW		E	P	N/A
CLINICAL DECISION MAKING				
Alerts/Flags	Drug interaction C - Crisis W - Warning A - Allergy D - Adv. Directive	Drug interaction and allergy checking	No electronic flags or alerts b/c chart is paper	N/A
Guidelines	Treatment templates neurological, mobility/ falls, mental status, cardiac, diabetes, dysphagia, etc.	None	Access to decision-support database for medication dosing and guidelines	N/A
Quality Monitoring		OASIS-based	OASIS-based	N/A

a. Staff were employees and providers were "owned" by system.
b. P = Paper; E = Electronic; Ph = Phone; Fax = facsimile; D = Dictation

At NMHS, an RN conducted the initial assessment electronically, but handwritten physician orders were faxed or called to the HHA. The nurse received the orders and drew blood for laboratory testing, and then the specimen was transported to the central laboratory. PH intake nurses conducted the assessment using the information obtained from the hospital and maintained a paper home health record, occasionally accessing further information from the EHR as needed.

The BP HBPC program did not require the use of OASIS data, but it will be moving to the home health Resource Utilization Group system in the future, which is based on

information derived from the MDS-HC. Both NMHS and PH used stand-alone software for OASIS data. Thus, these assessments are not integrated with the EHRs.

As in other parts of the record, the HBPC program clinicians entered all of their progress notes and narrative. Templates were used for the initial nursing assessment, care plan, and treatment monitoring. Using laptops in the field, nurses at NMHS dialed up from the patient's home for reading and writing visit notes. Because of problems encountered with phone lines and perceived use of the phone by the patients, they also could pre-load a patient's chart from their office and then update records directly into the EHR system, using a desktop in the branch office post visit. PH had a paper record for home health notes.

The BP home health record was part of the overall EHR, so when medications were entered into the system, flags and alerts were used. Similarly, the warning tabs were available on the record. Templates were created by HHA staff to establish treatment plans for neurological problems, mobility/falls, safety, respiratory problems, mental status, cardiac problems, diabetes, dysphagia, skin conditions, and other conditions. These were locally developed and sometimes developed by specific individuals.

3. Inpatient Rehabilitation Units

An inpatient rehabilitation unit that was attached to the hospital was studied at three of the four sites (Table III.3). Because these were considered acute units that were covered by a separate prospective payment system under Medicare, in all cases they utilized the acute hospital EHR adapted for acute rehabilitation care. The unit at BP was 154 beds. This is a large unit, reflecting the veterans' healthcare needs, the size of its service area, and the fact the VA is not restricted by Medicare's rules in terms of the types of diagnoses that can be admitted. At the time of our site visits, the 75% rule required that 75% of the diagnoses be in 10 diagnostic categories (e.g., stroke, hip fracture, amputation). The units at NMHS and PH were 30 beds and 18 beds, respectively. In the case of these units, workstations were available throughout, as in any other acute hospital unit, and there was the capability to read from and write to the EHR at all sites.

At NMHS, wireless carts were available for bedside use. At the time of admission, all sites could instantaneously view the comprehensive clinical records and incorporate information into the corresponding sections for the rehabilitation stay.

At BP, the patient was admitted by the physician who directly entered and viewed information using an admission template that imported the following information for review: diagnoses, allergies, and advanced directives. The template also included admission orders for vital signs schedules, consults, medications, and laboratory tests. The physician also used a template to enter an H&P or dictated it for later transcription. The clinical record involved the same tabs that are used in all other settings, including a cover sheet, problem list, medication list, orders, notes, consults, discharge summary,

laboratory results, reports, and vital signs. The cover sheet summarized key information, and the problem list included both active and inactive problems. IRF physicians indicated the need for common vocabulary and editing the problem list to render it more current and universal.

TABLE III.3: Inpatient Rehabilitation Unit Clinical Record[a]

	BP	NMHS	PH	DBC
NUMBER OF UNITS STUDIED	1	1	1	0
EHR CAPABILITY	Read/Write	Read/Write	Read/Write	N/A
ADMISSION ASSESSMENT				
Prior Hospital	Read	Read	Read	N/A
History & Physical	E[b] (templates/ dictation) (MD)	E (templates) (MD) P (MD)	E (templates/text) (MD)	N/A
Problem List	Read/Write (MD)	Read/Write (MD)	Read/Write (MD)	N/A
Nursing Intake	E	E	E (templates/text)	N/A
Therapy Intake	E (templates/ dictation)	E	E (templates/text)	N/A
IRF-PAI	Not required	Stand-alone	Stand-alone	N/A
PHYSICIAN ORDERS				
Written	E (templates/ dictation)	E or P	E	N/A
Transferred	E	E	E	N/A
Medication Tracking	E	E/P	E	N/A
Laboratory Results	E (Ph)	E/P	E	N/A
Radiology Results	E	E	E	N/A
Consultants	E	E	E	N/A
PROGRESS NOTES				
MD	E (templates/ dictation)	E and P (templates)	E-D (mixed)	N/A
RN	E (templates/ dictation)	E (templates)	E-D (mixed)	N/A
Therapy	E (templates/ dictation)	E/P	E-D (mixed)	N/A
SW	E (templates/ dictation)	E (templates)	E-D (mixed)	N/A
CLINICAL DECISION MAKING				
Alerts/Flags	Med alerts Allergies; warnings	Med alerts Allergies; warnings	Med alerts Allergies	N/A
Guidelines	Stroke Hip fracture Amputation	Stroke Hip fracture Amputation Deep vein thrombosis	Expert rules Order sets Clinical guidance	N/A
Quality Monitoring	FIM Change	IRF-PAI	Unknown/not confirmed	N/A

a. Staff were employees and providers were "owned" by system.
b. P = Paper; E = Electronic; Ph = Phone; Fax = facsimile; D = Dictation

At NMHS, templates were available for the physician and nurse intakes. Similar to the acute care hospitals, physicians wrote their notes, although several physicians were using online templates. In nursing, there was a standard nursing assessment conducted electronically, including: pain scale, Braden scale for pressure ulcer risk, emotional status, and motor function involving a balance assessment to trigger a fall prevention protocol where required. This nurse assessment automatically populated an electronic care plan. Noted benefits of the EHR included time-savings by pre-certifying patients using qualifying conditions as required by Medicare, and determining their

appropriateness for the unit. For example, the acute care unit therapy assessment could be used to determine whether the individual was able to tolerate three hours of therapy per day, which is a Medicare requirement.

At PH, the physician was responsible for conducting the complete history and physical and writing the admission note, while the nurse conducted the nursing intake. Physicians dictated their notes, abstracting relevant information from the hospital stay and incorporating that into the corresponding section of the rehabilitation note. PH physicians typed most of the information they collected into the workstations that were located throughout the unit. All clinical staff in the rehabilitation unit (nurses, therapists, physicians) had real-time access to all information that was in the acute care EHR, with limits based on job responsibilities. The physician reconciled the medication list with the acute care stay, using the inpatient pharmacy system (separate from the outpatient system). This system does not support over-the-counter medications, which was time consuming for pharmacists and nurses to manage in rehabilitation. Upon discharge, physicians or nurses wrote the orders.

At each of the rehabilitation units, orders were entered electronically; however, about one-half of the physicians at NMHS still wrote their orders, which then were entered into the EHR by clerical staff and validated by nursing and pharmacy. At PH, Computerized Provider Order Entry (CPOE) was a pilot study that the rehabilitation unit staff volunteered to conduct; it has been running for nearly a year including a time/usage component. They found a reduction from 14 minutes to seven minutes in typing admission orders and reported with CPOE they reduced medication errors from 25% to nearly 0%.

Because the three units were each part of an acute hospital, orders were transferred electronically. All aspects of the ordering process were conducted electronically, including receipt of the order in the respective department, filling the order, tracking the order, and transmitting results. At BP and NMHS, the entire pharmacy system was managed electronically, such that medication orders were included in the MAR, notification was provided of when medications should be given, medication administration was tracked, and missed doses/refusals were reported. At BP, this system used bar coding for dispensing and managing medications.

Progress notes in rehabilitation included both discipline-specific notes and interdisciplinary team meeting notes. At BP, templates were used by each discipline to report assessments and progress and a separate template was used for the interdisciplinary team meeting notes that occurred weekly. The physician was the author of the interdisciplinary team meeting notes, but all disciplines co-signed them. This was a complex template to develop, but was critical in this interdisciplinary environment. At NMHS, MD notes were handwritten. Therapist notes were a combination of electronic and handwritten notes. However, nursing staff wrote electronic notes. At PH, each of the disciplines (except physician progress notes) electronically documented their progress using a combination of templates and free-form text. Templates were increasingly emphasized pertinent to specific clinical problems.

The interoperability with the acute care systems for all three IRF units allowed access to all clinical decision-making tools in the EHR. At BP, this was the same set of tools that was available in the EHR throughout the system, including drug interaction and drug dosing alerts, and postings related to allergies, clinical warnings, crisis notes, and advanced directives. At NMHS and PH, more interactive alerts and flags were available at the IRF than in other long-term care settings including interaction alerts, medication alerts, allergies, and a warning to verify the correct patient in the case of PH. These were available at the time of information entry into the system, not just in the pharmacy where more extensive medication review was conducted. All three sites also included guidelines and standard order sets designed for inpatient rehabilitation such as stroke care, hip fracture care, and amputation care.

In all cases, quality monitoring by measuring change scores was available through the FIM (in BP) and IRF-PAI software (in other sites). Although not integrated with the EHR, PH's IRF first designed its system to view and copy the FIM data to the UDS reporting software and is now refining a system to populate the IRF-PAI from screens on its EHR. A representative at PH indicated that it is encountering problems in that the IRF-PAI software is not HL7-compliant, and all the demographic data are not collected on its EHR screen as required in the IRF-PAI.

4. Pharmacy Systems

With the substantial volume and complexity of medication prescribing for patients receiving post-acute and long-term care, medication administration and pharmacy represent one of the most critical functions in these EHR systems. In this section, issues related to medication administration and pharmacy services are consolidated across settings. Because IRF units had identical systems to acute care hospitals in all sites, the characteristics of the IRF pharmacy system reflected those in the acute hospital. While HHAs do not actually prescribe and administer medications, they may assist with medication set-up and education. Medication prescribing related to home health care consists of outpatient prescriptions that the patient fills. HHA nurses or GNPs may communicate with physicians about medication changes that are required; however, prescriptions are filled by physicians and picked up by patients as they are in the ambulatory care environment. Thus, this pharmacy review covers the entire continuum of care, including acute hospital, nursing home, and outpatient care.

Every site had a different model for ordering and conducting medication checks for interactions and contraindications, tracking medication administration, filling outpatient prescriptions, and managing the medication list across sites (Table III.4). Clinical staff who wrote medication orders, entered these orders directly into the EHR in all settings at BP, and physicians at PH entered orders into the EHR in the IRF/acute setting and outpatient clinic. A paper system also was used at PH where outpatient orders were faxed to pharmacies for entry. In the NH at NMHS, orders were sent electronically to the pharmacy as well as transcribed by RNs/clerical staff into the EHR. In all other sites and settings, medication orders were either scanned and transmitted to the pharmacy, or

faxed for the pharmacist to enter into the EHR. The advantage of clinicians entering medication information directly into the EHR was that medication alerts were programmed to occur at the time of entry so that the clinician could be alerted and consider alternatives while writing the order. In addition to interactions, alerts addressed allergies and might calculate creatinine clearance when appropriate. The BP medication-ordering template, which was identical across all healthcare settings, checked the dose and the diagnosis. The clinician entering the medication had to respond to any flags before submitting the order. Although all of these issues were addressed in the pharmacy, flags at the time the order was written prevented the pharmacists from needing to locate the physician, discuss the order and clarify issues, and revise the order if a decision was made to change it.

