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Report to the Chairman and Ranking Minority Member, Subcommittee on Readiness and Management Support, Committee on Armed Services, U.S. Senate

September 2002

INFORMATION TECHNOLOGY

Greater Use of Best Practices Can Reduce Risks in Acquiring Defense Health Care System

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Highlights

INFORMATION TECHNOLOGY Greater Use of Best Practices Can Reduce Risks in Acquiring Defense Health Care System

Highlights of GAO-02-345, a report to the Chairman and Ranking Minority Member, Subcommittee on Readiness and Management Support, Committee on Armed Services, U.S. Senate

Why GAO Did This Study

This report examines the acquisition of the Composite Health Care System (CHCS) II. It is one in a series of reports reviewing the Department of Defense's use of best practices in acquiring information technology systems. CHCS II is expected to cost about $1 billion to deliver full capability to almost 1,100 health facilities worldwide by 2008. GAO's objectives were to determine (1) what progress has been made against project commitments, (2) whether the system has been economically justified, and (3) whether effective technical and management controls are in place.

What GAO Recommends

GAO is making several recommendations to the Secretary of Defense, including ensuring expanded use of best practices in managing CHCS II by (1) modifying the project's investment strategy to justify investment in each system release before beginning development, and measuring return on investment; and (2) employing performance-based contracting practices where possible on all future delivery orders. Defense generally agreed with our recommendations.

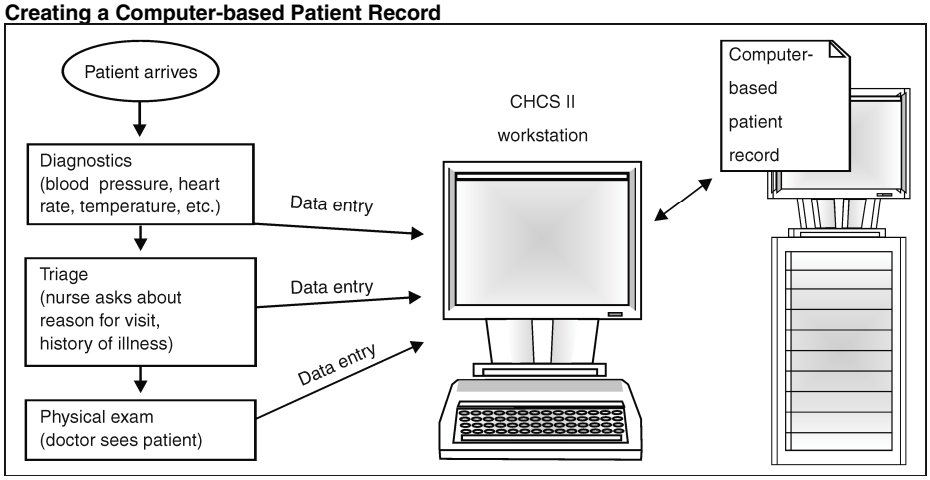
What GAO Found

CHCS II is envisioned as a state-of-the-art automated medical information system allowing improved health-care decisions and lower medical and system costs. An expected highlight is computer-based patient records that doctors and other health service providers will be able to access from any military treatment facility, irrespective of location (see figure). While early CHCS II progress was limited, clear improvement has been evident over the past 2 years, as Defense has begun to embrace industry best practices. The first incremental release of the system, with a deployment decision scheduled for September 2002, is set to contain more capability than was originally planned. The current schedule is nevertheless 3 years beyond the initial estimate, due in part to major program changes and a system redesign; benefits are in question since measurement has not yet begun; and costs to date are about 2½ times the 1998 estimate for deploying the first increment to one region.

Until recently, Defense's basis for investing in this system has been an outdated cost/benefit analysis that did not reflect important changes in assumptions and, further, justified all system increments beyond the first solely on an economic analysis of the entire system. Officials now, however, are finalizing an updated analysis and have stated they plan to adopt an incremental approach to justifying investment in CHCS II, a best practice that successful organizations have been following for years.

The department is moving forward in ensuring that effective acquisition controls are in place, but further progress can be made. Technical and management controls are largely in effect in several areas, including testing and risk management. But performance-based contracting is not being followed, resulting in the risk that CHCS II will take longer to acquire and cost more than necessary.

Creating a Computer-based Patient Record



Source: GAO based on DOD data.

This is a test for developing highlights for a GAO report. The full report, including GAO's objectives, scope, methodology, and analysis, is available at *www.gao.gov/cgi-bin/getrpt?GAO-02-345*. For additional information about the report, contact Randolph C. Hite (202-512-3439). To provide comments on this test highlights, contact Keith Fultz (202-512-3200) or email *HighlightsTest@gao.gov*.

