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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APPENDIX A: BAY PINES VETERANS AFFAIRS MEDICAL CENTER

A. Health System Overview

The Bay Pines Veterans Affairs Medical Center (VAMC) is one of 165 centers owned and operated by the Department of Veterans Affairs. On their campus of more than 300 acres, they have an acute care hospital with an integrated rehabilitation facility and emergency department, pharmacy, laboratory, radiology services, and outpatient physician offices. The geriatrics and extended care service oversees a geriatric evaluation and management unit, transitional care unit, a nursing home care unit (divided into two units), a senior clinic, home-based primary care, contract home health programs, and a hospice. They also have affiliated physician clinics at other geographic locations and contractual relationships with non-VA community nursing homes. A pilot program at Bay Pines consists of the community care coordination service, which provides remote monitoring for home patients.

Veteran Health Information System and Technology Architecture (VistA)/Computerized Patient Record System (CPRS) fully extends into all VA-owned and operated provider sites. They are just beginning to establish EHR linkages with contracted clinics that are not part of the VA system (e.g., audiology, ophthalmology, and radiology where required). In these situations, the VA will provide the equipment and the user has to comply with VA rules. They also are developing pharmacy linkages with state veterans homes. With the expanding number of primary care visits in the region (more than 80,000 patients in 2003), there is increased pressure to strengthen EHR linkages with clinics not on the Bay Pines campus.

Each VAMC, such as Bay Pines, is part of the larger national system for processing and transmission of the data to a central repository in Austin, Texas. There are other, more specialized processing centers where data are submitted and analyses are conducted and sent back to the VAMCs. The national user groups, for both development and troubleshooting the VistA/CPRS, provide patches that are implemented locally but each VAMC has considerable flexibility in customizing VistA/CPRS at each health setting within specific operational parameters. Central mandates are responsible for certain key aspects of implementation. For example, physicians are mandated to do their own entry of orders and notes, despite resistance at some sites. Medication bar coding is another area in which processes are mandated, even when there is staff resistance.

B. Clinical Functions

1. Structure/Content of EHR Used Across Settings

The VAMC EHR used at BP and all other affiliated Bay Pines facilities is a uniform record that can be accessed from any setting on the campus. Every patient record in the EHR can be accessed by name, hospital ward, clinic, physician, or service, simplifying locating the record. The clinical record includes the following tabs: cover sheet, problem list, medication list, orders, notes, consults, discharge summary, labs, reports, and vital signs. Each of these tabs then can be opened to view the designated aspect of the record. Postings are accessible in the upper right-hand corner of the screen, including crisis notes "C," warning notes "W," allergies "A," and advanced directives "D." The cover sheet is a distillation of information including a summary of the active problems, allergies, specific postings, clinical reminders, active medications, labs, vitals, and appointments. The problem list includes active and inactive problems entered by any provider, and an ICD-9 code is assigned; however, there is considerable question about the consistency of coding in the problem list, and the list is not edited in a systematic fashion. A single medication list is maintained that includes active and inactive medications. Entries into this list follow a structured format. Consults use structured templates typically designed by the consulting service, and lab orders, reports, and vital signs also are structured. Vital signs include blood pressure, pulse, respiratory rate, pain, and weight gain. These can all be graphed for viewing.

Local or individual templates are used for orders, notes, and discharge summary. On some services, the template is highly structured, providing a guideline for care, whereas in others, it is a broad outline of topics into which free text is typed. Variation exists in the use of templates such that some clinicians invest substantial time in developing templates to import objects from other portions of the record and other clinicians start fresh each time they type in a note. Clinicians that used more structured templates, by importing information from multiple locations, were often more enthusiastic about the system and the time saved.

Regardless of setting, clinicians were enthusiastic about the ability to access records from prior stays both at the VAMC in Bay Pines and other VA centers. Although it was sometimes difficult to access all aspects of the EHR from another setting, local information was readily available and most information from other settings also tended to be available. Thus, information necessary for transitions across settings (such as hospital to nursing home or home health care, or rehospitalization from inpatient rehabilitation unit) benefited from complete information transfer. The only problems occurred in relation to information about patients from providers who were not part of the VA. Because veterans also used Medicare services and/or purchased medications from other pharmacies, lack of extension outside the VA represented a problem for some patients. In particular, entering non-VA data was a workload problem and medication data were incomplete at times, even when other non-VA settings had electronic systems.

The EHR became the communication vehicle for clinicians and all ancillary services. Physicians, for example, would spend substantial portions of their day at the terminal entering assessment and order information, and reviewing the numerous messages/action items received from nursing staff, laboratories, pharmacies, radiology, and consults. Physicians and other clinicians also dictate a significant amount of information (annual dictation costs exceeded $400,000 in 2003) that is then given to a third party firm for transcribing. Transcribed information is then electronically downloaded into CPRS. The action items indicated when new findings were available to view or when a response was needed. Physicians needed to become facile in the use of the computer. Some were experimenting with word recognition software to expedite information input. A concern among some physicians was that they were spending more time at the computer and less time with patients. Others were favorably impressed by the system because of both instant communication and fewer problems interpreting handwriting. One major gap in the use of the EHR was noted as being recognized and was being addressed at the highest levels: during computer downtime (scheduled or unscheduled), staff in the Emergency Room or a clinic do not have access to the EHR. The current downtime contingency system stored pertinent clinical and administrative data on those veterans in an inpatient status or those with a scheduled appointment. This system did not account for emergencies or "walk-ins." A proposed "fix" is to move data for veterans seen within the previous 25 months to a secondary database to serve areas such as the ER and clinics.

2. Nursing Homes

Sites. Nursing home care units include the following:

1. Two Nursing Home Care Units (NHCU) have a bed capacity of 206. Previously there were more beds available, but now they have a geriatric clinic there as well as the home health programs. These units treat very complex and relatively short-stay patients as well as some longer-term patients that have been residing there for multiple years. In one unit, there is a heavy emphasis on wound care and the most seriously ill patients, and on the other unit there is respite care, oncology, and a mix of clinical problems.

2. The Geriatric Evaluation and Management (GEM) unit is an eight-bed unit that is used for triage. A majority (approximately 75%) of the patients are admitted from the hospital, and the remaining caseload is admitted from the community or nursing homes. GEM patients require complete evaluations and longer stays than those in the NHCU.

3. The Transitional Care Unit (TCU), which has 22 beds, admits patients from the VAMC. All post-acute nursing home patients with IV orders are assigned to this unit (the IV support team is located in the TCU), and all requiring intense pulmonary care are seen in TCU.

Each nursing home unit has a network connection to the EHR with read/write access. Laptops are used at the point of care, and terminals are located in hallways and nursing stations.

Geriatrics and extended care service are completely separate. There are three physician FTEs, and they are recruiting a fourth physician. All admissions to the extended care service begin with a screening, which is ordered as a consult in acute care, ambulatory care, inpatient rehab, home care, etc. They review the discharge summary, evaluate the patient, and determine what is the most appropriate extended care location. Both the physician and nurse are involved.

Admission. The referring hospital is asked to complete the discharge summary and a paper transfer form also is sent, including medication list, diagnosis, and both nursing and social work updates. Physician orders come first in the nursing home admission process. These orders activate the admission, alerting the Nurse Practitioner who then completes the H&P subsequent to the physician orders and develops a more complete plan of care. The physician admission process cannot begin until a clerk assures that the discharge occurs from the prior setting and another clerk assures that the admission to the NHCU has occurred.

Even though patient information can be accessed from another setting or from a prior admission to the same setting, the clinicians always conduct a reassessment for a new admission. The reasons are that geriatrics and extended care have a different perspective on the H&P than prior information may contain, and they need to become familiar with any patients that they will be treating.

Orders. Physicians enter orders into the system using standard order set (or non-order set) options, which involve admission templates regarding advanced directive status, social work, medication, and consultation (e.g., dietary, PT, and OT). The system reportedly takes twice as long to write the physician orders than when orders were written by hand. Urgent medication orders take approximately 25 minutes to be filled when called to the pharmacy; otherwise, the electronic pharmacy order process takes several hours to be completed. Bay Pines radiology results are obtained through electronically transmitted imagery and actual images as well as by text reports. Elevated lab results are called to the physician, in addition to the electronic message.

A problem for physicians is separating important messages from less important messages. Every day, approximately 200 action items can be sent to a geriatrician for review and sign off. The items are not clearly prioritized so that at times a nurse on the unit will leave the physician a message that a patient's temperature is elevated and the physician will not see the message until the end of the day, when it is more difficult to work up the problem. These situations can be handled by phone and not electronically, but the electronic system sometimes provides a false sense of security.

Narrative. Physician/NP notes used templates with free text. The Nurse Practitioner H&P can import objects from the physician orders such as problem list,

medications, advance directives, labs, and other orders. Nursing progress notes are entered in the EHR using free text.

Clinical Decision-Making. The drug interaction flags and other alerts upon entry are valuable but potentially too simplistic. If a patient is on one painkiller like Percocet, a flag will appear if a second painkiller like acetaminophen or Tylenol is added. Flags can be dispensed with easily by typing anything in the response field, so they are not overly burdensome.

MDS Integration. The MDS is completed in a completely different system called AccuMax. Only nurses utilize the AccuMax. The assessments are conducted by the nursing staff, social workers, and therapists. These are followed by a team conference involving this group to determine what should go into the MDS and also to choose the RAPs. The nurse goes through and manually pulls information from both the physician admission note and the H&P conducted by the Nurse Practitioner that is the basis for the treatment plan. Everyone at the care conference signs the care plan based on the RAP sheets. Data are manually documented and entered into the EHR by a nurse. The MDS is used in the Nursing Home Care Units, Transitional Care Units, and Geriatric Evaluation and Management Unit. The MDS is submitted to Austin and used for MDS QIs and to determine FTE allocation to each NH. Nursing MDS care plans and weekly ADL sheets are on paper.