All sites had pharmacy systems for reviewing drug interactions, which was only possible when a patient's entire medication list was available. In some cases, this was complicated by multiple medication lists (an issue that will be discussed below in relation to reconciling medications for transitions from one setting to the next). The BP pharmacists clarified orders with the physicians electronically because physicians checked their messages throughout the day. Telephone confirmation was used at other sites. Pharmacy systems at all four sites generated medication labels automatically, packaging as required for different settings. At BP, they were testing automated technology for storage and dispensing using robotics that sorted packaged medications and maintained their inventory. Inventory management was an important function of all of these large pharmacy systems.

Medication administration and tracking approaches varied substantially across settings and by site. BP had a bar coding system using unit doses, requiring that the medication, the patient ID bracelet, and the administering clinical staff were all read. This procedure, using a wireless terminal on the cart, was sometimes difficult to use according to nursing staff because of the difficulty reading all the bar codes and the waiting time at the terminal. Staff indicated the process increased time for medication administration by two to three times (from one hour to more than two hours); however, any inconsistencies between order, patient, time, and dose had to be resolved before administering the medication. Unit dosing with a drug dispensing cabinet was used in the IRF setting by both NMHS and DBC; this approach also reduced drug administration errors. At NMHS, this approach was coupled with an electronic tracking system in which the MAR was on a cart with a wireless unit or was completed on paper and then entered into the EHR. At DBC, this involved a paper MAR that was initialed and became part of the paper record. Nursing home systems were less sophisticated at both NMHS and DBC. At both of these sites, an MAR was generated electronically and available for tracking, but medications were distributed differently. At DBC, medication administration was provided with a 14-day supply; at NMHS, it was a bottle with a 30-day supply, and at PH, a bubble pack for unit dosing was utilized.

TABLE III.4: Pharmacy Systems[a]				
	BP	**NMHS**	**PH**	**DBC**
ORDER ENTRY				
IRF/Acute	MD	Clerk	MD	Pharmacist
Nursing Home	MD/GNP	Pharmacist/RN/clerk	Pharmacist	Pharmacist
Outpatient/HH	MD/GNP	Clerk	MD/GNP/Pharmacist	HH - N/A Outpatient - Clinic Pharmacist
MEDICATION ALERTS				
IRF	Entry/Pharmacy	Pharmacy	Entry/Pharmacy	N/A
NH	Entry/Pharmacy	Pharmacy/Entry	Entry/Pharmacy	Pharmacy
Outpatient/HH	Entry/Pharmacy	Pharmacy	Entry/Pharmacy	HH - N/A Outpatient - Clinic Pharmacy
ADMINISTRATION/TRACKING				
IRF	Bar coding/Unit dose	Electronic tracking/Unit dose	Unknown/not confirmed	N/A
NH	Bar coding/Unit dose	MAR tracking/30-day supply	Bubble pack/Unit dose	MAR tracking/14-day cassette
OUTPATIENT PRESCRIPTIONS	Electronically	Paper/Phone	Electronically	Paper/Phone/Pharmacy
MEDICATION LIST MANAGEMENT	Single medication list	Multiple lists by stay; cross-checks manual	Separate inpatient and outpatient system; cross-checks manual	Multiple lists by stay; cross-checks manual

a. Staff were employees and providers were "owned" by system.

Outpatient prescriptions, which were necessary in home health care, were provided to the owned pharmacy completely electronically at BP and PH. Electronic prescriptions were prepared by the physician at BP and by the physician/nurse practitioner or through orders to nursing staff at PH. They were submitted directly to the pharmacy where the patient could receive the prescription. At PH, scheduled narcotic prescriptions needed to be printed and picked up by the patient or her/his designee. At NMHS and DBC, a printed prescription was generated by the EHR or prescriptions were called in to local pharmacies not part of the system.

All four sites indicated that patient medication list management was critical. Aided by the fact that the VA uses only a single national pharmacy process, BP patients had only one medication list in the hospital, ambulatory care setting, or NH setting. This list featured active and inactive medications. The active versus inactive distinction eased transitions between healthcare settings that may require adjustments to chronic medications. Care providers were unanimous in reporting that this single medication list was an important feature of the VA EHR. This system was believed to have reduced errors in reading and filling prescriptions and medication administration in all settings and across settings, according to the VA analysis of errors and near misses. The functionality of this list raised awareness that many veterans obtained additional medications elsewhere; for example, from Medicare-paid facilities.

At NMHS, careful manual processes were used to check and recheck patient medication lists when patients entered or transitioned across healthcare settings. NMHS has developed and is beginning to implement a database of core data elements (i.e., the ACHE system), which will be shared among all of its major clinical IT systems; one of the primary drivers of this effort was a more unified medication list spanning episodes of care and healthcare settings.

At PH, the inpatient medication list for each acute care stay was unique, but available for reconciliation with subsequent stays and preparation of discharge orders. A separate medication order application also was accessible by PH employees at PH-owned clinics, and could be viewed by PH employees at the PH-owned HHA and non-owned NH. Medication lists were communicated in the acute care discharge/transfer process through a community-wide standardized transfer form. PH is currently evaluating alternative solutions to the problem of having multiple medication lists through an Agency for Healthcare Research and Quality (AHRQ)-funded project to develop a secure, Internet-based "shared medication list" that is accessible to patients and any clinicians to whom the patient chooses to give access. DBC inpatients had a medication list that was updated for each hospital stay. DBC's outpatient medication list, also kept in Clinical Workstation, did not interact with this inpatient list; however, these two lists can be viewed in Clinical Workstation. Post-acute and long-term care medication lists were maintained separately. Upon hospital discharge to a nursing home, the inpatient medication list was modified on paper by the nurse and physician and transmitted by fax or with the patient to be re-ordered by the physician and re-entered by pharmacist at the NH. Upon hospital discharge to home, the clinic physician had access to both medication lists to manually reconcile. DBC's new EHR will address this issue by merging the inpatient and outpatient medication lists.

B. Organization, Culture, and Impact

1. Business Plan

Business Agreements/Extension into the Community. Each of the four case study sites has some type of business agreement with outside organizations, although the extent to which these affiliated sites have access to their EHR varies.

The VA does not extend its VistA/CPRS into non-VA facilities except under rare circumstances. For example, although there are business relationships with community NHs in which the VA pays for veteran residents, CPRS does not extend into any of these non-VA facilities. An exception to this rule is that CPRS has been extended into a local radiology practice, because this group provides a critical service that cannot be provided at the BP VAMC. Similarly, DBC does not have any business agreements with non-DBC physicians to use the EHR *per se*; however, if a local non-DBC physician is providing care within a DBC facility, s/he has access to the EHR while on site. Non-DBC physicians have read-only access to their specific patient information from their clinic by accessing DBCDoc.com, a Web-based product. The physician is required to be listed as the referring physician by DBC. DBC assigns non-DBC physicians a password into DBCDoc, which, in turn, allows them to view the patient record in the read-only mode. DBC's future marketing plans will target referring physicians who are providing care in the larger community and the region to be able to take advantage of this Web-based product. If referring physicians choose to become affiliates, DBC will provide them with

other benefits, including some level of access to the new Cerner Millenium EHR (referred to as the Clinical Information System, or CIS).

NMHS, on the other hand, actively extends its EHR into the community, including affiliated organizations that are not owned by NMHS. It has extended the EHR to the school nurse program at local schools, nursing school facilities during clinical rotations in the clinical setting, physicians' clinics, and a non-owned nursing home. Each of these extensions operates at different levels, depending on the legal agreement with the organization. NMHS has an active marketing campaign that connects to the community through the media and community service.

PH has set up a separate subsidiary of the Healthcare Improvement Division to address growing independent physician interest in its electronic health delivery systems. PH offers technology services for a market-based fee, using an application service provider (ASP) model as the delivery vehicle. Although we are under the impression that PH plans to offer its Community Health Record (CHR) to affiliated post-acute and long-term care settings, we were not able to ascertain the timeframe in which these plans would be implemented. It does not appear that PH has any immediate plans to allow affiliated post-acute and long-term care settings to write to or modify the electronic patient record.

Business Goals. Each of the sites expressed a desire for its business, including its EHR, to be patient-focused with patient safety and quality care as issues of paramount importance. The other business goals articulated by the sites differed.

At the Bay Pines VAMC, the elimination of paper both in day-to-day operations and as a patient record was stated as a primary goal. All clinical and administrative staff must use CPRS in real time and do most, if not all, of their own data entry either directly into CPRS or through the use of dictation. If data are dictated, they then are outsourced for transcription and electronically downloaded into CPRS later. Widespread access (at a read-only level) to CPRS by all employees is common. The patient record is not health setting- or episode-specific, but rather it is a current record that contains historical information. An MS Windows graphical user interface (GUI) with ease of multiple screen viewing and functions such as cut and paste is provided to facilitate use of the EHR, and they are continually working on improving the speed and security of the EHR system.

NMHS's business goals are to enhance and improve the existing EHR system, optimize the rate of return, and fully leverage its IT investments. NMHS has prioritized building data interfaces with other commercial software such as Logician, which NMHS promotes for use in physician offices. NMHS provides IT technical support to these private physicians. This business strategy is to increase volume by expanding the catchment area and increasing the use of NMHS services (e.g., office visits and radiology services). Unlike the VA, NMHS does not seek to eliminate paper as part of the patient record. A duplicate paper record is maintained and many aspects of patient care utilize paper for various clinical care processes. The majority of information found

in the clinical record, however, is computer-generated rather than hand-generated. An ongoing issue that NMHS grapples with is whether the EHR or the paper record is the legal medical record.

In 1991 the CEO of PH, with the blessing of the board of directors, hired an outside group to evaluate its current health delivery system and make recommendations for future developments. The initiative, entitled the "Mission 2000 Project," identified three main goals or visions for the future:

1. Migrate toward a more integrated and seamless form of care;

2. Establish a culture of quality improvement and safety; and

3. Implement an information technology and information management structure capable of supporting the above goals.

These goals have persisted for the past 13 years. The success of PH's community health record (CHR) is attributed to its strong leadership and clearly articulated vision. The Healthcare Improvement Division (HID) was borne out of the Mission 2000 Project. The HID is a centralized corporate IT department that has worked closely with IDX during the past 13 years to design a single health information system that spans three states. A high-speed network is run to every PH physician's wall. Although this approach was expensive, it has paid significant dividends in the long run for PH. Access to clinical information outside of the hospital walls is seen as a significant benefit to clinicians, who then have been more forgiving when glitches or delays occur. In addition, as the clinical workstation became the center of care, the physicians' reliance on the PH EHR system was cemented. The goal of the CHR is to be a community asset, and one that can be used across the continuum of care. It includes (or will include) a longitudinal medical record, a laboratory system, a financial system, and a practice management system.

DBC's Information Technology (IT) primary business goal is to develop and implement strong and innovative information systems and technology that enable outstanding clinical care and a superior business model. Its two-year business plan includes: (1) implementing Clinical Information System (CIS) applications to improve patient care and patient safety, and enhance clinical efficiency and effectiveness and operational efficiency; (2) maintaining physician, leadership, and staff satisfaction at all levels; (3) identifying selected clinical, financial, operational and strategic measurements to benchmark quality pre- and post-CIS implementation; (4) integrating selected disease management tools, based on evidence-based medicine (EBM) into CIS; and (5) implementing Internet-based technologies in the delivery of patient care and relationship building with consumers, physicians, and patients. Deaconess Hospital is in direct competition with the other hospital in Billings. The two hospitals serve the majority of Montana and Northern Wyoming through their affiliated and owned clinics located throughout the two states. DBC has grown six percentage points in market share in the past few years, and the EHR is perceived as being one of the driving

factors for this success. DBC's marketing plan includes sharing the benefits of EHR, such as improved patient safety and enhanced communication, with the public. Currently, the EHR has not been heavily marketed; rather, the benefits of having an EHR that extend to patients is largely shared by word of mouth. This will be remedied after implementation of the Cerner CIS.