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Abbreviations

ASD(C31)	Assistant Secretary of Defense for Command, Control, Communications, and Intelligence
CIO	chief information officer
CDR	clinical data repository
COTS	commercial-off-the-shelf
CHCS	Composite Health Care System
CPR	computer-based patient record
DISA	Defense Information Systems Agency
DOD	Department of Defense
GOTS	government-off-the-shelf
IT	information technology
MHS	Military Health System
MTF	military treatment facilities
SEI	Software Engineering Institute

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United States General Accounting Office
Washington, DC 20548

September 26, 2002

The Honorable Daniel K. Akaka
Chairman
The Honorable James M. Inhofe
Ranking Minority Member
Subcommittee on Readiness and
Management Support
Committee on Armed Services
United States Senate

This report responds to your request that we review the Department of Defense's (DOD) acquisition of the Composite Health Care System (CHCS) II, an automated medical information system to be deployed to about 1,100 health facilities at 142 military installations worldwide. According to the department, CHCS II will facilitate the worldwide delivery of health care to active-duty service members, their dependents, and other eligible beneficiaries, when care is received in military facilities. DOD has invested about $320 million to acquire an initial version of CHCS II, and expects to invest about $1 billion to acquire and deploy the full system and an additional $3.2 billion to operate and maintain the system over its useful life. DOD began the last phase of testing of the initial version of the system in May 2002, plans to make a deployment decision for this version in September 2002, and plans to deploy it to all sites by October 2005. Over the next 6 years, DOD plans to acquire and deploy a series of more capable versions of the system, delivering full capability to all health facilities at all installations by 2008.

This report is one in a series examining DOD's use of best practices in acquiring information technology (IT) systems.[1] As agreed with your offices, the objectives of our review were to determine (1) what progress DOD has made against CHCS II project commitments, including required system capabilities, expected system benefits, and estimated project costs and milestones; (2) whether DOD has economically justified its investment in the system; and (3) whether DOD has effective technical and

[1] U.S. General Accounting Office, *DOD Systems Modernization: Continued Investment in the Standard Procurement System Has Not Been Justified*, GAO-01-682 (Washington, D.C.: July 31, 2001); U.S. General Accounting Office, *Information Technology: DLA Should Strengthen Business Systems Modernization Architecture and Investment Activities*, GAO-01-631 (Washington, D.C.: June 29, 2001).

management controls in place for acquiring the system. The controls reviewed were requirements management, test management, architecture development and alignment, risk management, and contract management. Details of our objectives, scope, and methodology are included in appendix I.

Results in Brief

Concerning progress to date, DOD did not meet its May 1998 commitment to deliver initial CHCS II system capabilities and associated mission benefits in April 1999; and, since it did not estimate the cost of delivering the initial system capabilities (release 1), it does not have a cost commitment against which to measure progress. Reasons for missing delivery of the capabilities include initial use of a Web-based architecture that did not meet system performance requirements, initial requirements that were ill-defined, a later influx of requirements changes, and unexpected budget cuts that forced changes in the project's scope and approach. By July 2000, 26 months later, the department had redefined its plans for CHCS II to include adopting a new technical architecture, establishing a means for controlling changes to requirements, committing to incremental releases[2] of system capabilities, and delaying the decision date for deploying release 1 to January 2001, which was 21 months later than its May 1998 commitment. It did not, however, similarly redefine benefits, or provide a cost commitment for the initial version.

Since July 2000, DOD has made progress in delivering release 1's system capabilities, although precisely which capabilities will be included in this release have continued to change, and the deployment decision date was delayed another 20 months, to September 2002. Progress against CHCS II's benefits commitment is not yet known, because the project has yet to measure the accrual of actual benefits even though versions of release 1 have been used at test sites for about 2 years. Similarly, progress against a cost commitment has not been measured because DOD did not develop a cost estimate for release 1 until April 2002, only 5 months before this release is to be deployed. Available measures of whether release 1 meets revised commitments[3] indicate that the system is maturing, but questions still exist as to the system's operational efficiency. For example, while

[2] DOD plans to divide the CHCS II acquisition into seven releases. Release 1 was scheduled for a deployment decision in September 2002; release 2 in July 2003; the remaining deployments following at about 1-year intervals.

[3] Examples include functional and performance requirements.

DOD has corrected all of the most serious defects, about 50 defects affecting system efficiency remain unresolved.

Second, DOD has not economically justified its investment in CHCS II releases, but it plans to do so from this point forward. It initially developed a single economic justification for CHCS II in 1998, which has been used as the basis for its past and ongoing investment in releases 1, 2, and 3. However, this justification had known limitations in the cost estimate and was not updated to reflect material changes in planned system capabilities, costs, and milestones. Further, although DOD has adopted an incremental approach to acquiring and deploying system releases, it did not treat investment in releases 2 and 3 as separate investment decisions. This approach is not consistent with best practices and federal requirements. As such, it has invested hundreds of millions of dollars in the system over 4 years without knowing whether the cost of a particular release is outweighed by its benefits. Recently, DOD updated its analysis and reported that releases 1 and 2 are economically justified. CHCS II project officials have acknowledged that incremental investment is a best practice that should be followed, and stated that they will change their strategy for future releases to include economically justifying each release before investing in it and verifying each release's benefits and costs after deployment.