Access. All staff can read all EHR data (e.g., admission information, prior admission information, ED information, physician narrative and orders, nursing narrative and care plan, therapy narrative and care plan, lab results, and radiology results). However, only MDs and GNPs can write orders.

3. Home Health

Sites. Bay Pines has three home healthcare programs.

1. Home-Based Primary Care (HBPC) has an 11-member multidisciplinary team including GNPs who conduct patient visits, nurses, dietary, therapists, social workers, and MD care if needed. All VA patients qualify for admission to the program, which provides short- and long-term care (after which the patients are turned over to primary care). Nurse practitioners provide oversight within a 50-mile radius and visit at least monthly. Dietary and therapy are available as consultants. HBPC created its own criteria for assessment, but will begin using the MDS data for home care. Nurse managers integrate records electronically with physicians. RNs visit at least every two to three weeks; the NP, at least monthly.

2. The Homemaker program is designed to divert patients from community nursing homes. This program includes almost 90 patients with more than 70% having a service-connected disability. To continue care, the agency needs to recertify the care plan and fax both referrals and recertifications. Referral and recertification

assessments (every six months) are conducted by the home health manager, who is a nurse. A community agency is contracted for personal care services (e.g., daily activities, plan of care, and supervisory visit responsibility of the agency). They typically visit two to three times per week. The agency sends a visit log, which is tracked in the EHR. The plan of care is not in the EHR.

3. The fee-for-service home program includes home IVs. It is a contracted service that is covered by Medicare. This program provides care to patients outside the 50-mile radius or provides services different than the other Bay Pines home care programs.

Admission. If a person was previously in the system, her/his information is brought up from eligibility data. Reasons for admission to agency, medications, allergies, advanced directives, etc., can be brought up on the EHR, but are always confirmed by the agency. This information is reviewed on the EHR to initiate admission. A team meeting takes place in which verbal communication is conducted for each patient. Paper referral documents also are provided for the actual referral. Beyond that, everything is electronic.

Orders. For HBPC, the nurse practitioner conducts the initial visit and does a history and physical. S/he writes or dictates the H&P and orders, both of which are co-signed by the physician. Prior to co-signing by physicians, the orders are not active. Immediately after the orders are entered, a message is sent to the physician indicating that the orders need to be reviewed and co-signed. Orders that are not yet co-signed cannot be viewed by the staff. Orders are electronically entered by the nurse practitioner for HBPC.

For contract home care under fee-for-service, the orders are not entered directly by the agency. Instead, they are faxed to the coordinator who reviews them and the H&P. S/he enters the orders and a summary into the system, either directly or using dictation. Assessment information and orders are obtained from other sources if possible. For the fee-for-service program, there is no access to notes from outside agencies, and all information is entered by the coordinator, who communicates with the agency by fax.

Narrative. With regard to clinical documentation in HBPC, a provider spends four to five hours providing care and then comes back to the office and enters notes for about four hours. NPs might type or dictate notes. In addition to the structured fields described in the uniform record, templates are used for the following: initial nursing assessment (H&P), care plan, and treatment. Under treatment, there are templates for neurological, mobility/falls, safety, respiratory, mental status, cardiac, diabetes, dysphasia, skin, and other conditions. Templates are locally (and sometimes individually) developed. Some templates are just broad outlines into which text is added. The team does the treatment plan. Vital signs can be plotted.

Nurses and social workers also see veterans in contract NHs, every 30 days and 60 days respectively. Their notes are entered into CPRS and orders written by community physicians (except pharmacy) are completed by BP clerical staff.

OASIS Integration. The OASIS data set is not required within the VA system. However, the MDS-HH data set will be incorporated into the system in the near future.

Access. Most home health staff have read-only access to the patient EHR information, although some also have write access. The MD, GNP, and acute care hospital staff have full access.

4. Rehabilitation Facility

Sites. The 154-bed inpatient rehabilitation facility unit at Bay Pines is fully integrated with the acute care hospital.

Admission. One of the rehabilitation medicine physicians conducts all admissions to the unit. S/he uses a template for the admission, which covers diagnoses, allergies, vitals schedule, medications, advanced directives, consults, and laboratory orders. The history and physical is completed from scratch using a template designed for physical medicine and rehabilitation, or dictation is used. Nursing staff and therapists are notified of the admission electronically and receive the physician's admission note.

Orders. During admission and throughout, the physician writes orders electronically for medication, supplies, laboratory, therapy, consults, x-rays, or any service as needed. Urgent medication orders can be verbally communicated for rapid receipt of medication, but the electronic medication ordering generally provides the medicine to the rehab unit within an hour. Procedures for ordering, notifying of orders, notifying that a blood draw is required, and documenting results are all electronic for laboratory data. Abnormal values, however, are communicated verbally.

Narrative. Progress notes are provided by individual disciplines and also weekly by the interdisciplinary team. The MD is the secretary for the interdisciplinary team and uses a template for the team's assessment and notes. Physical medicine rehabilitation has been working (with some difficulty) on how to structure this template. They can import information from other notes, but the note is largely free text. All members of the team co-sign the note. Notes are largely free text within broadly structured templates.

Clinical Decision Making. Medication orders for drug interactions and dosing are provided as part of the medication ordering procedure. These issues are checked further by the pharmacy. Allergies and warnings are included in the warning tabs and serve as flags. They have a specific inpatient rehab template relating to prevalent conditions such as stroke, hip fracture, and amputation care.

Functional Independence Measure (FIM) Integration. Although the VAMC is not required to use the IRF-PAI for payment, it does use the functional scales from the FIM

that are maintained by the Uniform Data System (UDS). A separate FIM coordinator from the therapy department maintains these measurements which are submitted to UDS. Also, the change of scores are calculated for individuals to track functional changes.

Transition. Transfer of veterans from the hospital to IRF requires a complete change in focus from acute care to rehabilitation. As a result, the EHR orders need to be completely changed with different activities and diet, for example. Sometimes this leads to confusion because hospital discharge summaries are out of date at the time of rehabilitation admission and when an individual is discharged from rehabilitation. The rehabilitation discharge summary to home care or HBPC is electronic, but a hard copy is used when the discharge goes outside the VA.

Benefits. Physical medicine and rehabilitation physicians suggest that the EHR has resulted in decreased lengths of stay. This has resulted from direct access to labs and radiology results, which expedites those activities. They have also benefited from prior hospital information that has improved screening and the ability to initiate care. Physicians indicated that they are spending more time on the computer and less time with patients.

5. Pharmacy

Bay Pines pharmacy has interconnectivity across all sites, and a single medication list including active and inactive medications; they use bar coding to identify and track drugs. The process for filling a prescription is mainly electronic, including transmission of the prescription, checking allergies, checking for drug-drug and drug-food interactions, clarifying the order with the prescribing physician (if indicated), labeling the drug container, recording controlled substance distribution, delivering to unit notification, and tracking drug orders. For ambulatory care prescriptions at Bay Pines and pharmacies at other VA clinics, the process is also electronic, yielding ambulatory prescription labels and an educational sheet for the patient with side effects, interactions, etc. The only step in the process that is not electronic is the manual preparation of the order. BP has been testing automated technology for storage and dispensing using robotics that sort packaged medications and maintain their inventory. CPRS does not have an effective electronic system for ordering nutritional supports (e.g., parenteral nutrition). These orders are still paper.

Interconnectivity permits the pharmacy staff to provide increased support to clinicians and enhanced communications across the health system, including PAC/LTC. These benefits are possible because pharmacy staff spend less time at the computer and less time trying to locate and decipher orders. For example, prescriptions are clearer so there is less need for pharmacy staff to call physicians regarding medication orders.

The medication bar code, patient wristband, and the provider bar are used code to uniquely identify each administration of a medication in the hospital and nursing home

settings. Medications are provided in unit doses by patient and stored in a cart that includes a wireless laptop with a bar code reader to be used for administration. For each dosage, the electronic medication administration record is used and the codes read for the medication, the patient, and the person administering it. Any conflicts between medication or dosage and patient are noted electronically, and the medication administration is ceased until resolved. Missed doses and refusals are recorded electronically in the electronic record, and all documentation of administration is electronic. Controlled substances also are signed out electronically.

Although time-consuming (some staff claim that it more than doubles the time needed to administer medications), this system reduces errors in medication administration. Quality monitoring in the VA has noted a great reduction in actual errors and near misses. Efficiency could be improved, according to staff, if the bar code reader could more consistently read doses and particularly tubes of topical agents. Sometimes several attempts are necessary with the current technology. Current tests by robotic systems are being conducted to eliminate incorrect medication administration as a result of damaged bar codes.

The care provider enters the initial medication orders, providing the first line of checks relating to dosing, diagnosis, contraindications, and interactions. The clinician has the opportunity to override these checks, which surface again in the pharmacy, but with the clinician's notes when a check has been overridden. Relevant lab results are accessed (e.g., creatinine, potassium) when ordering medications. Physicians are discouraged from creating complex orders for only administering a drug under certain situations or holding a drug under certain situations. Rather, a crisis note is preferred that is triggered when a certain sign or symptom occurs and then the decision can be made to stop the drug or initiate the drug as appropriate. Any drug change is instantaneously reported on the system. However, it is indicated as pending for one or two hours until pharmacy picks up the result and conducts a review. Communication with physicians can occur largely electronically. Generally, clinicians find the medication function one of the most beneficial aspects of the EHR.

C. Organization, Culture, and Impact

1. Business Plan

Business Agreements/Community Extensions. The VA does not extend its VistA/CPRS into non-VA facilities except under rare circumstances. For example, even though a business relationship exists with community nursing homes (where the VA pays for veterans), CPRS does not extend into any of these facilities. However, CPRS has been extended into a physicians' radiology group, because this group provides a critical service that cannot be provided at Bay Pines. One of the seven VA Community Based Outpatient Clinics (CBOC) is a privately-owned clinic that also uses CPRS via a direct connection to the Medical Center's Local Area Network.