Organizational Culture. All four sites have a culture that values information sharing. For example, at DBC, any templates or pathways that are developed in the Cerner CIS will be open source documents through publications. Likewise, PH embraces the concept that an EHR requires all healthcare providers (even competitors) to have access to the patient's health information. Because the VA is a closed system run by the Federal Government, the innovations are open and available to all. NMHS already has extended its EHR into the community and is looking at ways to further extend to areas within a 100-mile radius of Tupelo.

Physicians' needs and preferences were the largest influences in the design of the EHR at three of the four sites. The exception was the VA; there were multiple clinical and administrative inputs into the design of VistA/CPRS (i.e., IT, nurses, physicians, administrative staff). Local VA staff can modify their application, within broad limits, and these innovations might be fed back into the national model by central management. A local organization and its national counterpart called the Clinical Application Coordinator (CAC) group are both responsible for local and national changes, maintenance, and training for CPRS. The CAC group assists clinical staff in using the CPRS and helps them develop and implement modifications (templates) that facilitate the utilization and customization of the CPRS in various health settings.

At NMHS, the backbone of the EHR is related to a financial system. This system was implemented in 1975, and the clinical requirements of the EHR were incorporated later. NMHS's physician-friendly culture is driven by the physician shortage in Mississippi and liability issues. The legal environment in which NMHS operates has made legal documentation a priority, and NMHS also provides umbrella protection for some affiliated organizations relative to HIPAA. The legal environment also appears to limit any consideration by NMHS to allow patients' access to the MIS. Because recruiting and retaining physicians are difficult, NMHS goes out of its way to cater to physicians' needs. NMHS does not require physicians to use MIS (unlike all other staff who are required to use it), but rather provides clinical and administrative staff to enter most information into MIS for physicians. About 10% of the physicians use MIS at a significant level; 80% use MIS at some level. The main NMMC acute care hospital in Tupelo has implemented CPOE but only 50% of the doctors have used it. Most physicians elect to handwrite orders and notes and have them scanned in and/or entered by other staff.

At PH, both the financial and the clinical components of the EHR received equal attention and were rolled out at the same time. PH did not mandate the use of the EHR, particularly for physicians. Rather, it was developed for easy access by having a plethora of workstations located in the acute care settings and clinics; running cable

directly to the physician's door so that s/he had connectivity from her/his office or home; and making resources available to teach and assist care providers on how to use the EHR in order to mitigate frustrations. Ultimately, most physicians have seen the value of the EHR and willingly use it. This approach of being "physician passive" and not "drawing lines in the sand" by forcing physician use of the EHR has worked well for PH. Other PH-employed clinicians, such as nurses, therapists, caseworkers, etc., enter their own data directly into the EHR.

DBC's organizational philosophy of being community-owned and physician-driven has imbued the strategies it has employed in adopting and implementing its EHR. Physicians are encouraged to enter their information directly into the EHR, but this practice is not currently mandated. More than 99% of physicians dictate their progress notes in the clinic setting. Currently, there is less adherence in maintaining a robust problem list, and the medication list is more variable. Adherence depends on the individual physician/office practice style. All notes are handwritten in the hospital environment with the exception of ICU, where physicians can dictate inpatient progress notes. With the Cerner CIS implementation, the plan is to change the processes and institutional culture so that the problem list, medication list(s), and chronic disease registry will be maintained more rigorously through the EHR system-wide.

Leaders and Vision. All four case study sites began their use of IT by following the visionary leadership of an individual or small group of individuals, and all four health enterprises have evolved from the visionary leadership phase to their present states of more consensus-based, interdisciplinary governance. At all sites, the latter governance focuses on utility, process, and use of IT as one means of achieving desired goals, such as quality improvement and cost control.

At the national VA level, Kenneth Kaiser was the initial driving force for implementing CPRS. Linda Reed, nurse in charge of the Clinical Application Coordinators (CACs), and John Williams, IT manager, provided significant leadership at the BP facility to move the mandated national implementation forward. It was a middle-out effort that reached down to users and up to management. The IT group is closely associated with the CACs.

At NMHS, Dan Wellford, CEO and Linda Gholson, Nursing Vice President provided support and vision. Tommy Bozeman, CIO, is an enabler and an integrator to achieve enterprise-wide, patient-centered, longitudinal care.

At PH, the CEO and several board members had the vision that PH should deliver care that is patient-centric, integrated, seamless, and focused on quality and safety. They were not impressed with the commercial EHR systems offered in the early 1990s, and determined that PH would need to work with a vendor to create an EHR system that met their needs. They partnered with IDX to collaboratively create their EHR. They combined information technology (IT) and quality improvement/safety into one system-wide division, the Healthcare Improvement Division, headed by John Haughton, MD.

This division is responsible for actualizing the organizational goals of having a more integrated, seamless form of care.

At DBC, CEO Nicholas Wolter, MD and IT Medical Director Dennis Regan, MD provided the vision for the development and implementation of a robust and innovative clinical information system that would assist DBC in providing the right care for each patient, the first time and every time. This vision is supported by the Operating Council, which includes all of DBC's senior leadership and six full-time physicians representing various specialties. The Operating Council formulates general enterprise priorities, such as goals for increasing market share and financial attainment, and is the decision-making body of the organization. Chris Stevens, the VP and Chief Information Officer (CIO), and Dr. Regan are charged with formulating EHR plans that fulfill these and other strategic and operational goals. Mr. Stevens and Dr. Regan chair the steering committee and ad hoc committees, which consist of physicians and other healthcare staff who help evaluate competing vendor solutions, and submit their recommendations to the Operating Council. DBC has identified seven areas of focus: (1) outstanding quality and patient safety; (2) personal service excellence; (3) leadership; (4) growth; (5) community, regional, and national strategic alliances; (6) information systems; and (7) financial strength and operational improvement.

Vendors. Accounts of how vendors were selected varied by site. Representative of three of the four sites mentioned that they reviewed the capabilities and features of the commercial software available and found them insufficient to meet their needs. The VA built its own system, and NMHS and PH have co-developed their software with one or more vendors. NMHC will try to work with smaller rather than larger vendors to maximize control. NMHC looks for functionality and performance before paying all of the costs, builds into the contract requirements for response time and system stability, and prohibits "sun setting" of products. If possible, NMHC will use its own contracts to ensure its conditions are met. DBC implemented 3M Clinical Workstation four years ago, but quickly determined that it was going to be insufficient to meet the long-range desire of a truly integrated, seamless EHR. This resulted in a new search for a more comprehensive software system; the Cerner Millenium system, which is scheduled for implementation in the summer of 2004, was selected. DBC's overall information system philosophy has several tenets: (1) buy, not build; (2) DBC will not be an alpha partner; and (3) there is value to centralized systems and integration; however, "best-of-breed" department systems will be purchased and used when appropriate. For example, ophthalmology, dermatology, and labor and delivery may provide a winning argument for the need for a "best-of-breed" system rather than adopting what Cerner offers.

Payors. Although most services at the VA are provided in the closed system, non-service related treatment, particularly services paid for by Medicare or other payors, has increased during the past few years to several million dollars per year. These bills are mostly generated on paper, but facilitated by the CPRS system because data can be tabulated and distributed to payors in a timely fashion. Patient composition by payor at NMHS is about 10% NMHS PPO, 45% Medicare, 8% Blue Cross, and 7% Medicaid. The remaining 30% is a mix of self-pay and other commercial insurance payors. Patient

composition by payor at DBC is primarily fee-for-service, with less than 1% of the patients receiving capitated services. DBC does not have a Medicare or Medicaid HMO. Its managed care environment is discounted fee-for-service, and some aggressive insurance company competitions to build restrictive provider panels. The majority of PH patients are fee-for-service; specifically, the breakdown by payor is 20% Medicare HMO, 35% BC/BS PPO (discounted FFS), and 45% Medicare Part B FFS.

2. Organization Structure

Business Units. The implementation of the EHR system has impacted how the organization is structured, primarily in the acute care and physician office/clinic settings at NMHS, PH, and DBC. Each site has had to create or augment existing groups to attend to EHR-related issues.

For example, at the VA, the implementation of CPRS affected several business units. Of greatest significance is the Clinical Application Coordinator (CAC) group, both in terms of numbers and responsibilities. The CAC group was an established group that is present in every VAMC and is mandated at a national level. There is also a national CAC group that communicates with local CAC groups in various ways, such as at national CAC conferences. At both the national and local levels, the CAC groups are essentially IT support groups with clinical training that are responsible for CPRS upgrades, maintenance, and user training. At NMHS, the IT department has grown the most, with administrative and clinical staff largely remaining the unchanged. Within the IT department, NMHS created the clinical analyst group, which interfaces between IT and clinical staff.

PH created one system-wide division, the Health Improvement Division (HID), which combines information technology and quality improvement/safety. The HID group is responsible for all facets of the implementation, use, and maintenance of the EHR, including training and retraining, technical support, design and creation of administrative and managerial reports, and quality improvement activities in the acute care and owned physician clinics. At the owned and non-owned post-acute and long-term care settings visited during the PH site visit, no mention was made of any organizational changes such as the creation or consolidation of departments as a result of the implementation of the EHR.

The implementation of the Cerner CIS, which includes CPOE, required DBC to develop a CIS implementation organizational structure consisting of the DBC executive team support, Cerner executive team support, and a full-time project manager who provides oversight of numerous project implementation teams, including physician workflow, order entry, outpatient and inpatient clinical documentation, laboratory, radiology, emergency department, pharmacy, and others. This project also is supported by the Quality Benchmarking Team and Electronic Medical Record Committee. The Learning Team plays a vital role in that they are accountable for having all staff trained on CIS before the "go-live" date. No mention was made of any organizational changes at the post-acute or long-term care settings we visited.

EHR Implementation and Enhancements at Various Healthcare Settings. With the exception of the VA, the sites all prioritized the acute care hospital and physician offices as the first to implement the EHR. The roll-out of other applications such as bar coding, CPOE, and Picture Archiving and Communication System (PACS) varied by site.

At the VA, two criteria were used to prioritize the order of implementation for different healthcare settings or groups. The criteria were ease of implementation and potential for success. Some groups were more open to the idea, and some operations (workflow) were more conducive to integrating with an EHR. Nursing homes and outpatient clinics were implemented first. Acute care, especially surgery and ICU, were last. Some areas, such as the emergency department, are not fully integrated in real time, although all information is eventually entered into the CPRS. In 1997, the VA system implemented a GUI. Recently completed enhancements included PACS and an automation using bar coding for medication management and dispensing. Bar coding of medication (staff and patients as well) has been in the implementation process for several years. These implementation efforts are generally under a centrally mandated process in which one or more facilities are used to develop/pilot a particular process under the direction of national VA policy.

At NMHS, the implementation of the MIS occurred in the following order: acute care settings, inpatient rehabilitation units, home health, and nursing homes (implemented two years ago). Geographically, facilities on the main Tupelo campus were targeted for implementation first and then other campuses were connected. Financial and back office systems were first implemented in 1975, followed by order entry of nursing notes in 1979. CPOE was implemented in 1985, but it remains optional for physician use. Laboratory and radiology components were implemented in 1993. Future projects include the adoption of bar coding and digital radiology imaging over T1 lines. Clinical analysts are developing new templates for various health settings. For example, a series of templates recently were developed for NH clinicians that mirror selected parts of the MDS, both to meet MDS regulatory requirements and to assist in developing care plans.