Finally, DOD has appropriately given attention and priority to employing certain acquisition best practices, including those related to managing system requirements and test events, aligning the system architecture with the DOD military health system enterprise architecture,[4] and proactively managing project risks. Such practices better position the department for successfully acquiring CHCS II. Nevertheless, management can be improved upon. For example, performance-based contracting methods are not being used to ensure contractor accountability. Until this is changed, acquisition risks will remain higher than they need to be.

DOD's recent progress on CHCS II is due in part to its attention and commitment to adopting certain acquisition management best practices, such as those governing requirements management. We are making recommendations to the Secretary of Defense for similarly pursuing

[4] An enterprise architecture is the operational and technical blueprint for DOD-wide military health affairs.

improvements in CHCS II investment and other acquisition management controls.

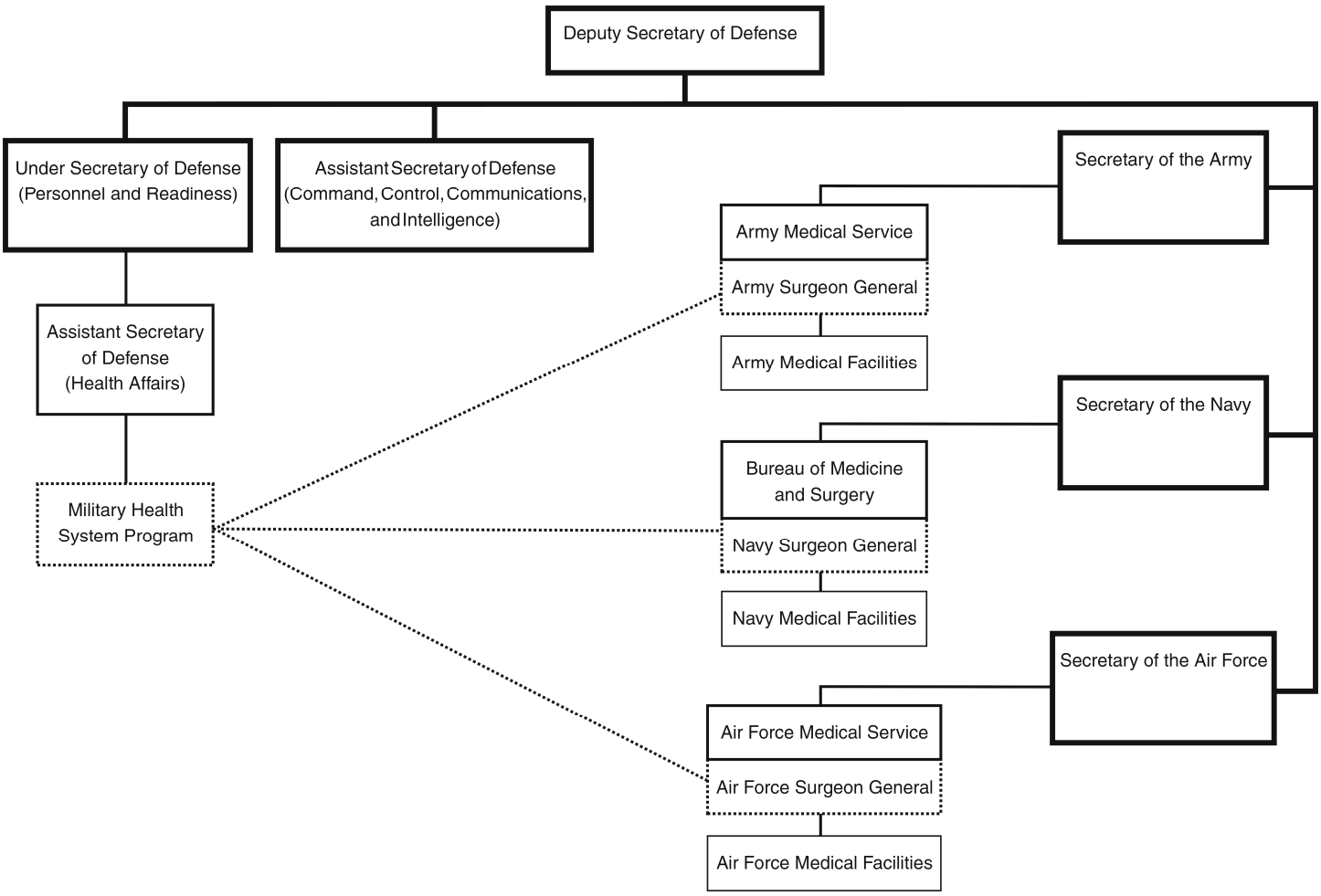
DOD provided what it termed "official oral comments" on a draft of this report. In its comments, DOD generally agreed with the report's message and recommendations. Its comments are discussed more fully in the Agency Comments and Our Evaluation section of this report.