Business Goals. Eliminating paper both in day-to-day operations and as a patient record is a primary goal at the VA. All clinical and administrative staff must use CPRS in real time and do most, if not all, of their own data entry. Although there is a substantial amount of dictation that is given to a third-party vendor for transcribing, this information is electronically downloaded into CPRS at a later time. Widespread access (at a read-only level) to CPRS by all employees is common. The patient record is not health setting- or episode-oriented, but rather it is a current record containing historical information. A Windows graphical user interface (GUI) with ease of multiple screen viewing and functions such as cut and paste is a high priority. Overall system speed is less than sub-second at times with wait times for some items quite long (tens of seconds) and others a few seconds. While important, achieving sub-second response time is a lower priority. Security of the patient record is a high priority. All patients and non-VA staff must go to the Document Release Office to get any part of a patient record.

Culture. The VA typically uses top-down mandated deployment of internally developed systems. VistA/CPRS is a national EHR application that was mandated for all VAMCs. However, it allows for local innovation and has been in place in some form for about 10 years. Systems are typically piloted (alpha and beta tests) at one or a few VAMCs to test for problems and then deployed to all locations once the system achieves an acceptable functional level. With CPRS, a variety of problems are known, but implementation has gone forward. As problems are identified, they are prioritized and addressed. Local staff can build in extensions to an application and, if successful, request a change to the Class-One code of the application. Local VAs do not have the discretion to change code; this is the responsibility of the development staff only. There is both a local organization and a national counterpart called the Clinical Application Coordinator (CAC) group that is responsible for local and national changes, maintenance, and training for CPRS. CACs assist clinical staff in both using the CPRS and also help clinical staff develop and implement modifications (templates) that facilitate the utilization and customization of the CPRS in various health settings. Budgeting is done by looking at the number of patients treated two years previously. Also, payment is by number rather than specific costs so each VAMC receives essentially a lump sum to run the facility. For a rapidly growing operation, the two-year lag can create some budgetary problems as expenses for the entire facility are underestimated as a whole.

Drivers/Vision. Kenneth Kaiser was the initial driving force at a national leadership level for implementing CPRS. Linda Reed, nurse in charge of the CACs, and John Williams, IT manager, provided significant leadership at the Bay Pines facility to move the mandated 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.

Vendors. There were no commercial systems (either hardware or software) that could meet the needs of the VA. Vendors were used at Bay Pines to help evaluate initial hardware and maintenance needs for budgeting, design, and implementation.

Payors. Billing of non-service related treatment is done by paper, but it is made possible by the CPRS system because information can be tabulated and sent to payors in a timely way. Billing for non-service related treatment given to patients but paid for by Medicare or other payors had gone from essentially zero to millions of dollars per year.

Planning. Selected health settings were implemented one or two at a time. There were two criteria for selecting the first settings: ease of implementation and potential for success. Some groups were more open to the idea, and some operations (workflow) were more conducive to the process. Nursing homes and outpatient clinics were implemented first. Acute care, especially surgery and ICU, were implemented last.

2. Organization Structure

Business Units. 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 is present in every VAMC and is mandated at a national level. There is also a national CAC group with various interfaces such as national conferences. Both at the national level and local level, the CAC groups are essentially IT support groups with clinical training that are responsible for CPRS upgrades, maintenance, and user training. The CAC group is critical to the successful operation of the CPRS.

Healthcare Setting Implementation. Once there was a national mandate to implement, a local steering committee developed an implementation and training plan. As mentioned earlier, the two criteria for determining the order of implementation for different healthcare settings or groups 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 implemented last. Some areas such as the emergency department are not fully integrated in real time, although all information eventually is entered into the CPRS.

Enhancement Implementation. The CPRS is in a constant state of innovation and enhancement. Until just a few years ago (1997), CPRS had no GUI and was accessed (and still can be) through a mainframe command line type interface. The GUI was put on top of the mainframe system. For those staff experienced in the original system, some tasks can be completed faster if the old interface is used. Recent enhancements included automation using bar coding for medication management and dispensing, and use of Picture and Archiving System (PACS) in radiology. Bar coding of medication (staff and patients as well) has been in the implementation process during the last several years. These implementation efforts are generally under a central mandated process in which one or more facilities are used to develop/pilot a particular process under the direction of national VA policy.

Resource Allocation. The Bay Pines VAMC receives a lump sum of money based on the number of patients that is lagged by two years. Different business units (such as

IT) then create budgets and lobby upper management for various programs or operations. Funding sources for IT are from two sources; the first is from a medical center equipment fund and the other is the overall funding source for all departments. In each case, IT is in competition for funds with all other departments. Unlike in the private sector where there is a pre-ordained percentage given based on the total, IT must justify its needs against other important priorities. There is competition for funds between health settings to some extent, but the CAC group appears to support each health setting for individual needs. In addition, the IT group that supplies terminals is mandated to provide the patient record throughout the system. Because each setting must use CPRS and no paper record exists, allocation of resources is fairly even throughout the VAMC for basic access. Allocation for major innovations, such as the bar coding of medications and the development of a PACS in radiology, are mandated generally from a national level.

3. Staffing/Training

Staffing Levels. Levels of clinical staff such as nurses and physicians changed very little, if at all. The shift of data entry from administrative staff to clinical staff has reduced the number of staff in administration that were transcribing dictation. The number of staff working in medical records (paper) decreased (35 to 16), while the number in information release increased (partially due to HIPAA). As pharmacy operations have been automated and brought into the CPRS, the number of pharmacy staff has increased. There was an increase in IT staff, both VA and contract, to maintain hardware systems. The number of CACs increased with the CPRS implementation.

Staffing Skills. The CAC group was critical not only for the initial implementation of the CPRS but also in ongoing maintenance, CPRS enhancements, and training. The CAC group is trained both in clinical skills and in IT. The CAC group interfaces between IT and clinical users to make sure users become proficient with CPRS and to help with innovation, either by developing system enhancements or helping clinical staff to develop enhancements (templates). The role the CAC group plays is essential for the successful operation of the CPRS. Clinical staff also needed to develop new skills to integrate the CPRS with clinical care. Data entry skills and integrating the terminal into patient interaction, as well as skills using the CPRS for team processes, needed to be developed. Pharmacy staff needed to have more skill sets relative to IT to deal with bar coding and medication handling that uses automated equipment and processes.

Training. Training was a major issue when CPRS was first implemented, and continues to be an issue. The CAC group is responsible for most training (other than a new employee orientation session lasting a couple of days that also covers other topics, including HIPAA). Training and support of clinical staff are ongoing processes. Various methods have been tried, including manuals, luncheons, personal tutoring, etc. No "right" method appears to have emerged. In addition to the initial employee orientation, clinical staff go through a tutoring period (one to four weeks) in which they have an experienced CAC or clinical person closely monitoring their input. After that, CACs are available for questions. The CAC group also has ongoing training, including national

conferences and a national user support group. With patches and innovation occurring on a routine basis, there appears to be a need for continued training.

4. Communication

Channels. With the implementation of CPRS, communication channels changed in a number of ways. While traditional communications methods are still used widely (telephone, fax, e-mail, two internal systems, VistA and external, Outlook, paper, and face to face), CPRS creates a one-source location for large amounts of patient information that is available anytime from multiple locations. Clinicians often will start with the terminal to begin learning about a patient or to prepare for a team meeting rather than talking to a patient or other staff. Patients used to carry around part of their paper records; this is no longer done. Instead of routing a piece of paper to various staff to create a home healthcare plan, the process is now done simultaneously online. No specific examples of urgent communications were observed, indicating that CPRS is probably used mostly for routine communication rather than urgent communication.

Frequency. With most providers having simultaneous read access to all patients within each VAMC, frequency of accessing patient records has increased. A name list of all patients in all VAMCs, alive and deceased, is provided as a starting point when accessing CPRS; however, only limited header information is available for all patients. Terminals are readily available within the facility, and CPRS is a one-stop location for much of the patient record. Clinical staff indicated accessing a patient's record is more frequent for a variety of tasks because of ease of access and complete information from one source.

Nature. The nature of communication is for reference, verification, or historical. There are some team interaction processes (e.g., patient screening for admission to inpatient rehab and in home health for creating a team care plan). However, CPRS is not built for team interaction and does not contain many communication functions. It mostly functions as a reference and storage tool, although there are alerts and a number of actions that can be initiated (from orders to medication). Decision support systems, care plans, and even alerts are minimally functional and generally outside of CPRS.

Real-time. Real-time, simultaneous access to a patient's record was mentioned often as one of the best features of the CPRS. Not having to hunt down a chart, having full access to a patient's record, and knowing that the CPRS contains the most recent information were all major advantages that improved both efficiency and quality of care. Having to enter information in real time had mixed reviews. Some indicated that it improved care, while others indicated that it interfered with patient care and disrupted the care process.

Alerts. Alerts were very much a part of the CPRS; however, the control and prioritization of alerts and also decision support appeared to not have been well developed. There appeared to be too many alerts, causing at least some of the clinical

staff to be "over-alerted" with unimportant messages and leading them to turn off the alerts. A physician may get hundreds of alerts in one day. Coupled with two e-mail systems, this "clinical spam" makes it difficult for staff to use alerts effectively. Staff reacted differently; some tried to cope with the overload of non-prioritized information while others simply ignored some or all of the electronic alerts. There did not appear to be urgent electronic alerts, either within CPRS or through some other mechanism (such as pagers or fax), but this issue was not fully explored.

Quality. Quality of communication is much better for several reasons. With handwritten paper essentially not present, problems with legible handwriting are eliminated. Also, there are a number of controls within the patient record that automate contents such as medication lists. Login authorizations limit those who can augment the patient record or create orders. With team review of records, mistakes are caught more easily. On the other hand, templates and especially boilerplates (pre-filled-in information) can result in information that is incorrect if not properly updated or customized.