PH's first "live" version of the EHR was implemented in 1996 at an acute care hospital in Washington. Since that time, the order of implementation has been: (1) the other five acute care hospitals; (2) PH-employed physician offices; and (3) non-physician entry of (a) problems, (b) medications, (c) laboratory orders and results, (d) patient demographic information, and (e) allergies. CPOE currently is being piloted in the inpatient rehabilitation unit, and there are plans for it to be implemented more broadly in the near future. This will be followed closely by having physician progress notes in the EHR. PACS has been implemented in the Cottage Grove, Bellingham, and Eugene PH facilities. The implementation will be complete in all regions by the fall of 2004. Extension into non-PH physician offices appears to be next. The EHR is currently read/write accessible in four facilities for PH-employed MDs/GNPs use; there is no

timeline for roll-out to other post-acute or long-term care settings located outside of an acute care setting at this time.

At DBC, the 3M Clinical Workstation and HELP systems first were implemented in the acute care hospital, hospital-based transitional care unit, and DBC-owned clinics and then extended into Aspen Meadows, the one DBC-owned SNF in Billings. When the 3M HELP system (ordering and results for medications, laboratory, respiratory procedures, and radiology) was first implemented at the hospital in 1988, there was great resistance by physicians. With time, however, the majority began to see the benefits, particularly because it included electronic charging costs for each of these procedures and requests listed above.

In 1998, DBC implemented the PACS for radiologists. Again, the first few years were fraught with physician resistance; now radiologists and other physicians cannot imagine life without it. The 3M Clinical Workstation was implemented about four years ago. It includes some useful clinical information, such as dictated physician notes (text), the medication list, prescription printing, problem list, allergy list, laboratory test results, and radiology test results.

The Director of Critical Care Services mentioned that with the pending Cerner system, DBC has a group of physicians that are resisting the change (10%), and others that are early adopters and exuberant about making the change (10%); the remaining 80% are non-vocal about their opinions or have come to accept the decision that they will implement the CIS. Clinical staff (not physicians) at the non-owned SNF do not have an opinion about the Cerner system, because there were no implementation plans when this report was written. DBC is not planning to extend the EHR system to its owned post-acute or long-term care settings until the completion of the hospital and the clinic system roll-out.

Implementation of the Cerner CIS will take place first at the acute care hospital, including the emergency department, hospital-based transitional care unit, and the DBC-owned clinics. Within a month or two of this implementation, CPOE will be launched at the ambulatory clinics. There are some systems within the DBC hospital and/or clinics that will remain stand-alone. For example, the GE Centricity PACS, which has been in use at DBC for six years, will remain a stand-alone system and will not interact with the new Cerner CIS. The ambulatory telemetry unit has a stand-alone quality monitoring tool called SoftMed ClinTrack. It currently is not integrated with the 3M Clinical Workstation or HELP, and it is not slated to be integrated with the Cerner CIS. SoftMed ClinTrack primarily is used by case managers to enter data, such as reason for admission, insurance, variances, clinical and laboratory data, and length of stay. SMS and Misys will remain the stand-alone scheduling and billing software for the hospital and clinic, respectively.

Resource Allocation. Funding to support or improve the EHR systems was discussed at two of the four sites. The Bay Pines VAMC receives a lump sum of money based on the number of patients treated during a fiscal year that is lagged by two years

(in fiscal year 2002, approximately 8,600 patients were treated in the hospital and there were more than 634,000 outpatient visits). Different business units (such as IT) then create budgets and lobby upper management for various programs or operations. Because there is just one funding source, if the budget goes up in one area it must go down in another area. All resources spent on the CPRS, including IT support, hardware, and training, must come from other departments. Allocation for major innovations, such as the bar coding of medications and the development of a PACS in radiology, is generally mandated from a national level. At NMHS, IT expenses are 2.1% of total corporate expenses with maintenance costs of $271,000 per year.

3. Staffing/Training

Staffing Levels. Levels of clinical staff such as nurses and physicians changed very little at all four case study sites, particularly in the post-acute and long-term care settings. The number of other types of staff such as data entry, administrative, and IT, in general, have increased, primarily at the main acute care hospital, which tends to be the IT department's base. The number of medical records staff (paper charts) has decreased at the VA and at PH's and DBC's acute care hospital and clinics. Because NMHS continues to have a dual record system (one electronic and one paper), the number of medical records staff has not changed. The NMHS IT department (particularly clinical analysts) has become larger. These analysts have clinical training and substantial IT training, providing a much-needed interface between clinical users and the IT group for planning and prioritization on MIS issues. They also act as expert users, trainers, and system innovators.

Staffing Skills. All four of the case study sites have identified a group or department that is responsible for implementing, maintaining, and upgrading to the EHR, as well as training clinical, administrative, and IT staff on the use of the EHR. At the VA, the CAC group is responsible for initial implementation, ongoing maintenance, enhancements, and training related to the CPRS. NMHS has a clinical analyst group that operates out of the IT department, and they too function as an interface between the clinical and IT staff for troubleshooting, planning, system enhancement, and training. At PH, the HID has staff with clinical, technical, and/or business backgrounds. This group is responsible for the implementation and maintenance of the PH EHR, as well as all initial training and re-training of staff. DBC has an interdisciplinary team within the IT department that works closely with the Medical Director of Information Services (a physician) and other clinicians.

Training. Considerable resources and time have gone into the EHR training. As mentioned above, each site identified a group that is responsible for both initial and ongoing training. A variety of methods have been used including paper and online manuals; "at the shoulder" support and tutoring while using the EHR; incremental, short training sessions; and luncheons. The training sessions often were tailored to specific groups of individuals.

NMHS and PH made a conscious decision to not force end users, particularly physicians, to use the EHR system. Both sites have engaged a number of strategies to encourage physician usage, including having support available round the clock to answer questions. PH reported that physician usage and acceptance of the EHR system are quite high; NMHS indicated that 10% of all physicians use MIS at a meaningful level, although the majority (80%) use it to some extent. For example, the majority may use it to access patient lists and retrievals, and up to 50% utilize CPOE features at some level. Non-physician staff at the PH PAC/LTC settings did not receive this same level of training, because their access to the EHR is limited.

Training for DBC's CIS project is guided by a formal learning plan developed with the guidance of Cerner Corporation, and the initial training already has taken place or will take place in the next few months. In all, DBC will train approximately 1,825 staff end users on one or more of the seven different applications being installed. More than 200 staff physicians and practitioners will be trained on the physician application by the end of Phase I. DBC has chosen a blended approach for training staff prior to "going live." Staff first completed an online Windows assessment and, if indicated, they attended an instructor-led Windows class. Prior to attending the CIS formal training classes, all staff will complete Web-based training (WBT) for the applications they will be using. These classes will be instructor-led and will be four hours in length. Classroom training will be provided by staff clinicians that have been assisting with the testing of the application and with the development of all the training materials. Classroom trainers will be assisted by "super-users" in all classes. PowerChart, RadNet, PharmNet and FirstNet will be implemented in Phase I. PowerChart Office will be implemented in Phase II. Hospital end-user staff will be trained first. Clinic end-user staff will be trained the following month. Physicians and practitioners will be trained using several methods, including Web-based training, formal classroom training and one-on-one training sessions. After the initial implementation, additional training will continue in the form of refresher classes, "lunch and learn" demonstrations, and updates in the DBC weekly newspaper.

4. Communication

Channels of Communication. Each of the sites continues to rely on traditional forms of communication (telephone, fax, face-to-face) to a large extent, particularly in the post-acute and long-term care settings. At the VA, the CPRS contains a great deal of patient information that is available "anywhere, anytime." Clinicians often access a terminal prior to seeing a patient or when preparing for a team meeting rather than consulting the patient or other team members. Home healthcare plans are created online and on paper. At NMHS, the use of paper to communicate information and drive clinical care is prevalent. For example, NMHS has paper communiqués called "Mis-o-grams," which are generated from the MIS and are sent to one or more printers. The content of these messages ranges from administrative to clinical topics. Traditional methods of communication such as telephone, fax, and e-mail outside of MIS are also used. Clinical staff use handwritten notes to collect information, which is then transferred into MIS (there is not much time lag between these processes), but there is

also direct entry into MIS with no paper intermediary, for example, nursing progress notes. Handheld devices are used in the acute setting to electronically download information directly into MIS (e.g., blood sugar levels).

At the PH and DBC acute care hospitals and clinics, workstations for accessing the EHR are liberally dispersed. At the affiliated nursing home and PH-owned HHA visited, the phone and fax are the primary forms used to communicate internally and externally. At Aspen Meadows, the DBC-owned SNF, there is a workstation with DBC Network Internet access over which DBC-physicians and physician assistants (PAs) can access Clinical Workstation (read-only). At the affiliate SNF (Beartooth), there was one workstation that has read-only access to Clinical Workstation. According to DBC's CIO, although the nursing home staff have read-only access to the Clinical Workstation, most do not use this capability; this is not a technological barrier, but rather a decision not to include the workstation in the workflow processes. At both SNFs, the use of paper (including facsimiles, handwritten notes, and documented phone calls) to communicate information and drive clinical care is evident. Within the DBC acute care hospital, transitional care unit, and ambulatory clinics, some DBC physicians are provided with wireless laptops, and some bedside workstations and handheld devices are used. Handheld units are used extensively by PAs in the long-term care facilities. All three modalities are being tested at this time to determine how/if these technologies enhance operational efficiencies. A growing number of physicians within the acute care hospital and downtown clinic are reviewing the clinical information available in 3M Clinical Workstation and/or HELP instead of requesting a chart pull.

Timeliness and Frequency of Communication. All sites acknowledge that the timeliness and frequency with which they receive information from the EHR have increased. With multiple providers having the ability to simultaneously read patient data online, the frequency with which patient records are accessed has also increased. Having key information such as laboratory and radiology results available within a few hours of giving the order is a great improvement, as compared to when paper charts were used exclusively.

As mentioned before, the reliance on the paper chart differs by site, and more specifically by healthcare setting within each health enterprise. At the VA, the CPRS allows multiple people to access the record, improving efficiency and the quality of care because the information in the EHR is up to date and widely available. This was evident in all of the health care settings within the BP VA system, including the home care services. NMHS likewise has patient data with "anywhere, anytime" access. PH and DBC would likely concur that the EHR, particularly in the acute care hospital(s) and clinics, has improved the efficiency by which they provide care. However, at both of these sites, most of the staff (excluding the "owned" physicians and/or nurse practitioner/PA) at the post-acute and long-term care settings we visited have limited read-only access to patient information (most of which relates to the patient's hospital stay and other ambulatory care services). Information about what types of care are provided while in the NH or HHA is not included in the EHR.

Alerts. The number and use of alerts in the EHR system varied by site. At the VA, the CPRS has a large number of alerts, but no computerized algorithm to prioritize them, making it easy for clinical staff to get overwhelmed with too much information. At NMHS and PH, more interactive alerts and flags were available at the IRF than in other long-term care settings. PH's inpatient rehabilitation unit had drug interaction alerts, medication alerts, allergies, and a warning to verify the correct patient's information was being accessed. These alerts were available at the time of information entry into the system. Physicians also were notified when their patients were admitted to the hospital or received care in the emergency department. There are no alerts in DBC's ambulatory and PAC/LTC settings at this time. However, clinical staff have access to Micromedex, which supplies information on drug-drug interactions and staff and patient education materials. In the DBC inpatient setting, alerts on medications in the HELP system appear to the pharmacist who then contacts the physician by phone or pager to discuss them.

Quality of the Communication. Not surprisingly, all users of the various EHR systems acknowledge that the quality of information available to them is much better than it was when they relied solely on a paper chart. Legibility of information has improved communication across disciplines and has decreased errors. For example, the CPOE implemented at PH's inpatient rehabilitation unit has drastically decreased medication administration errors due to incomplete or illegible orders from 25% to nearly 0%. Another aspect of quality is the structure of information. At NMHS, the MIS forces certain information patterns, which reduces missing information and also structures the information, including text such as progress notes.