Background

DOD operates a nationwide health care program, including overseas facilities, for its health care beneficiaries. This program is just one of the responsibilities of the Office of the Under Secretary of Defense for Personnel and Readiness, along with recruiting, training, educating, and a range of morale, welfare, and recreation services. Within the Office of the Under Secretary is the Office of the Assistant Secretary for Health Affairs, as well as assistant secretaries or deputy undersecretaries for force management, reserve affairs, readiness, and program integration.

The Assistant Secretary for Health Affairs is responsible for the military health system (MHS) program (see fig. 1). The MHS program has two missions: wartime readiness (maintaining the health of service members and treating wartime casualties), and peacetime care (providing for the health care needs of the families of active-duty members, retirees, their families, and survivors). The Assistant Secretary for Health Affairs establishes policy regarding health care for all DOD beneficiaries and also plans and budgets for health care operations and maintenance. At the same time, each military service has its own medical department, headed by a surgeon general, which operates medical facilities and recruits and funds military medical personnel. Health Affairs, through the surgeons general, provides policy direction, oversight, and resource support to these medical facilities, referred to as military treatment facilities.

Figure 1: Simplified DOD Health Affairs Organization Chart



Source: GAO based on DOD data.

MHS: A Large Health Care Provider

Today, over 8 million people are eligible to receive care from MHS facilities—about 80 percent retirees and dependents and about 20 percent active-duty personnel. Reflecting the magnitude of this patient population, MHS's worldwide operations are significant: about 130,000 personnel at about 1,000 Army, Navy, and Air Force medical facilities divided into 12 domestic plus European, Pacific, and Latin American regions. The fiscal year 2002 MHS budget is almost $24 billion, with about $5 billion of this amount funded by the three services' budgets for military medical personnel.

DOD provides about 75 percent of MHS services through these military facilities, supplementing this by contracting for health services with civilian providers. Active-duty members are required to obtain care at military treatment facilities if such are available; in contrast, retirees and dependents may obtain care at either military facilities, on a space-available basis, or through civilian contract providers.

Since 1968, DOD has pursued the goal of providing computer support to its hospitals and clinics. During fiscal years 1976 to 1984, DOD spent about $222 million to acquire, implement, and operate various health-care computer systems. The original CHCS, begun by DOD in 1988 and first deployed in 1993, is the primary DOD medical information system now used in all MHS facilities worldwide. This system supports DOD hospitals and clinics in registering patients, documenting inpatient activity, and providing laboratory, radiology, pharmacy, drug-interaction, and other functions. Other medical information systems include the Ambulatory Data System, Preventive Health Care Application, and the Nutrition Management Information System.[5] According to a 1996 analysis of the MHS mission, the existing medical information systems cannot meet DOD's needs. The department thus initiated CHCS II in 1997 with the goal of assisting clinicians in making health-care decisions and lowering medical and systems costs through, for example, replacement of each of the above-cited systems. (Appendix II shows a comparison of the capabilities provided by CHCS and CHCS II.)

CHCS II Design: A Brief Description

CHCS II is designed to be a multi-level, open system based on a client-server model.[6] (Appendix III describes the system in greater detail.) The system is to consist of user[7] workstations and application and security network computing devices, located at military treatment facilities. DOD plans to divide the CHCS II acquisition into seven releases. The decision to

[5] Each of these systems provides certain patient-related information. For example, the Ambulatory Data System captures certain outpatient information relating to diagnosis and treatment; the Preventive Health Care Application contains information on preventive health services; and the Nutrition Management Information System supports therapeutic nutrition therapy and medical food management.

[6] Open systems conform to industry standards so that commercial products can easily be used and support costs can be minimized. A client is usually a desktop computing device or program that is "served" by one or more networked computing devices.

[7] CHCS II users are physicians, nurses, other medical personnel, and technical or administrative support staff.

deploy release 1 is scheduled for September 2002; release 2 for July 2003. Remaining deployments are scheduled to begin at about 1-year intervals.

DOD's description of release 1 shows users creating and storing computer-based patient records (CPRs) using 30 CHCS II workstation- and computer-based software packages (21 commercial, 9 government-owned; see app. IV for more information on these packages). DOD plans to connect each facility's workstations and servers via each installation's local or wide area networks. Each installation is also to be connected through a wide area network[8] to a defense computing center, where the CPRs will be stored in a database known as the clinical data repository. As release 1 is deployed to more installations, DOD intends that medical providers will be able to access a patient's CPR from any military treatment facility, no matter where the patient is being or has been treated.