Content. With cut-and-paste capability as well as auto-generated text such as medication lists, the patient record tends to have a lot of unstructured text that reflects the style of individual clinicians. Several staff indicated that patient records are much longer with more information. CPRS appears to have increased the size of the record (in areas of unstructured text such as progress notes) because of the ease in creating text.

5. Workflow/Process Changes Due to EHR Adoption

Management Functions. Many paper processes have been eliminated. For example, sticky notes had been used extensively in acute care but now are no longer used. A major change in workflow is that staff no longer have to search for a physical record, but rather they have round-the-clock, simultaneous access to the CPRS. Clinicians now spend time with CPRS that results in better preparation for various activities, such as patient interaction or staff meetings. Simultaneous access creates workflow that is more integrated, in that there are real-time peer interview and checking processes. Home health indicated control of supplies for home care is more coordinated so that when the nurse visits the patient it is much less likely that there will be missing items to provide the needed care. Because patients are transferred rather than admitted to rehab, there are restrictions in how the CPRS can be updated that can cause some inaccuracies or delays. This is not fully understood. Also, because the CPRS has checks and balances, there are instances in which patient care moves faster than administrative record keeping. For example, a patient may be transferred physically to a new health setting but have no electronic transfer so there is no record-to-record care. Generally, when the CPRS is down or lags for some reason, care is recorded on paper and later input into CPRS.

Patient Interaction. Clinical staff mentioned that CPRS adds a terminal to the 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 in that the care provider would work with the terminal while the patient waited. Also, integrating computer skills into patient interaction requires additional skills that all care providers may not have. Login/log off procedures are too cumbersome in fast-moving environments, such as acute care. Rapid logon and mobile dictation equipment are two options being explored to mitigate this problem. In the past, patients would carry part or perhaps all of their paper records with them, but this is no longer allowed. While most patients do not ask, about 10% do request a copy of all or part of their health record after a visit. To get a copy, the patient now must go to a central source rather than get it from the care provider.

Staff Interaction. Team care processes have improved in that simultaneous, real-time access lets team members be better prepared and also allows for team processes that were not possible before CPRS. Staff are better prepared for meetings because they are able to review a comprehensive, legible, up-to-date record. Clinical staff spend more time at the terminal and less time walking around looking for information. While this is more efficient, there also is some loss of personal interaction with patients, other staff, and the facility itself. This reduction in face-to-face or other ways of communication, coupled with an alert system that is not sufficiently prioritized, may result in "the ball being dropped" (e.g., "Didn't you get my e-mail/alert?") There is better evaluation for care planning and next steps for care because of "virtual meetings." An example of this is in home health in which the process used to be the routing of a paper form to various team members, each adding her/his input. With CPRS, this form is completed electronically in a much shorter time and, even more importantly, each team member can see what others have contributed which may show the need for additional modifications. The old paper process sometimes had to be completely duplicated as various team members' input was evaluated.

Care Implementation. CPRS coupled with bar coding of medications has changed how medications are dispersed and also reduced medication errors. Drug interaction alerts are an integral part of the CPRS. Some staff indicated that the time to dispense mediations has increased. There appears to be a number of problems such as scanners not being able to read bar codes, but these issues are being resolved with new technology or process changes. Care planning, both in the NHCU and home health, has changed with CPRS because there is more complete, legible, and up-to-date information. Care planning processes are still independent from the CPRS to a large degree. Customized templates direct processes, making patient care more uniformly implemented. Because the templates are localized innovations, they benefit only the local VAMC; however, these local innovations can be brought back to the national level for evaluation and implementation, if warranted. Using boilerplate templates also can cause care to be to generalized for a special needs patient, driving care down a path that may not be as appropriate.

Tracking. CPRS has made it possible to track non-service related patient care in a timely manner, and to bill an outside payor for these services (which could not be done in the past). A comprehensive patient record allows for complete history review by

clinicians as well as the ability to historically track various items, such as a patient's vitals. Medication tracking using bar coding helps track proper dispensing as well as mediation errors. A national electronic patient record of "core" standardized information is available from national data centers such as Austin, but not through CPRS locally. Because of this, national studies for a variety of areas can and are done and then sent back to VAMCs to review for potential action.

Security. Patients and others must now go to a central office, the Release of Information Office, to get a copy of their record. There also is a new national initiative, "My HealtheVet," that will allow veterans to access some clinical information via access to the VA's intranet. Various controls are applied to individual users. While nearly all staff have read access at all health settings for all patients at a particular VAMC (and also a list and a few fields of information about all VA patients), each ID also has other specific attributes that allow for different write and view capabilities.

Documentation. Documentation requirements that are now in place are only possible with CPRS. It would not be possible to go back to paper and maintain the same requirements. All documentation must exist in the electronic form. For those items that do not "fit" in CPRS, such as diagrams or oversized paper, information is scanned into CPRS. Documents must be stored for 75 years after a patient's death; thus, storage of paper documents was a continuing problem.

File Room. Five years ago, the file rooms at Bay Pines and the Ft. Myers Outpatient Clinic delivered up to 2,300 records daily. Today, that number has dropped to 20 records per day. The delivery of those 20 records will end in May 2004. There also were 38 employees spread among three shifts. The shift work included gathering records from all locations, scanning the records back into the file room, reordering the records into terminal digits and returning to the shelves. Other work included sorting incomplete records, preparing for the next three days of appointment deliveries, fulfilling requests from other sites, and pulling death records and those for retirement and record repair.

The file room currently consists of 13 people, including the supervisor. Five of the staff support document scanners, and the remainder are support staff for traditional file room functions, support of medical coding, and work in completing JCAHO record requirements. BP expects the number of file room staff to drop even more by the end of 2004.

Physician documentation at the hospital remains handwritten. Upon completion of the document imaging system implementation, these documents will be scanned into the system. Nursing and other staff documentation is nearly 100% online.

Physician orders are handwritten. About 50% of physicians have begun to write orders electronically into the computer-based provider order entry (CPOE) system. Otherwise, a nurse/clerical staff member transcribes handwritten orders into the EHR, which then performs some alerts and guideline checks. Alerts may prompt a phone call from nurse to physician for instructions. Medication orders are sent to the pharmacy; a pharmacist verifies these orders, and then delivers medication via courier, tube system or dispensing cart delivery to the unit. Laboratory orders are sent to the lab, where a requisition and a label are printed. The phlebotomist uses these papers to locate and identify the patient and double-check the order. Radiology orders are sent to radiology. Once the test is conducted, the result is viewed by a radiologist who dictates a note that prints on the ordering unit and is subsequently available in the EHR.

The Eclipsys E7000 system is the backbone of the clinical data repository. It is available and fully interactive in all owned, acute care and PAC/LTC facilities at NMHS including hospitals, clinics, nursing homes, the inpatient rehabilitation facility, and home health care. It allows clinical documentation by physicians, nurses, and other clinical staff, although most physicians handwrite their notes. It also allows physician order entry, which is accepted by about 50% of the physicians, and order management and transmission, fully implemented in the inpatient nursing units, in the IRF and the nursing homes. Additionally, the clinics use GE Logician to document outpatient encounters. NMHS has developed its own continuity database dubbed ACHE (Admission Clearinghouse Enterprise) that stores 220 data elements about the patient for ongoing use and synchronization between the various EHR systems. Physicians are using Logician. However, Logician is not yet integrated into the data warehouse (i.e., ACHE database), although this is to be accomplished within the next year. The ACHE 200-300 data elements are common across the continuum and include the home medication list and medical history.

NMHS has been effective at extending its EHR not only to the breadth of its internal enterprise, but also to non-affiliated healthcare organizations. There are several models of extending the NMHS EHR to non-owned practices. First, both the E7000 and Logician licenses have been extended to five private clinics (cardiology, GI, endocrine, OB/Gyn, urology) outside of the integrated delivery network and not affiliated at all with NMHS. NMHS serves in some sense as a "utility company," providing services for which the clinics pay. For the payment, the clinics use E7000 as their front-end registration system, with Logician as the electronic health record system. The clinics have full access to the entire longitudinal NMHS database, and all the functions of Eclipsys and Logician that NMHS has developed. Also, the main Tupelo medical center is one mile away and can send physician analysts to support their system, as if they were a local EHR systems vendor.

Cedars, a Methodist nursing home, is also a non-owned facility. NMHS resident physicians do practice there. NMHS extended a virtual private network connection to a PC at the nursing home where the residents can access patient data, write notes and record medication orders in Logician, and print out these papers to be filed in the official Cedars medical record. There is no charge to Cedars for this access, but the Cedars staff members have no direct access to the workstation or Logician software.

2. Nursing Homes

Sites. Two NMHC-owned nursing homes were visited. The city of Pontotoc has a critical access facility composed of 19 swing beds, 10 subacute beds and 44 long-term care beds. On site there is an ER, a radiology suite, and a pharmacy. The city of Baldwyn has a 107-bed nursing home, which stands alone, with no attached acute care facilities. Both are in medically underserved communities.

Admission. The Pontotoc nursing home receives a phone call from the social worker at the hospital, referring a patient for possible admission. NH staff have full access to the EHR for the acute care episode in the Tupelo hospital and NMHS clinics. The social worker finds this to be very helpful. Instead of a long telephone conversation about the patient and her/his candidacy for the nursing home, the social worker at the NH only receives initials of the patient with a room number. The social worker and NH staff then can look up primary clinical information for themselves, and determine appropriateness for their setting. This can avoid a time-consuming visit to the hospital, which is more than 60 miles away. This entire decision can be made in 30 minutes.

Once the patient arrives, the patient's intake is done by nurses directly onto the EHR, using a mobile laptop on a cart. Similarly, nurses take a cart to the bedside to document their initial patient admission/intake data.

The physician does not interact with the computer on patient admission to NH. Physicians write their orders and documentation on paper, the nurse verifies them, and the clerk enters them into the EHR.