Staff at PAC/LTC settings with limited, read-only access to the EHR (DBC and PH) commented on the value of being able to read clinical progress notes, medication lists, emergency department and outpatient notes, results, etc. online.

Content. The amount of unstructured text as compared to drop-down menus or limited fields in which to type information was different for each site. The VA has both cut-and-paste capability and text that is generated automatically (e.g., medication lists), which bloats the patient record with unstructured text. In contrast, NMHS has no graphical content or cut-and-paste capability; and data entry templates force structured input that minimizes text. DBC has developed more than 180 templates to be used upon installation of CPOE that will provide baseline content and automates the customization of content. Information in the EHR is primarily generated through dictation; however, templates and free text can be used for real-time entry of data.

5. Workflow and Procedural Changes due to EHR Adoption

Managerial Oversight and Functions. The reduction or elimination of paper processes has positively impacted clinical workflow processes at each case study site, particularly in the acute care and ambulatory care settings. For example, the simple fact that many users can simultaneously access an electronic record has reduced the amount of time necessary to hunt down the paper chart and leaf through it to find the

necessary information. This benefit also allows for more integrated care delivery by all disciplines. Clinicians now review information in the EHR prior to interacting with the patient or when preparing for meetings.

Managerial oversight and administrative workflow patterns also have improved. Because of the EHR, most of the sites are able to conduct cost/benefit analyses, trend clinical information to improve care and financial information to contain costs, target clinical quality indicators, and retrospectively analyze information for strategic and tactical decision making. Each EHR generates a unique patient identifier, thereby reducing the potential for duplicate patient records.

At PH and DBC, the PAC/LTC settings' workflow patterns were not greatly impacted by the EHR, because these settings have limited access. Clinical notes, care planning, reconciliation of medication lists, etc., are still largely performed by hand. However, being able to view potential residents' information in the EHR enables them to contain costs to some degree by determining if the patient can be placed there.

An example of a glitch in EHR design that has negatively impacted workflow can be found at the VA. There are some instances in which patient care moves faster than the administrative record keeping. A patient may be transferred to a new health setting, but the electronic transfer of information takes longer to arrive, delaying the patient's admission to the new care setting. Distribution of medications, which can be quite complex in the nursing home care units, has been negatively impacted by the EHR in some cases. For example, the bar coding process can delay the distribution of medication if bar codes do not read correctly or medication alerts cause a delay in the distribution while the alert is investigated.

Patient Interactions. At PH and DBC PAC/LTC settings, patient interactions have not been affected by the larger enterprises' EHR system because their processes are still paper-driven. Information is not reviewed or entered electronically in front of the patient. At the VA, CPRS has a module allowing for patient/physician/provider interaction. Some indicated this was good, as the terminal could become a teaching tool with graphical display of information. In other cases, the terminal took away time with the patient, because the care provider would work with the terminal while the patient waited. At NMHS, patients are aware of computer terminals because they are visible, but staff indicated patients are not that aware of MIS. Because paper is still widely used (although computer-generated to a great degree), patients do not see the computer interaction. NMHS has no plans to increase patient access to their EHRs.

Staff Interactions. Care coordination has improved at the VA and NMHS as a result of the EHR system. Legible, accurate, timely information that can be simultaneously accessed allows the clinicians to work more efficiently as a team. At the PH and DBC PAC/LTC settings, care coordination is still largely paper-driven. That said, having read-only access to information such as diagnoses, problem list, medication list, and case management notes from the acute care episode has been very helpful in developing appropriate care plans.

Security. Each case study site mentioned that they are in the process of becoming or have become HIPAA compliant. Access to the EHR is dependent on the user's profile, with certain roles having read/write permission, others read-only, etc. All sites audit who accesses patient information to ensure that privacy violations do not occur. Staff have been terminated, suspended, or reprimanded for accessing patient records for reasons other than patient care at two of the four sites.

Documentation. The legal medical record is different at each site. At the VA, all documentation is electronic (in CPRS), and therefore the legal medical record is the electronic record. At NMHS, where a great deal of documentation is entered into the EHR, there is a duplicate record system whereby the paper record is mostly computer-generated. Staff enter information directly into MIS (e.g., nursing notes). Currently, NMHS is implementing Sunrise Record Manager, a document-imaging product. Once it is fully implemented, all handwritten documents will be scanned in with feeds of electronic data from MIS fed in automatically to create the fully electronic record. Therapists' clinical documentation is mostly hand-written, but some physical and speech therapists and social workers are beginning to use electronic templates to capture clinical narrative. The PH and DBC acute care hospitals and ambulatory clinics have a more complete electronic record, although some components, such as physician inpatient notes, remain in the paper chart. PH physician outpatient notes are electronic and part of the EHR. The paper record is the legal record for all DBC-owned facilities.

C. Information Technology

1. Core System Name and History

Each of the four EHR systems leverages a different EHR IT infrastructure that in major part is more than 20 years old, indicating that no particular IT infrastructure (equipment and network features) is required for the successful operation of an EHR system. Among other things, this maturity yields, on the positive side, speed, reliability and time-tested functionality. On the negative side, there is a general lack of flexibility, "evolvability," and reusability. These same qualities, plus and minus, are found in most "heritage" transaction-based systems both inside and outside health care, though they are rapidly disappearing from domains such as banking and financial services.

The VA EHR system, CPRS, is a collection of applications that makes use of the Veterans health information system and technology Architecture (VistA). VistA is a file system, database, and run-time environment that supports the applications that make up CPRS. VistA is more than 20 years old; CPRS is more recent and includes a Microsoft Windows-based client. The VA's EHR has become essentially paperless only within the last few years. The NMHS EHR has, as its core application, the Eclipsys 7000 system, which is an evolutionary descendent of the Technicon system first deployed by Lockheed at San Mateo Hospital in San Mateo, California more than 35 years ago. The PH IDX/Lastword® EHR system is an evolutionary descendent of the proprietary

PHAMIS system that evolved from a Federal Government project. DBC currently uses the 3M HELP EHR system, which is a direct descendent of the HELP system first developed at the University of Utah as an acute care EHR. DBC also uses 3M Clinical Workstation, which is a more recent Microsoft Windows-based system better suited to ambulatory care. DBC plans to deploy the Cerner Millenium system in the near future, which is Cerner's latest offering in a long line of EHR applications.

2. System EHR Information Technology Strategy

While all four sites share "anywhere, anytime" access as a central EHR goal, the means of achieving this access, and the corresponding functionality, are profoundly different. These differences are best summed up in the form of the system IT strategy.

The VA has a long history of successful, custom, internal development and deployment of EHR functions. Widely recognized as the most functional large-scale EHR system in the United States, this EHR system was first implemented in acute care, and has expanded incrementally to its present organization-wide, essentially paperless status. Nationally mandated new applications and updates to existing applications are deployed to 128 Veterans Affairs Medical Centers (VAMCs) such as Bay Pines, Florida on a fairly frequent basis. Local staff implement and support these upgrades along with potential customization at each VAMC. While there is potential to transfer a patient's electronic record between VAMCs, the transferred information is a standardized subset of the patient's entire health record due to data incompatibility between VAMCs as a result of local customization of the CPRS.

Because the CPRS is "monolithic" (that is, a single, relatively seamless system) it is easy to extend its deployment for use into different healthcare settings within the VA. Thus, while the CPRS was not initially designed for PAC/LTC use, it has been successfully deployed in these settings. There are two observed reasons for this success. First, providers in PAC/LTC settings want access to the acute care and ambulatory care records for review as part of the PAC/LTC record and care initialization process. Second, the core functionality provided, including support for a problem list, medication list, laboratory results reporting, radiology image and report viewing, notes, and order-entry, is useful independent of the healthcare setting. In addition, acute providers reported using PAC/LTC records, such as problem lists and physical assessment, upon readmission of their PAC/LTC patients to acute or ambulatory care.

By virtue of its development by the Federal Government, CPRS is in the public domain and, therefore, is used at other sites around the world that are not affiliated with the VA (e.g., Helsinki University Hospital, University Hospital of Kuopio, Finland, University of Wurzburg, Germany, XORS, Inc., Czech Republic, and many others). The real benefit of the public domain status of the VistA/CPRS application and content, however, may be the freedom to enhance and deploy it without legal constraint.

In contrast to the VA, NMHS eschews custom EHR application development, and has won a Davies Award by successfully integrating highly functional, proprietary EHR

applications that interoperate with one another. That is, NMHS selects and deploys proprietary EHR applications based on their functionality and their ability to interoperate in an NMHS-created infrastructure. Part of this deployment includes the availability of EHR functions in PAC/LTC sites. In evaluating new EHR applications, NMHS considers any trade-offs between decrements in response time and improved functionality. The mix of the EHR system applications at NMHS combines current and legacy applications in a way that maximizes system return on investment (ROI). Initially, the NMHS EHR system focused on the use of a common master patient index (MPI) and the transfer of text from one application to another. Currently, additional investment is being made in the interoperational framework so as to enable all applications to share and re-use a common, locally standard, core set of data elements on all patients. Interestingly, NMHS's strategy includes interoperation between an acute care EHR and several instances of an ambulatory EHR.

In contrast to NMHS, PH uses a single vendor strategy wherever possible. Custom development is used only when the selected vendor cannot provide the desired EHR functionality. PH's strategy includes a systematic, interdisciplinary process, by which EHR functionality is being deployed incrementally across departments and levels of care. Lessons learned from this process, as well as from the CPOE pilot test currently underway in the hospital-based IRF, are used to improve the process. Constant process evolution is a system objective. Currently, the only EHR interoperability with PAC/LTC facilities (home health care and a non-owned NH) is read-only access of the acute care EHR by *most* of the staff. Contracted PH MDs/GNPs have read/write access to the EHR. Part of the single vendor strategy is eventual migration to newer offerings from that vendor, a migration that is planned but not yet scheduled. It is unclear if these newer offerings will include components to serve NHs and/or HHAs.

DBC plans to replace its current, multiple vendor/applications EHR system with a single vendor EHR solution (Cerner Millenium) in 2004. The current EHR system consists of two separate care applications from the same vendor; one that historically had been used for inpatient use (3M Clinical Workstation) and the other for ambulatory (clinic) use (3M HELP). Currently both applications are used in the acute care hospital and all DBC-owned clinics. This core system is supplemented by more specialized applications from additional vendors. Custom, locally developed, interoperability includes use of a common MPI and an integrated billing system. The current EHR system, which has evolved during more than a decade, is deployed and useful, but it is insufficiently functional to provide the integrated, patient- and provider-centric functionality desired. Operating in a highly competitive care market, DBC plans to use a single vendor EHR system to provide seamless care within its system (currently defined as Deaconess Hospital and the DBC-owned clinics) and to have interoperability with referring physicians outside of its own system. At the affiliated NH, inpatient and ambulatory records can be viewed but not altered by DBC physicians and physician assistants (PAs). At Aspen Meadows, the DBC-owned NH, all clinical staff have read-only access to the 3M Clinical Workstation and interactive access to HELP, including laboratory, medication, and pharmacy order entry. However, the Aspen Meadows'

Director of Nursing noted that a limited number of staff (pharmacist and the DON) regularly use the current DBC EHR.

3. Core System Hardware Implementation

None of the four sites mentioned being limited by the cost, performance, or availability of computer hardware. Instead, at each site, premiums were paid to buy otherwise obsolete hardware to sustain the functionality of usefully deployed legacy systems. At BP, ever more powerful computer servers have been constructed using arrays of Digital Equipment Corporation (DEC) Alpha chips. Compaq purchased DEC, and Hewlett-Packard (HP) purchased Compaq; the most recent servers at BP have been made by Hewlett-Packard. At BP, server arrays are replaced approximately every four years to help forestall hardware failures. However, current increases in usage are out-stripping current models of server sizing.