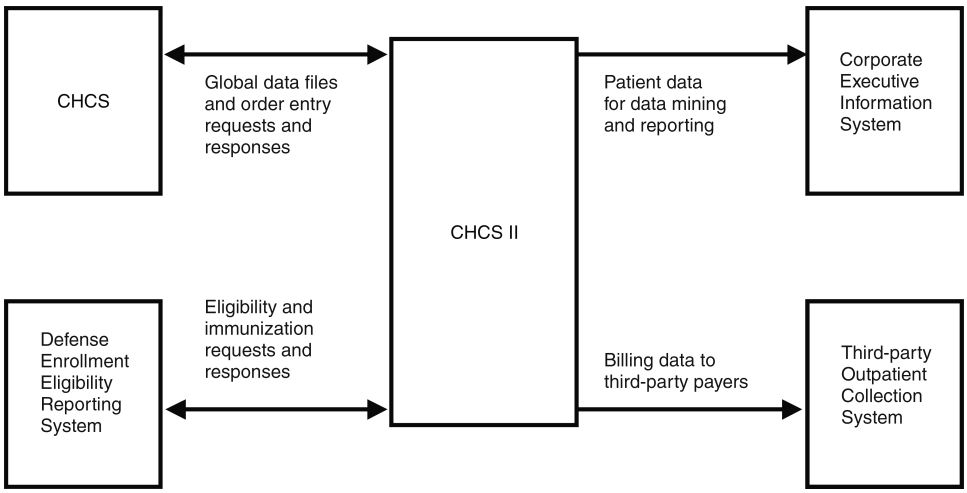
Release 1 is not intended to meet all needs, and thus additional system capabilities are to be added over several years, beginning in July 2003. DOD plans for release 1 to provide system security; user and system interface controls; and various functions such as appointment management, order-entry/management, reporting, preventive health care, immunization tracking, and CPR management. Release 1 will target ambulatory beneficiaries (out-patients). Other service categories, such as inpatient support, are planned for future releases. Release 1 will also replace the Ambulatory Data System and the Preventive Health Care Application.

Release 1 is planned to interface with four systems: CHCS; the Defense Enrollment Eligibility Reporting System, which receives and responds to CHCS II requests for eligibility and immunization information; the Third-party Outpatient Collection System, which receives third-party billing data from CHCS II; and the Corporate Executive Information System, which receives patient information from CHCS II that is used for executive reporting (see fig. 2). Two additional interfaces are planned for release 2, one to a new patient eligibility system and one to a new primary care manager system.[9]

[8] The network is DOD's Unclassified but Sensitive Internet Protocol Router Network.

[9] The new eligibility system is intended to replace the existing Defense Enrollment Eligibility Reporting System and improve MHS sharing of health care information and eliminate manual benefits determinations. The new Primary Care Manager System is intended to allow assignment and change of beneficiaries's primary care managers.

Figure 2: Release 1 Interfaces with Four Existing Systems



Source: GAO based on DOD data.

The acquisition plan calls for release 1 to rely on certain existing CHCS capabilities, including patient appointment/scheduling, radiology, pharmacy, and laboratory; plans call for future releases to gradually replace CHCS, allowing it to be shut down by 2008. Table 1 provides details on releases 1 and 2 deployment dates and capabilities. Appendix V provides details on capabilities and deployment dates for later releases.

Table 1: CHCS II Releases 1 and 2 Capabilities and Expected Deployment Dates

Release number and expected deployment date	Capabilities included
1 September 2002	Automated health evaluation/assessment questionnaire Beneficiary population health reports Centralized health record repository CHCS, eligibility, executive information, and third-party collection system interfaces Clinical outpatient graphical user interface CPR Enrollment and eligibility data Immunization data New ambulatory data and preventive health systems Patient data transcription Patient encounter documentation Patient encounter results codes Patient health history Patient satisfaction reports Patient self-assessment data entry Provider profile data Specialist consults results reports User alerts and reminders User role-based access to system
2 July 2003	Automated clinical practice guidelines Dental charting and documentation Enhanced clinical decision support Global health record repository New eligibility and primary care manager systems interfaces Optometric documentation and order entry Theater (deployed) functions

Source: GAO based on DOD data.

CHCS II Project Management

Several DOD units within the Office of the Assistant Secretary for Health Affairs, supported by other DOD components, are involved in acquiring and deploying CHCS II. The MHS chief information officer (CIO) under the Assistant Secretary is responsible for several MHS IT projects, of which CHCS II is but one. MHS's clinical information technology program office provides direct management of the project. The Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (ASD(C3I)) is responsible for overseeing the project and deciding whether it can proceed to the next acquisition cycle milestone. Table 2 shows how management responsibility for CHCS II is divided among DOD units.