Orders. At both nursing homes, a small number of physicians (one at Baldwyn, three at Pontotoc) see all the patients. None of them currently enters orders into the computer system; they write them on the paper chart. The orders then are entered by the clerk into the EHR and transmitted to relevant departments (laboratory, radiology, pharmacy) where the orders are interpreted. The medication administration record (MAR) and other documents such as the patient care summary are generated by the EHR, based upon the medical orders and the patient's plan of care. These documents are used to conduct rounds and dispense medications. This printout also is used to conduct "sign-outs" to the next shift. This paper is ultimately destroyed as all new clinical data, medication administration notes and other findings are keyed by nurses into the computer.

At Pontotoc, a local pharmacist receives the scan of the written medication order, interprets the medication and dispenses a 30-day supply of medication and hand delivers this to the unit. At Baldwyn, there is no local pharmacist. There, the order is transmitted to the central NMHS pharmacy in Tupelo, and the medication then is delivered on the next courier run.

Radiology orders are entered and x-ray films are taken locally, then transported daily for radiologist reading at the main NMHS site. Although NMHS anticipates adopting a Picture Archiving and Communication System (PACS) soon, it is not yet in place. Results are printed in the ordering location and are available in the EHR. Laboratory orders are similarly entered by clerical staff; phlebotomy is done locally and transported to the main NMHS laboratory. Results are printed at the ordering location and are also available in the EHR.

Narrative. At both NMHS nursing homes, physicians handwrite their clinical narrative into the paper chart. Nurses, non-licensed staff and social workers all use the EHR (E7000 Eclipsys system) to document their care. In some cases, they type their narrative; in other cases, they have text templates built to accommodate their needs.

Nurses see significant benefit to using the EHR. They note that about four hours of a 12-hour shift are spent using the EHR. In the past, they would spend about half of their shift writing in the paper chart. At end of each shift, 30 minutes used to be allocated to "sign-out" and informing the next shift what was happening with the patient. With the EHR, that time is reduced to five to 20 minutes, and documentation is better and easier to read. They use paper printouts of their EHR documentation as a bridge between shifts, and a walk-around tool during shifts, then throw it away after all notes made on paper are transferred to EHR. Non-licensed personnel increasingly utilize the EHR in a variety of ways, including data input and information review. Certified Nursing Assistants (CNAs) take vital signs and enter them directly into EHR, which benefits other care providers. As a result, CNAs believe that the work they do and the data they gather are more important; RNs have less transcribing of someone else's work and are released to perform other higher level nursing functions; and physicians see a clean printout of entered data. At one NH, Cedars (an affiliated, non-owned nursing home), NMHS extended an EHR access point to the facility for the use of resident physicians who enter clinical notes using templates and typed narrative in Logician, and then print them to include in the patient's chart. The NH staff do not have access to the Logician system.

Clinical Decision Making. CPOE is available on the EHR for NH, as for the acute care site. However, as physicians do not use the computer to a large extent, nurses/clerical staff enter the orders. When an alert (such as a drug-drug interaction or a drug-allergy alert) is triggered while the nurse is entering a physician's order, the nurse responds by paging the physician or the pharmacist based upon the indicated severity of the allergy/interaction. Nurses also have access to Micromedex for RN education and patient education handouts.

There are numerous guidelines specific to long-term care that nurses use and that are available in the EHR, including fall precautions, pain control, wound management, nausea management, and restraint guidelines. The nursing home staff have customized pathways.

Quality monitoring takes place separately from EHR on MDS software, which is not currently interfaced with the EHR.

MDS Integration. NMHS owns several nursing homes. One big achievement in the past year is that MDS data are now being collected in a uniform fashion on one software platform: American HealthTech. Although there are future plans for integration, this software is not integrated currently with the EHR. This produces double work on the part of nursing and clerical staff who enter data in slightly different ways for each system.

Access. All physicians and staff have access to the EHR. There are more than 260 levels of security, with different levels of access to patient data based on role. Several physicians indicated that they do not use the MIS to a large extent. Rather, they rely on staff to print information, as well as enter data on their behalf. Nurses have interactive access to the EHR, and nurse aides are beginning to input vital signs, linen changes, fluids, diapers, and oral care. Clerical staff find that access to EHR has reduced the amount of walking and being off the unit and unavailable to other staff, since orders and communications are transmitted electronically. Dietary, environmental services, and physical therapy also have access to the system, to track patient status and needs.

Transition. When sending a patient to an ER or hospital for acute evaluation, a nurse can generate a summary viewable at an NMHS-owned hospital. This includes a medication list, problem list, and therapy interventions. The transfer summary is generally printed for physician viewing: treating physician, primary care physician, or ER physician. This paper is printed and travels with the patient, regardless of whether s/he is transported to an owned ER or to a non-owned ER.

Unique Characteristics. The degree of access and interaction by the nursing home staff with the EHR is remarkable in its depth and scope. Not only do they have full access to the patients' previous clinical data from their acute care episode, thus reducing the likelihood of handoff errors, but they also have a functional information system to document clinical care relevant to long-term care goals. In particular, extending the EHR to CNA documentation of vital signs has proved effective and beneficial.

In one non-NMHS nursing home, a decision was made to provide a fully interactive EHR access point within the facility. This access point is for the exclusive use of resident and faculty physicians from NMHS; the NH staff do not have this access. The physicians enter their progress notes and orders and print them to put in the official paper chart. This serves to capture clinical information for longitudinal care of the

patient and improves the quality and legibility of the paper chart. To some degree this is double work for the physicians who are interacting both with the NMHS EHR and also handwriting some of this information in the patient's local chart. Because of the perceived value of EHR continuity, the physicians initially requested this access from NMHS and continue to document in this way.

3. Home Health

Sites. The home health division was not included in the site visit due to time constraints. Visiting nurses had a choice of pulling up patient data at the central office, printing and carrying them to the scheduled visits, or taking a laptop to the patient's home and viewing patient data in real time. The second option was limited by phone line access and patient perceptions of phone line usage. In these cases, nurses could update records directly into the EHR system, using a desktop in the branch office post-visit.

Admission. Home health nurses have read/write access to the EHR (E7000). They are assigned a laptop computer and take it with them, but dial-up connections at the patients' homes have been problematic.

Orders. When patients being seen by a visiting nurse require a lab test, the lab orders are handwritten by the physician, then faxed or electronically sent to the home health agency. The visiting nurse takes the paper request, and draws the samples for laboratory testing on the patient at home; then the specimen is labeled and transported to the central lab. It is the central lab technician who inputs this order into the EHR and subsequently reports the lab result. This is done because neither the visiting nurse nor the physician has access to the registration system to create a new outpatient episode of care. As this is an outpatient, a patient has to be registered and an episode of care has to be started before any tests can be ordered. In the clinic, the clinic staff would register the patient. For the home health patient, the laboratory tech is the first person who has the access to do this information.

Narrative. Home health day-to-day visit notes are not online. The nurses encountered problems when using a dial-up from patients' homes to access MIS. Patients were concerned about the nurse using their telephone line (i.e., concerned that the calls were long distance). Sometimes telephone line did not work. Therefore, NMHS is moving to an upload and download system.

Access. Home health nurses have read/write access to EHR both from central office and from laptops, which have dial-up access to EHR at the patient's home.

Transition. The home health nurse has full read-only access to the EHR and thus can view the patient's problem list, medication list, allergies and clinical notes and discharge summaries from the acute care facility, nursing home and clinics.

4. Rehabilitation Facility

Sites. NMHS has a 30-bed, fully owned inpatient rehabilitation facility (IRF). There is full integration between the IRF and the acute care hospital in Tupelo; it is simply another floor in the physical hospital. There is full integration with the acute care EHR. There are templates for physician and nurse documentation in the EHR. Nurses use the templates and automated documentation extensively, and physicians are beginning to use the system for more than just looking up data. The majority of computers on the IRF unit are fixed desktop units. There are two wireless carts used by both nurses and physicians.

The IRF and NH settings within NMHS agreed to use the same nursing screens to document care. For example, they both use the Braden scale to automatically total a patient's risk for ulcers. They also can consult the multidisciplinary wound team online by submitting text information along with a digital photograph. The wound team then can reply with recommended treatment options.

Admission. To make a determination about a patient's admission to the IRF, the IRF staff are able to view the patient's entire acute care stay in the hospital, including therapy notes, nursing notes, and all orders. Using the EHR, the IRF staff are able to make a determination about the patient's appropriateness for the unit more quickly as compared to reviewing a paper chart.

IRF, NH, and inpatient units use the same EHR: the E7000 Eclipsys system. The IRF and NH have agreed also to use the same screens for admission assessments by RNs.

Similar to the acute care hospital, physicians handwrite notes. Information technology allows the physician to view the patient's full clinical data from her/his acute care stay. In addition, the admitting physician is frequently consulted by the inpatient medical team prior to the patient's admission to the IRF. This familiarity makes the actual process of admission more straightforward.

For admission to the IRF, there is a two-way exchange of information between ACHE (the Admission Clearinghouse Enterprise) and E7000. Upon a patient's admission to the IRF, a nurse documenting the intake history and physical pulls up a new "encounter" in the EHR. Doing so prompts the E7000 to query the longitudinal ACHE database for this patient, and populates the known data elements. The nurse then uses this baseline data to interview the patient, confirm the existing data and make updates to the information as needed for this episode of care. Any updates that affect ACHE data elements also are written back to the longitudinal ACHE database at that time.

Upon admission, there is an electronic nursing assessment that includes a pain scale, the Braden scale for wound assessment, emotional status, motor functioning, and balance. Based on various scores, a high-risk patient may generate an automatic

consultation with the wound care multidisciplinary team, and/or a fall prevention protocol, with arm bands and color coding on the patient's door.

Nurses document into an electronic care plan in the EHR, using templates and some limited typing. This template content was developed by local consensus and, at this time, does not link to the nursing intervention classification or the nursing outcome classification (NIC/NOC).