NMHS's strategy is to use its IBM server hardware as long as possible, for example, until maintenance contracts can no longer be obtained or until replacements are unavailable. While migration to more contemporary hardware is constantly under review, no plans to do so are currently scheduled because no vendor has been able to adequately meet NMHS's data migration and functionality requirements. In contrast, NMHS's PCs that use terminal emulation software to interact with the IBM mainframe are replaced on a regular schedule, and those that still function are donated to local educational institutions.

The PH IDX/Lastword® EHR system runs on Tandem servers. Tandem is now owned by HP. There currently are no plans in place to replace these servers, but there is a commitment to move to more current IDX products, possibly in a few years.

The DBC 3M HELP system runs on Legacy servers. The 3M Clinical Workstation system runs on IBM RS 6000 servers. DBC's planned replacement by Cerner's Millenium system will make use of remote servers in Cerner's national data center.

4. Core System Software Implementation

Most staff at each of these four sites are not keenly aware of the implementation history of their EHR system. However, the software environments in which these EHR systems were developed, and now run, not only are very relevant to many work functions, such as quality of care and workflow processes, but also to any pending adoption of a standard environment, such as that offered by Java. Because of generally poor separation of the EHR system computer code from the EHR content such as terminology or care plans, the reuse of such content from one system to another is nearly impossible, even when not considering other issues such as privacy or intellectual property (IP) status.

All VAMCs such as BP use MUMPS, which is an ANSI standard programming language. M is a proprietary dialect of MUMPS that supports almost all CPRS and VistA

systems. M supports the application, file system, and database functions needed by the VA EHR, and it is tuned to support high transaction rates.

The NMHS EHR system was initially built by Technicon (primarily for back office applications) and was developed in IBM assembler (a programming language) and third-generation programming languages then available. The Eclipsys implementation of this EHR system has been made more interoperable through the use of an interoperation package named eLink. eLink has been used by NMHS to help it develop its interoperation infrastructure.

At PH, COBAL, an ANSI standard programming language, has been used for the EHR system. IDX/Lastword®, now PHAMIS, was implemented in Tandem's proprietary dialect of COBAL called COBALT. The latter, in analogy with M, made use of file and data management services available with Tandem hardware. PH plans to move its EHR system to IDX's next generation EHR system, Nextword®, with an attendant increase in functionality and flexibility. Meanwhile, any ad hoc reports from the existing EHR must be written in COBOL.

The DBC HELP and Clinical Workstation systems are implemented in separate software environments, the former in programming languages supported by Legacy and the latter by 3M. Whatever the limitations of these environments, DBC has been able to custom develop a degree of interoperability sufficient to support unified billing and some database and interface functions. Because access to Cerner's EHR system will be provided using an ASP model, Cerner's software development environment will not allow for its customers/users, such as DBC, to undertake any customization efforts. However, DBC personnel report that some enhancements are being contemplated by Cerner as potential enhancements to its product line based on DBC input.

5. Health System Architecture

The main IT architecture (fundamentally how the IT system is put together) challenge is the configuration, management, and utilization of distributed system resources that usually comprise PCs, servers, and data in most environments today. Thus, if a particular architecture is considered the best solution, the question is usually how do distributed computing resources in a given environment communicate with one another? Again, each site uses a different architecture to support its "anywhere, anytime" access and associated functionality.

The BP CPRS makes use of "fat clients." In this context, a client is a small computer supported by a larger server or mainframe computer. Software applications written in a contemporary (fourth generation) programming language are downloaded to the client PC during each login by a given user. The downloaded program is what makes a "fat client" as opposed to a "thin client," which has a more limited functionality such as one that uses terminal emulation software. The downloaded software equips the PC with applications that support a multi-window, GUI to the CPRS. Originally, CPRS ran solely under a mainframe terminal emulation interface, but now both options

are available. Thus, while patient information and applications reside and execute on the BP VAMC servers, the applications that manipulate that information on the PC and interact with the user through mouse and keyboard interactions, reside on the local PC. For example, the resident PC application manipulates "pick lists" without having to interact with the server. In this way, each VAMC reduces network traffic, improves response time, and achieves greater functionality, especially interface functionality, than would otherwise be available. However, a major concern of users at BP is system response time, termed "watching the hourglass," which can be multiple seconds in length for some processes.

In contrast to the VA, NMHS uses a "hub and spoke" architecture with the hub being the central (Eclipsys) core EHR system, and each spoke being a potentially unique interconnection with another system or a PC mostly in a terminal emulation mode but with some limited multiple windows ability. The spoke system might be departmental, for example, a radiology reporting system, or it might be a separate (ambulatory) EHR system such as Logician (now owned by General Electric). Common to all spokes is the NMHS MPI, and unique to each spoke is whatever is required to interoperate with the particular proprietary system on the end of the spoke. Separate from the hub and spoke architecture, the core EHR system supports access through terminal emulation that has evolved from the original light-pen interface used by early Technicon systems.

PH uses a server-based architecture that supports access via terminal emulation only. Each PC accesses the PH EHR with what used to be called a character-based computer terminal. These are essentially command line oriented with minimal mouse and click-and-point functionality but rather typing in text on command lines. NMHS also is predominately terminal emulation (it has no cut-and-paste capability).

The architecture resulting from DBC's current EHR system strategy might be called a "multi-system architecture." In this architecture, there are separate core applications: one for inpatients, one for clinic (ambulatory) patients, and one for billing. Each has its own way of interfacing with users. To a limited degree, the separate databases supporting these systems cross-populate one another using custom methods, and some user interfaces support access to other remote systems. As stated, and as with NMHS, all systems and interfaces make use of the DBC MPI. As a default, and in contrast with the current EHR, the planned Cerner CIS will be accessed entirely from Web browsers running on PCs connected by redundant networks to Cerner's data center.

6. Staff and Affiliate User Interface

Each of the four sites support user interfaces with their respective EHR differently. During each user login at a BP VAMC PC, whether that PC is on a wireless or hardwired network connection, a copy of a client application is downloaded from the EHR server. This client application presents a multi-window EHR GUI built around a tabbed model (clicking on a tab presents different windows of information) of a patient

chart. The tabs are for a problem list, laboratory test results, medications, notes, images, order entry, etc. All VA care providers interviewed indicated that they value the information that can be retrieved about a patient. This interface, and its implementation of the tab metaphor, provides a uniform way of accessing and displaying patient information for all care providers regardless of healthcare setting. Customized templates also can be created for specific needs, both at local VAMCs and within a VAMC in different care settings.

The core EHR at NMHS also uses PCs for access, but a terminal emulation application is used to simulate the upper-case character, light-pen interface. This interface was one of the first commercially available ways to make laboratory results reporting fast and easy for physicians. Because of the NMHS-implemented interoperation framework, this same interface provides transparent access to information about a given patient in other systems. Users know they are interacting with a different information context, but they are not confronted by interoperation details.

The PH EHR also supports mixed-case, character-based interactions with Lastword® through terminal-emulation on PCs. At DBC, access to the HELP system is character- and Windows-based; access to Clinical Workstation is Windows-based. The latter currently is supported through Citrix, a "thin client" Windows emulation. Access to the planned CIS will be through Web browsers and Citrix.

7. Governance

A critical organizational transition for most EHR systems is the evolution from governance by visionary leadership to governance by an interdisciplinary assemblage of stakeholders. All four sites have made this transition, although the details of current EHR governance processes vary between sites. Currently, VAMCs such as BP are in charge of local implementation of the CPRS and local interdisciplinary groups recommend changes in the national VistA or CPRS code line to one of 21 Veterans Integrated Service Networks (VISNs) in which all VAMCs reside. In turn, VISN authorities can either take unilateral action or recommend that changes be made nationally. Predictably, there is some frustration resulting from the tradeoffs between central control and decentralized control of EHR evolution, but, clearly, there is ongoing local, regional, and national evolution and a broad sense of stakeholder involvement. Evidence of local evolution is most evident in the development of context-specific templates, which are customized screens/reports that guide specific aspects of EHR use, particularly the context-dependent collection of information about patients.

At NMHS, EHR governance is part of the annual departmental budgeting process with input provided by small clinical/IT user teams. These user teams meet, often weekly, to discuss various system issues. Departments submit annual budgets that can include recommendations regarding EHR expenditures, such as the purchase of a PACS. These budgets are reviewed by management and, if approved, become the responsibility of departments to implement. Changes to annual plans are allowed if they are budget-neutral. Management dictates EHR strategy and tactics; for example,

NMHS's "best-of-breed" approach to EHR vendor/application selection and its desire to communicate with regional group practices.

PH's EHR plans are reviewed annually by a governing council; for example, a plan to purchase a PACS has not yet received enough votes relative to other EHR expenditures. The council submits its recommendations to management. Management sets larger priorities, such as the potential extension of EHR access to non-affiliated physicians. The initial EHR investment was focused on the continued, evolutionary improvement of patient care; however, one result of this investment has been overall system financial improvement.

At DBC, the Operating Council, consisting of senior leadership and physicians, reviews EHR recommendations submitted by the Steering Committee, which is chaired by the Vice President and Chief Information Officer (an IT professional) and the IT Medical Director (a physician). Senior management formulates general system priorities, such as goals for increasing market share and attaining financial objectives. The CIO and IT Medical Director are charged with formulating EHR plans that fulfill these and other goals. The Steering Committee, made up of physician department chairs and ad hoc committees of other healthcare professionals, help evaluate and put forth recommendations regarding competing vendor solutions. This process determined that, at present, the Emergency Department (ED) would share use of the planned integrated Cerner CIS, instead of purchasing a specialized ED system, but that a separate, specialized system will be considered for dermatology.

8. EHR Standards

Until recently, few EHR standards were available other than those mandated by federal, state, and local reimbursement and reporting and, typically, mandated standards tended to be used only to fulfill the mandate and not as part of any care process. Two exceptions to this are Health Level 7 Version 2 (HL7v2) messages, used for laboratory results reporting and other tasks, and National Drug Codes (NDCs) used to identify lots of packaged medications. While both these standards will probably be replaced during the foreseeable future by better standards that incorporate lessons learned from the use of HL7v2 and NDCs, they remain important as examples of the economies of scale afforded by standards, and they are in use at all four sites. Except for the terminology standards required for reimbursement and reporting, little use of standard terminologies was evident at any of the sites; however, as will be described, all sites used terminology-enabled applications, providing one measure of the potential utility of standard terminologies.

The BP VAMC makes heavy use of HL7v2 standard messages. The VA has its own national standard terminologies (e.g., laboratory tests, medications, and problems) that are locally deployed and modified. These national terminologies will evolve toward emerging national standards such as LOINC (for laboratory test results and other uses) and SNOMED CT (for problem lists and allergies), but no deployments of these and related standards are yet scheduled. Most CPRS applications are terminology-enabled.

Any terminology maintenance is manually undertaken with potential economies of scale afforded by national terminology resources.

At NMHS, terminology for terminology-enabled applications is seen as the result of local consensus processes (NMHS internal working committees). For example, the qualifying diagnoses for stroke that trigger a care plan and care management applications are determined by one such committee.

As with NMHS, PH's EHR terminology is the result of local, consensus processes, except where applications, such as some of those that support order entry, come with built-in terminologies. As PH grows (it has patients and providers in three states), these terminology consensus processes become both more difficult and more important.

Most vendor applications used at DBC come with their own vendor-supplied terminology. This terminology is then localized (e.g., with local synonyms) for DBC use. Current plans call for localization of the terminology that comes with the anticipated Cerner Millenium system.