Table 2: Division of CHCS II Management Responsibilities and Functions Among DOD Units

Entity	Responsibility/function
MHS CIO	Oversees the MHS information management and technology program.
Program Executive Office	Directs all centrally managed MHS IT system acquisitions, including oversight of procurement, development, implementation, deployment, maintenance, and operations.
Clinical IT Program Office (includes the CHCS II project team)	Acquires and deploys CHCS II; monitors contract performance; performs testing and training on use of the product delivered by the contractor.
Other DOD organizations	Service military treatment facilities upgrade power needs, validate data conversions, and uninstall and remove older system hardware. Another MHS program office provides communications systems infrastructure. The Office of Program Analysis and Evaluation is responsible for verifying and validating the reliability of economic analyses for major projects such as CHCS II. The Army Test and Evaluation Command is responsible for conducting the operational test. The Navy Center for Cost Analysis is responsible for validating the CHCS II life-cycle cost estimate.
ASD (C3I)	Approves the project to proceed through its acquisition cycle on the basis of a review of key documents – an independently evaluated life-cycle cost/benefit estimate, a component cost analysis, and an acquisition strategy and project baseline. (Is also the milestone decision authority for CHCS II, which is categorized as a major automated information system initiative.)[a]
Joint Requirements Oversight Council	Approves mission need and operational requirements for automated information systems with joint (multiservice) interest.

[a]A project that is either designated as such by the Assistant Secretary, or estimated to require (a) project costs in any single year in excess of $30 million; (b) total project costs in excess of $120 million; or (c) total life-cycle costs in excess of $360 million, all in fiscal year 1996 constant dollars.

Source: GAO based on DOD data.

DOD Has Made Recent Progress Since Missing Early Project Commitments

Best practices and related federal guidance emphasize the need for disciplined processes and information to help ensure that projects are implemented at acceptable costs and within reasonable and expected time frames.[10] They also recognize that acquisitions should contribute to tangible, observable mission performance enhancements. In short, projects are expected to meet the capability, schedule, benefit, and cost commitments upon which their approval was justified.

For the last 4 years, MHS has invested about $320 million in CHCS II but either does not know if it is meeting its commitments or has largely not met them. The exception is in its system capability commitment, where it is delivering more in release 1 than originally envisioned. The reasons for missing commitments relate to a flawed initial design, user dissatisfaction with the system prototype, additional requirements, technical problems,

[10] Clinger-Cohen Act of 1996, Public Law 104-106 and Office of Management and Budget (OMB) Circular A-130, *Management of Federal Information Resources* (Nov. 30, 2000).

such as slow network performance, and a funding cut for the 1999 MHS budget. As a result, the deployment and concomitant benefits have been delayed, and costs have risen substantially over the initial costs approved for release 1. Nevertheless, release 1 is now in the last phase of testing and available data suggest that it is largely performing as intended, although some issues surrounding system efficiency remain.

Overall Progress Against Project Commitments Has Been Limited, but Recent Events Show Improvement

During the first 2 years of the project, MHS made little progress against the CHCS II capability, schedule, benefits, and cost commitments it made in 1998. Progress has improved since then, however.