Orders. As in the inpatient hospital, about one-half of the physicians enter orders through the CPOE system; others handwrite orders and have them entered by clerical staff and transmitted to the relevant departments; and others have their orders entered directly into the EHR system. Because of the scarcity of physicians, they are being gently persuaded to move to online ordering; however, the system fully supports the physicians' choice to work on paper or electronically.

Clerks on the unit enter the physicians' orders into the EHR. For medication orders, the pharmacist views the scanned document, interprets the physician's order, and enters it into the pharmacy system. This system then prints instructions to fill a dispensing cart, which is subsequently delivered to the unit. For laboratory orders, the lab technician receives a printout of the order and a bar-coded label. The phlebotomist then draws the blood. The sample is scanned, run on the analyzer, and results reported by printout to the ordering unit. The result is available also in the EHR. For radiology orders, the technician similarly receives a printout request and performs the test. The radiologist reviews the films and dictates a report, which is then transmitted to the ordering unit and also is available in the EHR.

Narrative. Physician notes are handwritten. The notes will be scanned in the future, using the document imaging system once it is fully implemented. In the rehabilitation gym, physical, occupational, and speech therapists' notes are a combination of electronic and handwritten notes. Similarly, nursing notes are entered via template into the EHR.

Clinical Decision Making. Nurses and pharmacists in the IRF receive drug-drug, drug-food, and drug-allergy alerts via the EHR when they are entering the physician's orders. When this occurs, they page the physician/pharmacist as indicated by severity rating. The IRF follows a number of guidelines of care, including post-stroke care, hip fracture care, amputation care, and DVT prophylaxis. Quality monitoring is done through the IRF-PAI and FIM software, which is stand alone at this point (not integrated with the EHR).

IRF-PAI Integration. There is a separate stand-alone software system that captures information on IRF-PAI and its precursor, the FIM.

Access. IRF physicians and staff have full access to the EHR from desktops throughout the unit as well by wireless laptop. Physicians also have access from their offices and homes. NMHS finds this access so critical, that it will send analysts to the

physician's offices and to their homes to set up their computers and connections for no charge.

Transition. Transfers from the acute care side of Tupelo hospital to the IRF side are greatly facilitated by access to the common EHR. The IRF can view the orders and full reports of therapies (PT, respiratory) conducted in the inpatient setting. All the data from the acute care episode of care are available for review by IRF faculty and staff. The allergies and medication list also is shared.

5. Pharmacy

Overall. The pharmacy has three to four primary focus areas: (1) four to five hospital affiliates (one is online and will be bringing the others online); (2) home infusion (home care patients); (3) ambulatory care -- about 1,200 patients/month (about 40 patients are walk-ins); and (4) staff model pharmacy for employees and dependents. The system intends to use Pyxis at all sites (except nursing homes). Pyxis is a unit dose dispensing system The Pyxis (medication dispensing device) is linked to the E7000. On the other hand, nursing home medications are dispensed 30 days at a time. The medication and interaction database is from First DataBank (FDB). NMHS is considering bar coding for drug administration, but this is not likely to be implemented for the next five years. A transport tube goes between pharmacy and ER, ICU, and CCU to facilitate delivery of orders and medications. A quality control process is in place to track errors, but it is not a punitive system. This electronic system tracks medication errors, falls, and equipment problems and allows internal monitoring.

The ACHE database helps provide medication continuity despite the episode-based nature of the main EHR (E7000). For example, upon hospital discharge, a patient's discharge medications are entered into the E7000 by the nurse. This list also is written to the automated discharge summary (ADS). When the patient is subsequently seen in clinic, the clinical staff can view the medication list from that episode of care, and may elect to enter that information into the Logician system. Additionally, there are plans to fully integrate the Logician outpatient medication list with ACHE in the coming year, so that this data entry no longer will be necessary. If the patient is subsequently re-admitted to the hospital, the nurse starts a new admission assessment for that episode of care. S/he has access to the medication list from the previous episode of care. As the nurse creates an admission assessment in the EHR (E7000), the system pulls in the most recent information from the ACHE that will contain the most recent medication list. The nurse verifies the list with the patient, and types in any medication changes noted by the patient. The physician then can view the nursing notes, and handwrite or enter into the EHR the patient's admission medications. This list then is scanned or electronically sent to be reviewed by the pharmacist. The pharmacist verifies accuracy, checks for drug interactions or alerts, and then sends the medication by courier, tube system or the routine dispensing cart delivery.

Acute Care and Physician Offices. The Tupelo main hospital houses both an inpatient and outpatient pharmacy. The outpatient pharmacy is also the primary

pharmacy for employees of NMHS. The inpatient pharmacy has both a centralized location as well as satellite pharmacies on the floors. Because the physician orders are mainly on paper and nurses cannot interpret medication orders, drug orders are entered into the EHR by the unit clerk and scanned to the pharmacy using Pyxis-connect system. This scan then generates a trigger for the pharmacist that a medication order is pending interpretation by printing a notification on the pharmacy printer. The pharmacist then reviews the scan, interprets the medication and dosage, and verifies the order for that medication in the E7000 system. This triggers either a courier to take the medication to the floor, a tube transport of the medication to the ER, or a staff member filling a drawer on the Pyxis drug-dispensing cart that is later delivered to the floor. Often, if the medication is ordered stat, the nurse goes to the pharmacy to wait for the medication order to be filled. If the pharmacist has a question about an order, s/he notifies the floor nurse who then contacts the physician. This happens when a medication order is illegible, or if there are drug alerts or interactions that would require physician action. Once the medication is in the Pyxis on the unit, the nurse logs into Pyxis, enters the patient's name, and documents that a unit dose was withdrawn from the correct cabinet. NMHS does not yet have bar coding to fully close the medication loop. Drug alerts show up (as a piece of paper) to the person entering the drug and also at the pharmacy. Allergies and drug-drug interactions are in First DataBank (FDB); the nurse enters the type of reaction.

Nursing Homes. The outpatient pharmacy also supports a number of NMHS-owned nursing homes that fax in physician medication orders. A pharmacist reviews that information and enters it into the pharmacy system, which has vendor-based drug-drug interaction and drug-allergy checks. For the nursing homes, a bottle is filled, labeled, and delivered by courier to the nursing home. This bottle of medication is placed in the patient's drawer on the medication cart. As nursing home patients are considered outpatients, the organization can only bill $3.50 for a monthly dispensing fee, which is very different from being paid for unit dose dispensing (as is the case in acute care settings and IRFs). This financially limits the adoption by long-term care facilities of unit dose dispensing and bar coding and other patient safety technologies.

Home Health. Not Applicable.

IRF. The IRF is identical to the acute care hospital pharmacy. Medications are billed when they are charted as "given." Some nurses dispense medications with a wireless laptop at the bedside and chart in real time as medication is dispensed; others take a paper printout and make notes that are later transcribed into the EHR.

6. Radiology

The next big NMHS IT project is PACS. Interest in such a system exists for several reasons, including improved patient care, reduced delays in reading films, and increased radiologist satisfaction. NMHS engaged a consultant to do a cost-benefit analysis, which showed that it would take 10 years before the costs of a full PACS system would accrue net cost savings. However, other considerations predominated.

Ordering physicians wanted immediate access to the radiology report. Radiologists wanted immediate access to the image to provide this report. Given the 100-mile geographic spread of the organization, this was becoming increasingly difficult. Ultimately, either an expensive courier delivery system or an expensive radiologist driving between sites would be necessary to interpret radiology films quickly. An investment in PACS would meet all of these needs: better clinical service by radiology, reduced delay in reading films, and increased radiologist satisfaction. It also would provide increased flexibility of location without driving or waiting hours for film arrival. Given the shortage of radiologists throughout Mississippi, PACS would be an attractive recruiting tool as well.

NMHS contracts with two different Alabama radiology practices for film interpretation at two of the NMHS affiliates. The x-rays are generated on film, then scanned into an electronic system for transmission. The Alabama practice also has read-only access to the EHR, given at no cost because the radiologists provide a consultation service to NMHS. The volume of x-ray films and need for radiologist services are anticipated to increase as NMHS takes over community radiology from the other campuses.

7. Laboratory

The flow of physician orders for clinical laboratory is as follows: (1) orders are entered into the system electronically (by physician or by clerk); the laboratory requisition is electronically transmitted and printed to paper in the laboratory; (2) a label is generated and a phlebotomist comes to the unit to draw the blood; (3) the laboratory completes the test, and the results are transmitted to the ordering unit via an interface; (4) laboratory results either go directly into the EHR or are hand-entered; and (5) a paper copy of the laboratory results is delivered to the physician's office by mail, or electronically via Logician and also can be viewed with the EHR.

There are no automatic or electronic alerts for abnormal lab values, although values that fall outside ranges are flagged in the EHR (bold and with a # sign). An issue with having automatic alerts is how these should be distributed (i.e., who's on call, who has been switched to be on call). NMHS uses CPT codes, as they will be easily paid. It does not use LOINC. Bar codes are used for lab orders/results. Bar codes include patient name and test, and allow the ordered test to be automatically read and then run by machine with results automatically or electronically generated. Results are validated by the unit clerk and then sent electronically or faxed to the referring unit or physician. Pathology dictates results, which then are transcribed and then entered into the EHR. Cytology results are entered directly into the EHR electronically.

C. Organization, Culture, and Impact

1. Business Plan

Business Agreements/Community Extensions. NMHS actively extends its EHR, referred to as MIS, into the community in various organizations affiliated with but not owned by NMHS. NMHS would consider putting read-only terminals in non-owned SNFs but it has never been asked. This is possible because NMHS maintains a system that is easily extended into any facility from a technical/hardware perspective (only a PC and communication line are needed). IT support staff can be mobilized to support geographically dispersed facilities (including training and troubleshooting). NMHS extensions to other organizations include the school nurse program at local schools, nursing school facilities during clinical rotations in the clinical setting, physicians' clinics, and a nursing home. Each of these extensions operates at different levels during clinical rotations at any NMHS facility, 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. Local TV commercials were observed that stressed the availability of the patient record throughout the system. Outdated computers are donated to the local school system.