9. Data Repository Functions

Though not yet well developed at any site, each site recognizes the need for data repository functions and sees these functions as an incremental approach toward evidence-based medicine (EBM). In this context, a data repository is an architectural solution for the need to process patient data in the aggregate without interfering with the performance or functioning of the EHR. That is, the data repository is a physically separate database system that is loaded periodically from the EHR that supports analytical functions. The current focus of these functions is not yet on care provided at PAC/LTC settings.

A structured subset of data at the BP VAMC (and all other VAMCs), in particular the data that use terminology standards developed internally at the VA and required for reimbursement and reporting, is submitted and then aggregated at a national level in several data centers, such as the Austin Data Center, Austin, Texas. From these centralized data centers, summary reports are created and used by national VA management. This information also is provided at various levels to individual VAMCs. The VA also has a real-time data repository prototype under development. The rate-limiting factor for the useful deployment of such a prototype is the lack of EHR data that are electronically comparable across VAMCs. The principal reason for the lack of comparability is the local customization permitted at each VAMC, especially in the area of terminology. However, because most local terminologies derive from national terminologies, standardization on national terminologies for the purposes of enhanced comparability may be a goal that can be achieved in a predictable amount of time. In the meantime, each VAMC develops its own local aggregate reports to fulfill local needs and national VA needs such as quality measures.

To compare its care performance with national norms, NMHS submits data to Care Sciences in Philadelphia, Pennsylvania for analysis. Local ad hoc reports track internal quality and cost metrics. By design, the common data elements to be deployed as part of the enhanced interoperation infrastructure will be comparable and permit enhanced local reporting.

Perceived vendor product shortfalls led PH to commit to the development of its own data repository. Pending completion of this repository, PH uses the reports supplied with its EHR to track the performance of individual physicians. These reports are presented to departments so that each department can see the distribution of physician performance; however, individual physicians are not identified.

At DBC, some integrated financial and physician productivity reporting is supported by the current EHR system. Internal ad hoc reports track quality and patient safety metrics. Individual physician productivity reports are shared with the physician and are used by the department management team to track physician performance and maximize scheduling opportunities. A robust, integrated reporting module is anticipated from the planned Cerner deployment. This reporting will be used to validate quality of care for selected populations with chronic diseases such as diabetes. Reportedly, the Cerner deployment will include "back-population" of the Cerner database with current EHR patient information.

10. EHR Impact on the Use of Paper

Use of paper for various processes such as health record documentation, clinical care, and administrative processing varies at each of the four sites, depending on the business and clinical goals of the organization. The use of paper has evolved at a number of levels ranging from elimination, to redesign, to duplication as a result of implementing the EHR system. Paper records for care documentation at BP are created only during rare down times of the EHR, and once the EHR is up, any information recorded on paper is transferred to CPRS. There is no paper patient record; however, paper generated by CPRS is utilized in various administrative and clinical processes. Across all VA health care settings, the use of paper is minimal, and in the case of documentation has been essentially eliminated.

In contrast, NMHS not only has many workflow and clinical processes that utilize paper, but also retains a complete paper record (mostly computer-generated) for use in the clinical environment. This paper chart is a mixture of scanned, dictated, and computer-generated reports. For example, all nurses must type in their notes; however, physicians can handwrite information that is scanned or hand entered into the system at a later time. Printers are widely distributed at facilities as paper is often used to provide alerts (a paper printout initiates requested laboratory tests), communications to staff ("Mis-o-grams") facilitate clinical care (daily printouts are used for medication distribution in nursing homes), and many other workflow processes. Currently, there is no intent to reduce the content or scope of the paper record although process improvement is ongoing. For example, flow sheets that are currently created manually

with paper will be entered electronically once the EHR system has been modified to accept the flow sheets.

At PH, part of the process of introducing EHR technology has been a review of record keeping practices in general. For acute care patients, this has led to an interim, abbreviated paper chart that is a highly focused, compact, paper, episodic, record of care (primarily comprised of physician progress notes and orders). Use of paper records will continue to decline as CPOE rolls out across additional departments. The PH-owned HHA maintains the entire clinical record on paper. The non-owned NH also has its own paper chart.

The DBC legal patient record continues to be the paper chart. At the acute care hospital and DBC-owned clinics, electronic data currently are reproduced on paper in the paper chart, but this practice reportedly will be phased out so that there will be less overlap between the paper and electronic charts. At that time, the defined legal patient record will be re-evaluated. With regard to the NHs that were visited at DBC, the EHR has not impacted their paper charting in any way; they still maintain their own paper chart and will continue to do so after the acute care and ambulatory care settings have launched the CIS.

11. Laboratory System

As with pharmacy systems, laboratory reporting and management systems historically have been separate systems sold and maintained by separate vendors. The BP VAMC was the only site of the four visited that had a fully integrated laboratory system. Laboratory personnel at BP saw this as a limitation because if the EHR was down for any reason, the laboratory also was down. However, all sites understand the need for integrated decision support, because, for instance, laboratory test results can affect medication ordering. Because laboratory tests are used to track or follow many PAC/LTC patients, implementation of integrated decision support is important in all healthcare settings, not just acute care. The VA has begun to implement some decision support features as it relates to medication administration. For the present, the selection and use of laboratory computing systems is not a reported differentiator for the other three (non-VA) sites and their extensions to PAC/LTC sites, with the possible exception of NMHS. At NMHS, the EHR generates a paper notification in the laboratory. The laboratory then performs the required tests and enters the results into the EHR. Laboratory results are available from the NMHS EHR, but the laboratory also sends laboratory results either in paper form delivered to physicians' offices or via an electronic inbox in the Logician EHR. One reason for this relative lack of differentiation is the fact that laboratory systems generally use standards such as HL7v2 , which shows the relatively mature status of laboratory systems. Of the three non-VA sites using proprietary, non-integrated laboratory systems, only DBC saw the identity of the vendor, Cerner, as significant. This is because of the planned transition to the Cerner CIS, which will integrate with the Cerner laboratory system that has been in place at DBC for the past few years.

12. Radiology System

In contrast to laboratory systems, the status of radiology systems at each of the four sites is a differentiator. Care providers at BP, including PAC/LTC providers, report uniform appreciation for their access to images through the local PACS. Radiology personnel regret only that the VA has been late to adopt DICOM, a radiology image transmission standard, with the result that they cannot yet share image access with other VA and non-VA care sites in the region.

A radiology reporting system (text analysis and description in the EHR) is in place at NMHS, and a PACS will be purchased in one to two years. One motivation for the latter is to make it possible to view images more promptly and at distant care settings, including PAC/LTC settings. This will substantially reduce costs, because currently a radiologist spends a great deal of time traveling to the image location or waiting for an image to be hand-delivered there. As mentioned before, PACS is implemented in some of the PH regions; it will be fully implemented at all of them by the fall of 2004. The current EHR supports radiology reporting functions, and reports can be viewed at an associated PAC/LTC setting.

A General Electric PACS is fully implemented and used by all physicians in all DBC-owned facilities. Rural sites have access through the DBC portal, DBCdoc. Roll-out of radiology to non-owned clinics will be evaluated after the Cerner CIS implementation. DBC invokes an innovative system called NightHawk for overnight radiology interpretations. This Idaho-based company employs United States-licensed radiologists living in Australia to provide immediate preliminary readings on teleradiology films, which are verified the next morning by DBC radiologists.

13. Master Patient Index (MPI) Solution

All four sites attribute their successful implementation of an EHR system partly to the availability of a smoothly functioning MPI. None can imagine an EHR working without such a feature. All VAMCs use the patient's social security number (SSN) as an MPI unique to each individual. Each VAMC EHR has a full master list of all VA patients; only a complete record for those patients served at that particular VAMC can be retrieved. Only a few standard variables, such as name and death indicator, are provided for all VA patients. Limited, standardized data sets of patient information aggregated to the national level for all VAMCs are available from national data centers, such as the Austin Data Center.

A majority of the population in the NMHS service area are represented in the NMHS MPI with nearly 500,000 patients. An interoperational infrastructure objective is that all applications and systems, including those in PAC/LTC, use the same MPI. Only selected staff at NMHS are allowed to admit patients as these staff are trained to carefully query the system to ensure that patients have no more than one unique identifier.

The PH EHR has an integrated MPI containing patients from three states. The DBC EHR and medical records system use an MPI with about 600,000 patients from three states. For operational and security reasons, DBC utilizes data entry procedures that are similar to those described for NMHS.

14. Patient Access to EHR

No site currently supports routine patient access at any level to its EHR. All sites would like to have over-the-counter medications used by their patients represented in a system medication list. All PAC/LTC sites observed the importance of involving family members and proxies in the PAC/LTC care process. All sites cited concerns regarding HIPAA privacy management as one impediment to the dissemination of patient information beyond caregivers. While plans for patient access to the system EHR differ from site to site, patient access is not currently a site differentiator. As part of its HealtheVet initiative, the VA is beginning to extend patient access to its EHR via the Web.

Using IDX Patient Online®, PH has developed a module called *Patient*Connection®. Using secure e-mail, the patient has access to secure messaging, appointments, registration, payments, referrals, medication management, test results, prescribed content, and disease management. This Internet-based access has only recently been available; it is unclear how many patients currently access PH's *Patient*Connection®. NMHS indicated there are no plans under consideration for patient access at any level. DBC currently provides its patients with an online solution for requesting an appointment at their convenience through its Web site, http://www.billingsclinic.org. Patients provide basic scheduling information and the best time for a DBC Healthline nurse to contact the patient to schedule the appointment based on the criteria the patient identified. Patients can also e-mail an appointment request through this Web site. The IT Medical Director would like to provide patients with an electronic method of communicating with their personal physicians via secure e-mail in the future.

IV. DISCUSSION

The four sites that we visited had the most fully developed interoperable PAC/LTC EHR systems that we were able to locate. These sites all had connectivity with one or more PAC/LTC providers and had made considerable inroads into the development of EHRs that met the unique characteristics of PAC/LTC settings. Each system was developed with strong local leadership, and an organizational and cultural commitment to enhancing quality of care and increasing efficiencies. Extension into PAC/LTC settings generally occurred following acute care and ambulatory care EHR development, reflecting national trends. As forerunners in the field, the systems were deployed before EHR standards were available for terminology and content, which have recently been under development.

The most highly valued function of the EHR to clinicians in PAC/LTC settings was access to prior records from previous providers, including acute hospitals, former PAC/LTC settings, ambulatory care, and pharmacy. Such information was used to evaluate patients for admission from geographically removed settings, which is frequently required in PAC/LTC, and to initiate care, enhancing continuity. Clinicians used information from previous history and physicals, intake notes, transfer medications, medication administration records, allergies, radiology and laboratory results, and progress notes. With real-time access, PAC/LTC providers were not dependent on discharge summaries and orders that can be difficult to read and that may take 24 hours or longer to arrive. Because so many errors occur during transitions across settings, such as medication problems that depend on accurate information, this transition functionality is an extremely high priority in PAC/LTC. All four of the visited sites had this capability, with reported benefits in terms of patient safety, quality of care, and efficiency.

Nonetheless, clinicians with real-time access to prior information repeated some work from these immediately prior stays. To some extent, this is justified. Geriatricians and nurses who treat patients in PAC/LTC require a comprehensive assessment that may not have been conducted elsewhere. Just as we would not expect a cardiologist to consult without conducting her/his own history and physical exam, a geriatrician must assess from her/his own perspective. In addition, some health information is static, whereas other symptoms and physical findings require monitoring to observe important changes. Abnormal laboratory values require repeating to monitor whether a single value may be in error, whether a treatment is working, or if the test had not been completed during an appropriate interval. Normal values that need to be monitored, such as International Normalized Ratio (INR), also require repeating. However, repeating work for liability reasons or financial incentives that encourage repetition of assessments and laboratory testing is potentially problematic and costly. Thus, some consensus among clinicians is important to achieve and build into system alerts in order to optimize the benefits of the EHR with respect to decreasing redundancy.