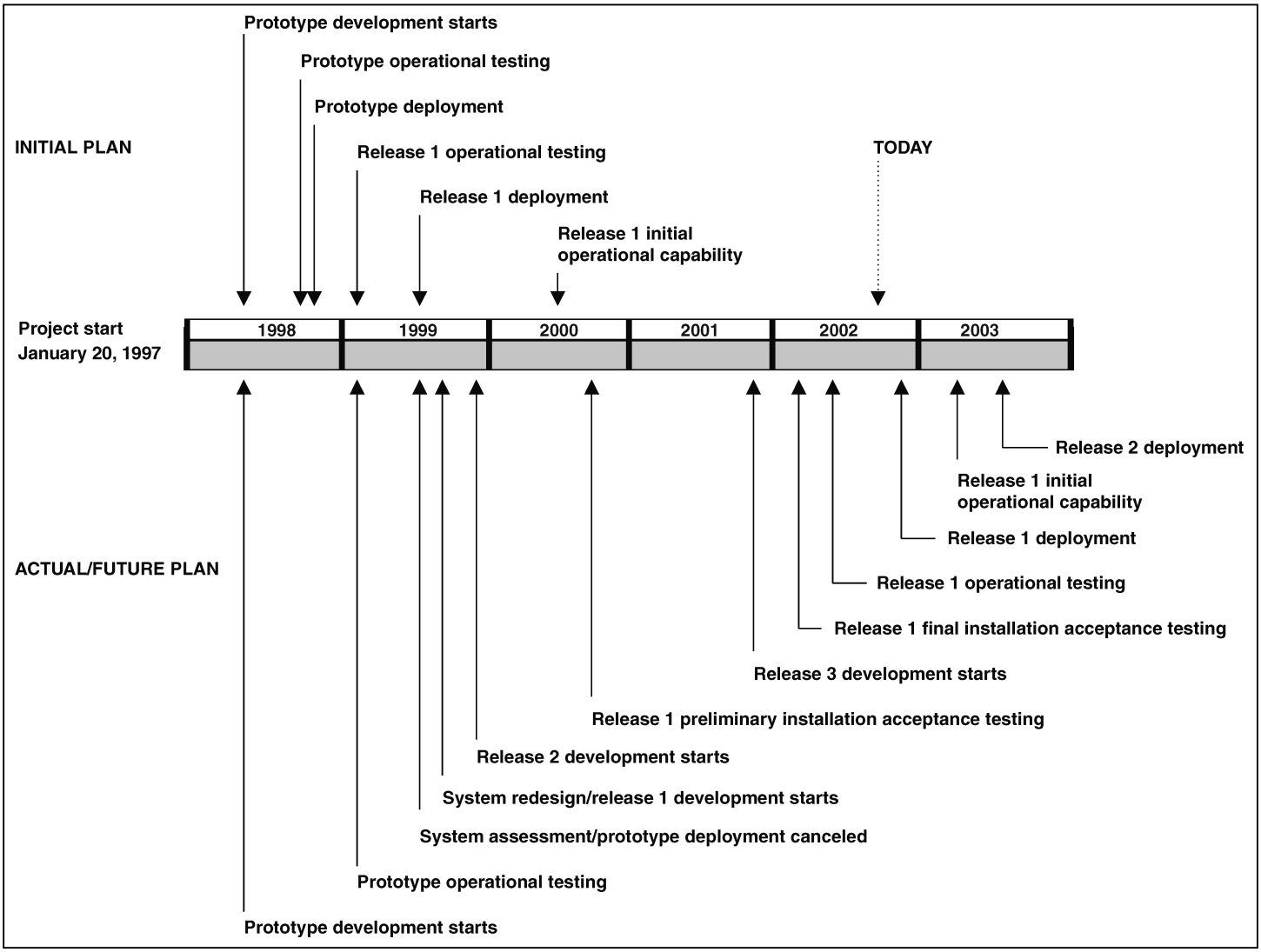
- *Capability Commitment.* CHCS II release 1 is intended to meet foundational system functional, performance, and interface requirements, allowing medical providers at military treatment facilities to exchange, display, and place data into beneficiaries's medical records regardless of where the patient is being treated or where past treatments occurred. Release 1 is also expected to deliver more capabilities than the original commitment due to the requirements added in 2001 in response to user demands. Examples of added requirements (originally planned for future releases) include Windows 2000, pathology order entry, patient self-assessment, and certain patient medical charting features. MHS reports that these additional capabilities added about $7 million to the cost of release 1, and about 6 months to the schedule.

- *Schedule Commitment.* MHS plans to make a deployment decision for release 1 in September 2002—over 3 years late. When the project was approved in May 1998, MHS envisioned deploying a prototype system beginning in October 1998 and beginning deployment of the initial version about April 1999. The initial deployment has been delayed for several reasons. The prototype architecture, which employed a Web-based user interface,[11] was found to cause slow system performance. Further, medical personnel were not satisfied with other system functions, such as the ability to view and print patient documentation, causing requirements redefinition and a system redesign; and the Joint Requirements Oversight Council added more CHCS II requirements in 2000, which added 15

[11] A program used to connect the user to the system. The prototype version was based on a program used to connect to the World Wide Web.

months to the schedule. DOD also cut the MHS budget for fiscal year 1999 that MHS reports caused the initial deployment to be delayed 6 months. System users demanded a number of additional requirements in 2001, and system testing found technical problems with the implementation, such as slow network performance. This combination of the additional user requirements and technical problems added another 20 months to the schedule, for a total delay of 41 months past the original April 1999 estimate. Figure 3 provides a time line of CHCS II's initial and current schedules through 2003.