Business Goals. A business focus is to enhance and improve the existing system. NMHS has prioritized building data interfaces with other commercial software such as Logician that NMHS promotes for use in physician offices. NMHS provides IT technical support to these private physicians (i.e., will help define workflow and will provide onsite office support for one month). This business strategy strives to increase volume by expanding the catchment areas and to increase use of NMHS services (e.g., office visits and radiology services). The EHR at NMHS is fully integrated with the back office information system (MIS) and, in fact, back office systems are the foundation for all other systems. The next most critical items include medical records, document imaging, data warehouse, etc., and then are followed by results reporting such as pharmacy, laboratory, radiology, etc. Next comes much of the clinical data such as medical charting, notes, patient care plans, etc. Finally, emerging technologies are incorporated into the system. NMHS is in a position of near-monopoly. When NMHS grows, it is not competing with other health systems; rather, patients who previously did not have access to health care are being brought into the system. NMHS has a goal to increase market share by extending service to all of the population in its catchment area (about 100 miles around the Tupelo hub). NMHS does not seek to eliminate paper as part of the patient record. A complete paper duplicate record is maintained, and many aspects of patient care utilize paper for various clinical care processes. The change is that the paper record is completely computer-generated rather than hand-generated. NMHS maintains continuity with its information systems, minimizing systems upgrades. While all PCs observed were running Windows XP operating system, MIS is still the original mainframe system supported by Eclipsys. Optimizing rate of return and fully leveraging IT investments are high priority goals for NMHS. Migrating existing data and functional capability to a new hardware or software platform is under continuing evaluation, but no commercially available products are seen now or in the near future as being acceptable.

Culture. Philosophically, NMHS believes that fundamental to its achievements is a culture of sharing: "Our physicians have come to realize that if we can share information electronically, it's good for us and good for the patient. We will work together for the common good. It is the key to clinics linking together." Working relationships both within NMHS and within the community are important to cultivate and maintain. NMHS believes that a spirit of cooperation by all to improve health care is very important in design and implementation of its health network. NMHS annually writes off about $20 million in charity care.

Mississippi's physician-friendly culture is driven by the physician shortage and concerns surrounding liability. 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 access by patients or the community to any part of the MIS. The EHR has had no impact on liability rates, which are still high due to the litigious environment in Mississippi.

Recruiting and retaining physicians is difficult. As a result, and also due to resistance by many physicians to using EHR systems (a nationwide issue), NMHS does not require physicians to use MIS (unlike all other staff who must use MIS). Rather, NMHS provides clinical and administrative staff to enter all information for physicians into MIS. About 10% of physicians use MIS at a substantial level; the remaining interact with MIS on a limited basis. For example, the majority may use it to access patient lists and retrievals, and up to 50% utilize CPOE features at some level. NMHS works with physicians to convince them that CPOE is the right method to use for physician orders. Physician peer pressure, gentle persuasion, and nursing/administrative support are currently used to increase physician usage, rather than mandating. Another incentive offered to physicians includes education and CME approval. New physicians to the organization are required, for admitting privileges, to begin entering information in the EHR within their first year. NMHS's main acute care hospital in Tupelo has implemented CPOE, but only about one-half of the physicians have entered an order online. The remaining doctors write on paper and have that scanned in and/or entered by other staff. There is a pilot study to have physicians in clinics followed by medical assistants who will enter information into the EHR as it is spoken aloud by the physician. This program has allowed physicians to increase the number of patients seen daily from about 14 to about 20 while documenting at point of care into the EHR. This study has proven to be a cost-effective strategy because of the increase in physician billing with the use of these assistants. Some doctors write, some dictate, and others type entries. Written or dictated entries are either scanned or transcribed into the EHR. It takes on average 24 hours to transcribe.

Drivers/Vision. In 1979, the goal was to develop order entry at nursing stations. Dan Wilford, CEO and Linda Gholston, Nursing Vice President, provided support and vision. Visionary leadership from top executives seems to have been most important, both in getting started and in further enhancement. Tommy Bozeman, CIO, is an

enabler and an integrator to achieve enterprise-wide, patient-centered, longitudinal care. NMHS has begun to envision a community health network with private practices using a common data exchange that is based out of the NMHS EHR. The IT group with clinical analysts (nurses with IT training) is the front line in the continuation and enhancement of MIS. A group of 30 clinical analysts that operate out of the IT group provides broad support for system maintenance, ongoing employee training, and system enhancement.

Vendors. NMHS works with a number of vendors utilizing a number of systems. It conducts a careful review of product features and contractual vendor support. An important component to NMHS success is structuring strict IT vendor contracts. NMHS does not change its IT vendors/products very readily. Request for Proposals for IT products are large and detailed, approaching 200 pages. NMHS has found that larger vendors (e.g., Cerner and McKesson) generally are not able to meet its needs. The need to find a vendor willing to become a co-development partner drives NMHS to smaller vendors.

Also important is the way a contract's payment plan is structured. For example, NMHS limits its payments to a 1% down payment until the vendor produces 25% of functions. The payment structure is based on a functioning system. Payments are weighted towards the back end of the contract period (i.e., 40-50%) after the system "goes live." The contract also builds in requirements concerning uptime/downtime/response time. NMHS seeks a clause stating that the IT system or product must be stable for five years (i.e., a functioning system for five years); otherwise (if, for example, there are hardware problems), reimbursement is prorated. NMHS generally uses its own contracts to ensure vendor compliance. NMHS prohibits the "sun setting" of products contractually to ensure continued vendor support (although NMHS recognizes this is not an enforceable permanent ban). Because of this, NMHS continues to receive support from Eclipsys on the E7000 (the core system mainframe system for MIS) even though this product has been discontinued in the marketplace. Two other software packages were identified in use. These were GE Logician, used in physician offices, and American HealthTech, an application used to capture and send MDS data to CMS.

Payors. 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. As mentioned earlier, back office applications are the backbone of MIS and have been in place the longest. NMHS has the capability to analyze and track many statistics, both administrative and clinical. NMHS is a nonprofit facility that receives no federal or state funding, so accurate budgeting and tracking are of high importance.

Planning. Because all administrative and clinical applications are integrated into one system, NMHS has substantial capability to track costs and clinical processes. There are always ongoing enhancements; some recently have been completed, others are in progress, and others are in planning stages. Local committees meet weekly to

review and prioritize problems and potential enhancements. NMHS is currently focusing efforts to implement a PACS for radiology; also, bar coding for medication management is under review. NMHS rarely appears to be "leading edge" in what it is doing; rather, it waits for new technology to be tested by others and then carefully evaluates what would work best by implementing "tried and true" processes and technology.

2. Organization Structure

Business Units. Since the initial implementation of E7000 for back office application in 1975, the MIS has expanded to include many clinical and data warehouse functions. While some changes in administrative and clinical staff likely resulted as various clinical components were implemented, the largest impact has been in the growth of the IT department and, in particular, the creation of the clinical analyst group. The clinical analyst group within the IT department is a support group that interfaces between IT and clinical staff.

Healthcare Setting Implementation. Implementation of the MIS occurred in the following order: acute care settings, inpatient rehabilitation, home health, and nursing homes (two years ago). The above capabilities operate differently in some health settings today and vary by facility as well. Geographically, facilities on the main Tupelo campus were targeted for implementation and then other campuses, such as Pontotoc, were connected. The implementation of MIS functions has been a fairly complex mix of features vs. health setting vs. geography.

Enhancement Implementation. Financial and back office systems first were put into place in 1975. Order entry nursing notes were implemented in 1979. CPOE was implemented in 1985, but it remains optional for use by physicians to date. Physicians are encouraged and supported to use MIS, but they are not required to use it. Laboratory and radiology components were implemented in 1993. In 2004, initiatives in pharmacy (bar coding) and radiology (digital imaging over T1 lines) are under review. Clinical analysts are in an ongoing effort to develop new templates for various health settings. For example, a series of templates recently were developed for nursing home clinicians that mirror selected parts of the MDS to help both in completing MDS regulatory requirements and clinical care plans.

Resource Allocation. IT expenses are 2.1% of total corporate expenses with maintenance costs of $271,000 per year. Telecommunication expenses for high speed T1 lines are about $600,000 per year. MIS enhancement and maintenance are done both at a local level with weekly project committees comprised of both IT and clinical staff and also at the executive level for major initiatives such as radiology digital imaging. The "Project Team," which has been in existence since 1983, is responsible for the change control process. This body is the keeper of the EHR. For example, the Project Team will help clinicians (e.g., nurses) if they need additional screens built or data elements added to the EHR. Financial analysis of cost and revenue centers, workflow efficiency, quality improvement, patient safety and satisfaction, technology, and other factors are all considered as a whole and determine which initiatives are

funded. The DRG capitated payment method drives increased efficiency. NMHS is an integrated delivery system and has had visionary leadership for the last 30 years. Loss leaders include air ambulance, ambulance, ER, and ICU. The core billing and back office functions of MIS are set up to capture and record clinical process (e.g., therapy billing in 30-minute increments), so that clinical data supports billing functions and the reverse. Revenue enhancers are radiology and rural clinics (40), all of which are staffed with physicians with admitting privileges to NMHS.

3. Staffing/Training

Staffing Levels. Most clinical and administrative staff have not changed due to MIS implementation; however, the IT department staff and especially the clinical analysts within the IT department have increased. The clinical analyst group currently has grown to a staff of 30 (13 physician analysts, 15 nursing analysts, and two clinical analysts). These analysts have clinical training (many began their careers as nurses), but they also have substantial IT training. They not only provide an interface between clinical users and the IT group for planning and prioritization on MIS issues, but they also are expert users, trainers, and system innovators. The IT department also has grown as the MIS expanded and data exchanges between other software packages have been developed.