The comprehensiveness and usefulness of prior records could be enhanced if standardized terminology and content were used in the EHR system. That is, with the exception of diagnoses, laboratory values, and medications in some sites, reviewing previous data resembled reviewing a paper record except that it was easier to read and, in some sites, consistently indexed. Problem lists, allergies, advanced directives, functional assessments, history and physical, and progress notes from the previous stay would benefit from standardization of vocabulary and content. This requires vocabulary standards, like those used in ICD-9-CM for diagnoses, LOINC for laboratory, SNOMED, and those that have been endorsed through CHI that clinicians and others in the private sector support. Use of standardized, machine-readable vocabularies would assure that content is understandable across settings. Use of content standards would assure that the necessary information is included in each part of the record. Such standardization along with messaging standards would allow EHR information to be exchanged outside these systems. Clinicians from all settings would be more likely to accept documentation from other settings if it was clear, comprehensive, unambiguous, and available when needed.

Content and formats of the EHR varied considerably across the visited sites. This occurred in part due to balancing the tension between imposing constraints on providers, particularly physicians, and allowing free text to obtain provider cooperation and minimize training in use of the system. Templates represent a middle-of-the-road attempt to impose some structure, but allow free text within. However, when every clinician can create her/his own templates, then documentation uniformity is not promoted. The information is no longer meaningful to other clinicians who access it, and it cannot be used in decision analyses, alerts, or guidelines. In the longer run, document architecture standards are needed for the format of documents in the EHR, including components of an EHR used in PAC/LTC, in order to facilitate real-time exchange and optimize the electronic functionality of the content.

One observed difference within and across systems and provider settings was clinical content. For example, the health and functional status information collected across providers within and across health systems, while similar in some areas, often was not comparable. This, in part, was due to the absence within a health system of standardized vocabularies and core content that would facilitate the collection and use of comparable health and functional data.

In fact, in 2000, Congress recognized the importance of and need for comparable health and functional data and passed BIPA §545, which requires the HHS to submit to a report to Congress in January 2005 on the development of standard instruments for the assessment of health and functional status of patients for whom an array of Medicare services are provided. This provision requires that in "the development of standard instruments for the assessment of the health and functional status of patients...the Secretary shall design such instruments...such that...elements that are common...may be readily comparable and are statistically compatible [and that] only elements necessary to meet program objectives are collected." ASPE partnered with

CMS on a project to help frame HHS' approach to the BIPA charge. The following lessons emerged from that work:

- a common data dictionary is needed for functional status;
- Federal Government-required assessments should be more clinically useful;
- real-time exchange of comparable data across settings would promote continuity and coordination of care; and
- electronic health information systems are needed.

This provision seems to require that as the Secretary develops instruments that collect health and functional status information, and if this information is common across providers, then the data should be made comparable. The standards endorsed via the CHI process create a method by which some comparability could be realized. When common health and functional data are needed across providers but there is no agreed upon standard, such as is the case for functional status, work is needed to fill gaps.

Lack of integration between the EHR maintained in PAC/LTC and the Federal Government-required data sets (MDS, OASIS, or IRF-PAI) was evident at all sites. The information systems were completely distinct. None of the sites was able to import information from the comprehensive clinical assessments contained in the EHRs completed in the PAC/LTC settings and populate any one of the federally required data sets. In IRFs, clinicians appeared to rely on the functional assessment in the IRF-PAI for their clinical assessment, and attempts were underway at one site to populate the IRF-PAI during the clinical assessment. This may reflect the fact that this instrument was an outgrowth of a clinical data system -- the Functional Independence Measure (FIM) developed and used by clinicians for assessments before it was used administratively. Neither the MDS nor OASIS, however, was part of the EHR and the staff completing them could not import clinical assessment data from the EHR while completing these forms. In the VA NHCU, for example, nurses, therapists, and social workers based their initial assessment and care plan on the MDS, using paper and non-integrated software for transmission to a central repository. However, the MD, GNP, nursing staff, and therapy staff used the EHR for their H&Ps, orders, progress notes, medication administration records, vital signs, etc. Thus, duplication of effort could be reduced and care coordination improved if the content of clinical data and federally mandated data were more comparable, and systems were designed so that EHRs could populate federal data systems.

Physicians or GNPs/PAs wrote orders based on history and physical, problem list, and review of past medical history. Order entry, which is rapidly evolving in both acute and ambulatory settings, was acknowledged as one of the most beneficial aspects of the EHR in PAC/LTC. The challenge with order entry is structuring the order entry process to minimize burden and maximize direct entry of orders by clinicians. At BP where physicians entered orders and at PH where they were testing CPOE on the rehabilitation unit, benefits such as reduction in errors and increased alerts at the time of entry were apparent. However, physicians in some systems such as NMHS were not willing to change the practice of handwritten orders, so scanning and entry by other

clinical staff (pharmacists and nurses) provided a less efficient option. Minimizing the burden placed on physicians was a concern that drove system design in all sites, except in the VA where direct physician use was centrally mandated.

Non-physician staff often were more receptive to using the EHR for directly documenting assessments and progress notes when it was available to them, providing some evidence of potential EHR benefits. Nursing staff, including CNAs, at an NH that was part of NMHS used the system, reportedly improving quality and efficiency of documentation.

Medication list management is one of the essential functions of PAC/LTC providers and has the greatest potential to impact medical errors. This can involve reconciling lists from before a hospital stay, during an acute stay, during PAC/LTC stays, and new discharge medications. With different providers and pharmacies, a clinician and patient can easily become confused about which prescriptions the patient should be taking. Clinicians at some of the visited sites indicated the difficulties they encountered reconciling the medication lists from inpatient and outpatient systems or at time of discharge because they had multiple lists. The single medication list at BP, with both active and inactive medications, overcame many of these problems and was strongly endorsed by clinical staff. However, lack of connectivity with non-VA pharmacies limited inclusion of non-VA prescriptions. Given the high proportion of medical errors that are related to medications, the large number of medications taken by persons in PAC/LTC, and the relatively advanced state of terminology standards for medications, this area is a high priority for development in the PAC/LTC EHR. All sites recognized this and were moving toward a single medication list.

Because medication coverage in Medicare nursing homes is limited by prospective payment rates that do not adequately cover high-cost medications, investment in nursing home medication management systems was substantially less than in hospitals. Thus, cost of medication administration tracking was an important consideration in PAC/LTC, and expensive technology, such as bar coding, was difficult to support. To the extent that Medicare payment system refinements will more adequately cover the costs of medications used in PAC/LTC, technology investments in these settings may occur. Otherwise, low-cost solutions will continue to be emphasized.

Several organizational themes emerged from these case studies that appeared to promote extension of the EHR into PAC/LTC. First is the size of the local health system and community served. The health systems that we visited were generally composed of urban referral medical centers in medium-sized cities, including the surrounding environment and sometimes smaller communities and hospitals where they were the dominant providers. All had outreach into rural areas covering a large geographic area where they often had little to no competition with other systems. This locally controlled environment with sufficient resources to maintain an EHR and database for the majority of lives in the area seemed to result in a sense of ownership on the part of diverse stakeholders. Much of the VA's current EHR success has been attributed to such local autonomy, in contrast to previous attempts at national VA IT strategies. All sites evolved

from the vision of a strong leader to consensus-based and interdisciplinary governance at the local level. One of the greatest challenges that governance at these innovative sites will encounter is adapting their system as new messaging, terminology, and content standards become accepted.

Another hallmark of the visited sites is that they owned most of the provider sites and employed most of the physicians in their system. To varying degrees, sites were branching into relationships with affiliated providers after developing a large base of owned sites and staff providers. Despite the robust VA record, users were almost exclusively VA employees. Contracting with providers who are not employed by the VA is complicated by the difficulties inherent in mandating the VA user requirements that employees must accept. However, if providers want to treat VA patients, then they will need to follow the system requirements. Although the VA system is seen as comprehensive, providers frequently raised concerns about services that were received elsewhere and covered by Medicare. The success of the VA in establishing affiliations with non-VA providers who access the EHR remains to be seen. The VistA/CPRS system is constantly undergoing revision; not only are "patches" used to fix minor problems and add new features, but there have been major innovations and changes (e.g., addition of the GUI). There are also significant changes in process.

The other visited sites were all pursuing strategies to share their EHR with affiliated providers. Such affiliations are particularly critical in PAC/LTC, where so few of the providers are owned by the system, except for the small number that are hospital-based. However, the majority of NHs and HHAs are freestanding and geographically removed from hospitals. DBC is actively expanding the physician access that it currently provides to non-DBC physicians. NMHS has extended into a nursing home and physicians' clinic plus other community providers, whereas PH offers access to its system and technology support for a fee. Issues of extending into non-owned settings appear to include technology, legal arrangements, business strategies, and standards. Affiliation arrangements require further examination if EHR models are going to be developed that are applicable more broadly to systems where providers are not all owned and clinicians are not all employees.

FREQUENTLY USED ACRONYMS AND OTHER TERMS

ACHE	Admission Clearinghouse Enterprise
ADL	activities of daily living
ADS	automated discharge summary
AHRQ	Agency for Healthcare Research and Quality
ASP	application service provider
ASPE	Office of the Assistant Secretary for Planning and Evaluation, U.S. Department of Health and Human Services
BP	Bay Pines
CAC	Clinical Application Coordinator (Bay Pines VAMC)
CEO	Chief Executive Officer
CHR	Community Health record (PeaceHealth)
CIO	Chief Information Officer
CIS	Clinical Information System (Cerner's EHR system to be used at DBC)
CNA	Certified Nurses Assistant
CPOE	computer-based provider order entry
CPRS	computer-based patient record system
DBC	Deaconess Billings Clinic
DON	Director of Nursing
EBM	evidenced-based medicine
EHR	electronic health record
FDB	First DataBank
FFS	fee-for-service
FIM	Functional Independence Measure
GEM	Geriatrics Evaluation and Measurement Unit
GNP	Geriatric Nurse Practitioner
GUI	graphical user interface
H&P	history and physical
HBPC	hospital-based primary care
HHA	home health agency
HHRG	home health resource group
HID	Health Improvement Division (PeaceHealth)
HIPAA	Health Insurance Portability and Accountability Act
HL7	Health Level 7
HMO	healthcare management organization

HP	Hewlett-Packard
ICU	intensive care unit
IRF-PAI	Inpatient Rehabilitation Facility-Patient Assessment Instrument
IT	information technology
LOINC	Logical Observation Identifiers Names and Codes
LTC	long-term care
MAR	medication administration record
MD	Doctor of Medicine
MDS	Minimum Data Set
MIS	Medical Information System (North Mississippi Health Services)
MPI	master patient index
NDC	National Drug Code
NH	nursing home
NHCU	nursing home care unit
NHII	National Health Information Infrastructure
NMHS	North Mississippi Health Services
NMMC	North Mississippi Medical Center
OASIS	Outcome and Assessment Information Set
PA	physician assistant
PAC	post-acute care
PACS	picture archiving and communication system
PH	PeaceHealth
PPO	preferred provider organization
PPS	prospective payment system
RAP	Resident Assessment Protocol
RN	registered nurse
SNF	skilled nursing facility
SNOMED	Systemized Nomenclature of Medicine
TCU	transitional care unit
VA	Veterans Administration
VAMC	Veterans Affairs Medical Center
VISN	Veterans Integrated Service Networks
VistA	Veterans health information system and technology Architecture
WBT	Web-based training

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