Staffing Skills. The clinical analyst group that operates out of the IT department has a critical skill set that is essential for maintaining and enhancing the MIS. This group has clinical and IT skills that provide critical functions of interfacing with clinical and IT staff for troubleshooting, planning, and system enhancement. Clinical analysts also train other staff in the use and optimization of MIS. Finally, clinical analysts provide ongoing MIS enhancement by developing templates for customized use in various health settings. Other staff, both administrative and clinical, have acquired specialized skills related to workflow and data entry. IT staff have developed data interface building skills (logician and ACHE) that have allowed a number of innovations from the core E7000 system.

Training. Nearly all NMHS staff must work closely with MIS, using terminals or paper output from MIS in a variety of clinical and administrative functions. The main exception to this is physicians who have support staff that provide system access and data entry. NMHS has tried a number of efforts to increase physician use of MIS, with the most successful being peer modeling. Successes by physicians who do use the MIS are highlighted to other physicians. Initial training is provided for new employees in one to two day employee orientation sessions. After that there is a mentoring period of one to three weeks in which employees might have limited system access and/or be assigned a clinical analyst or a peer staff to assist them. Clinical analysts train clinical staff in the use of MIS both in an expert advisor role and also in implementation of training teams. For example, when MIS was introduced to the nursing homes, clinical analysts came as a team and worked intensively with the nursing home staff to implement, staying a number of days until all nursing home staff were comfortable and fully functional with the implementation.

4. Communication

Channels. Workstations for accessing MIS are widely distributed at all facilities. Some users have their own personal computers (PCs), generally managerial or administrative staff, but shared workstations are a more typical scenario. Some PCs are mobile. The use of paper to communicate information and drive clinical care is prevalent. There are a number of special work processes to handle paper, such as special paper that does not allow copying and shredding protocols so that paper generated by MIS is properly handled. Printers are widely distributed as paper protocols are integrated with MIS for patient care. Paper is used both for alerts to staff and to facilitate workflow process for patient care. One example of this is the use of printers for "Mis-o-grams." Using MIS, messages can be sent to one or more printers. The content of these messages can be to one or more individuals and cover administrative or clinical topics. Traditional methods of communication such as telephone, fax, and e-mail outside of MIS also are used. Clinical staff use handwritten notes to collect information and then transfer it into MIS (there is not much time lag between these processes), but there also is direct entry into MIS with no paper intermediary (e.g., nurses' progress notes). Handheld devices are used in the acute setting to electronically download information directly into MIS (e.g., blood sugar levels).

Frequency. MIS has increased communication frequency. For example, nurses indicated that they spend about 30% less time entering their progress notes. Laboratory results are processed electronically and are usually available on MIS within a few hours after tests have been completed, while paper copy is supplied (through Logician) within 24 hours. The goal to shorten time for availability of radiology images is one of the primary drivers for implementing a PACS.

Nature. MIS has been built primarily for historical storage and review of the patient record. The E7000 record also serves as a legal record. MIS has the potential to provide alerts and process control. Functions such as team collaboration are minimal. MIS provides a wide range of reports, both electronic and paper.

Real-Time. A high priority at NMHS is to maintain sub-second response time so that information is quickly accessible from terminals. Simultaneous, one-stop access to the patient record has improved the care process by giving clinical staff more time with the patient or other activities rather than physically search for patient records. Real-time access of some information has highlighted the need for real-time access in those areas where it is not available (e.g., with digital images from radiology).

Alerts. Two electronic alerts generated by MIS were observed. The first was a passive alert in that an item was flagged on the patient record. For example, results from a laboratory test would appear with associated normal parameters. The second alert related to laboratory results. If they fell outside the normal parameters, the pound character, #, was placed next to the laboratory result and the text was accented in bold.

Quality. Quality of communications has improved most in terms of legibility. Converting handwritten notes into electronic form (either through transcription or direct entry into MIS) has made review easier by other staff. Processes are in place to ensure accuracy of transcription. For example, medication orders handwritten by physicians are scanned in as well as typed in by nurses. A pharmacist then compares the two versions; if there are discrepancies, the physician is consulted before finalizing the orders into the patient record. Another aspect of quality is the structure of information. MIS forces certain information patterns that reduces missing information and also structures information including text. Text entries, such as nursing notes are often built from list selections that generate standard text. Graphical content is not possible in MIS. Interaction is solely text based with toggle selection of screen menus and only viewing one screen at a time (some recent innovation has provided limited multiple screen viewing). Screens are difficult to view and menus are difficult to navigate compared to a graphical user interface (GUI).

Content. Because there is no graphical content and no cut-and-paste capability, and because data entry templates force structured input that minimizes text, content is very distilled but contains a great deal of information. Various limitations are overcome or at least mitigated by a number of strategies. For example, a method was developed to display the information in the ACHE database in a separate window along with the E7000 information. Text strings on multiple rows are used to create simple graphical images to make screens easier to use. Analysis of images from radiologists in text form is provided rather than the image. The mainframe, command line oriented nature of MIS clearly imposes some limitations on content and functionality.

5. Workflow/Process Changes Due to EHR Adoption

Management Functions. Because back office applications are the foundation of the MIS, there is opportunity to do many types of analyses to improve processes for planning, administration and clinical. NMHS utilizes cost and revenue center information to do cost/benefit analysis. One example is a major project to both streamline and put quality control measures into the admission process. NMHS has standardized electronic admission, discharge and transfer information and an electronically generated transfer summary. The template includes addressing procedures such as medications upon discharge, follow-up appointments (e.g., laboratory testing) and medication instructions. These are the discharge instructions sent home with the patient. There is also a physician discharge summary that includes the above plus more detailed recounting of the patient's stay. Patient satisfaction has been increased because patients no longer had to supply information repeatedly as they moved to different care settings. Also, NMHS reduces inefficiency by assuring that patient records are not duplicated with admissions by having a rigorous cross-checking capability and process to check for previous admissions using a unique patient identifier. Paper generated at printers often initiates some type of action. For example, laboratory tests are initiated by a paper printout that is requested via MIS by a physician. Results provided to the physician are provided electronically in MIS, and also a paper report is automatically generated and delivered to the physician's office. MIS-generated paper often is used directly in patient

care. After admission, a paper document accompanies the patient to entry into the appropriate health setting. Nurses use daily MIS printouts to dispense medication.

Patient Interaction. 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. Finally, NMHS resisted the idea of allowing patients or informal caregivers even limited access to the EHR.

Staff Interaction. Clinical and administrative staff have many processes that are predominately electronic team interactions. For example, pharmacy and lab tests are handled by MIS. Computerized paper that appears at printers often starts a process. Staff interaction may center around a paper output, such as a care plan in nursing homes or medication dispensing in acute care. Clinical staff spend less time looking for a patient record or verifying handwritten notes, resulting in less staff-to-staff interaction and more time with patients. Clinical analysts from the IT group interact with clinical staff on a weekly basis in team efforts for planning, training, prioritization, implementation and other activities to optimize the use of MIS and patient care. Efforts at NMHS to standardize nursing practices initially were difficult because there was no consensus among nursing units and staff. Implementation of the EHR in all facilities pushed the issue of standardization of schedules and terminology.

Care Implementation. Simultaneous, real-time, legible access is a significant benefit that is often mentioned by staff. Clinical staff reported they spent less time spent walking around looking for a chart, which results in more time with the patient. Less time is spent entering notes so, again, there is more time to spend with patients or other activities. Patient care is more organized and efficient with legible computer printouts of various activities. There are automatic reminders, and task lists are available daily. Processes to transfer information and care during shifts from one staff group to another are easier, take less time, and have fewer errors because information is more organized, clear, and structured. It was reported that the average length of stay has decreased with EHR implementation.

Tracking. With back office functions as the foundation for the MIS, various financial analyses such as cost/benefit analyses and inventory tracking are possible. NMHS tracks a number of clinical and patient processes, including customer satisfaction and medication errors. The QMS Quality Management System is a risk management process that focuses on near misses, missed dose, falls, pressure ulcers, and monitors effectiveness of interventions. Data are pulled monthly from EHR to ID problems and track trends. This system was created by NMHS's previous liability insurer. Allocation of resources is very important. Substantial effort is made to target those areas most beneficial to the organization for improvement or modification. Historical patient information can be tracked, such as vital signs. NMHS does a significant amount of process improvement, such as a major effort recently completed to streamline and standardize the patient admission process throughout the organization.

Security. NMHS stated that essentially an unlimited number of access levels are possible, but that roughly 200 are most commonly used, with 400 levels covering nearly all users. Exceptions to access levels can be approved by the project team. Different tasks such as read/write authorization and various template access are allowed depending on the user's profile. There is an audit of who accesses what information. Staff have been terminated, suspended or reprimanded for access violations. Thus, privacy is better protected with the EHR than with the paper record. Processes to shred paper on a daily basis have also been implemented. NMHS has tried Internet-based EHR registration, but there were concerns about privacy and security issues. School nurses register students via E7000. There was some concern about privacy issues, but HIPAA has helped them with the privacy issues that emerge from EHR. Parents have to sign a waiver. NMHS had a small study on using an EHR terminal at the patient's bedside to see the impact on the patient and nursing staff. There was a negative outcome in that, among other things, there was a security problem with an unauthorized patient access of the system. It was difficult to get the State Boards of Nursing and Physicians to accept electronic signatures.

Documentation. More than 34,000 screens (typically 500-600 in a given setting) are in use in various workflow processes (e.g., patient admission screens). Entry is structured to minimize long blocks of text, although free-form text entry is allowed. NMHS maintains a fully duplicated electronic and paper patient record, although the paper record is mostly computer-generated. Staff enter information directly into MIS (e.g., nursing notes), and handwritten information will eventually be scanned into the Sunrise Record Manager (SRM), the document imaging system, as it becomes fully implemented. Therapists' clinical documentation is mostly handwritten, but some physical therapists and speech therapists are beginning to use electronic templates to capture clinical narrative.