Figure 3: Time Line of CHCS II's Initial and Current Schedules



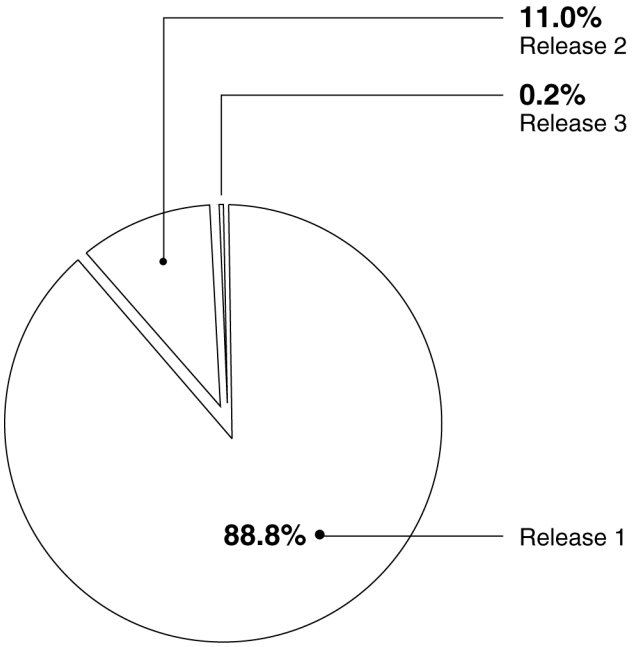
Source: GAO based on DOD data.

- *Benefits Commitment*. The 1998 economic analysis estimated CHCS II benefits at about $5.7 billion in 1998 dollars, including $86 million in benefits between fiscal years 2000 and 2002. A May 2002 update of this analysis estimates benefits of about $6.6 billion in 1998 dollars, but accrual of benefits is not expected to begin until fiscal year 2003. Thus, MHS has not met its original benefit commitments. In addition, it has yet to begin verifying whether its benefit expectations are being met, and only began

validating its plan for measuring benefit accrual in March 2002, although versions of release 1, each providing more capabilities, have been operating at test sites since June 2000. According to project officials, they did not begin this process earlier because users at the sites would not yet have been in a position to determine how CHCS II affected their work.

- *Cost Commitment*. MHS did not prepare a baseline cost estimate for acquiring and deploying release 1 until April 2002. However, on the basis of the 1998 economic analysis, DOD did approve project funding of about $109 million for acquiring and deploying CHCS II from 1997 through 1999. This included the acquisition cost for release 1, plus costs to deploy the system to the sites in a single MHS region from April through September 1999. As of April 2002, MHS reports it has spent about $284 million to acquire release 1, which is about two and one-half times the amount approved in 1998 to acquire and deploy release 1 to a single MHS region. As with the schedule delays, MHS reports that these additional costs are due to the problems with the prototype, additional requirements, and technical complexity. In addition to the release 1, MHS reports that it has spent about $35 million to date on release 2 and about $700,000 on release 3, as shown in figure 4.

Figure 4: CHCS II Expenditures to Date



Source: GAO based on DOD data.

Recent Test Results and System Defect Rates Show Initial Release Is Maturing, But Issues Remain

Two indicators of system maturity are the results of system testing and the number of system defects remaining. One type of testing that both best practices and federal guidance advocate before a system is deployed is system acceptance testing, the purpose of which is to verify that the system meets key technical and system requirements. Defects are system problems that require resolution. As a system matures, the number of defects should show a downward trend. The CHCS II project categorizes defects by severity, ranging from 1 to 5, with 1 being the most serious and the highest priority.[12] According to the test plan, priority 1 and 2 defects, which jeopardize patient safety or adversely affect mission-essential capabilities, need to be resolved before the system can continue to operational testing and deployment. Priority 3, 4, and 5 defects do not need to be resolved since these defects have less effect on the system.

Both the system acceptance test results and trends in priority 1 and 2 defects show that release 1 is maturing. Trends in priority 3 defects, which require inefficient workarounds to overcome, do not yet show a maturing trend.

Acceptance Test Results

The project team conducted the acceptance test to validate that the system is effective and suitable when operating in a production-representative military treatment facility environment, and that the system meets all critical operational issues and key performance parameters. An outcome of acceptance testing is a determination of the system's maturity and its readiness to proceed to the final phase of testing—operational testing and evaluation.[13]

The acceptance test was sufficiently scoped to provide a basis for making each of these determinations. For example, the test was conducted at 4

[12] Priority 1 defects prevent the accomplishment of an operational- or mission-essential capability or jeopardize personnel safety. Priority 2 defects adversely affect the accomplishment of a mission-essential capability, degrading performance, for which no alternative workaround is known. Priority 3 defects are similar to priority 2, but workarounds are available. Priority 4 and 5 defects are less serious.

[13] Operational testing is used to independently assess effectiveness and suitability for end users.

sites and covered all 28 categories of release 1 functionality,[14] and all 1,138 release 1 requirements, including performance (e.g., system availability) and interface requirements. While two functionality categories—telephone consults and self-assessments—were not exercised at all test sites, this was mitigated by the fact that "telephone consult" was exercised at one site using an automated test tool, and "self-assessment" was tested at one site and also used by the test team on test patients at another site.

The acceptance test also defined 15 system maturity parameters/ indicators.[15] According to the test results, 10 of these 15 were fully satisfied (judged to be mature) and 5 were partially satisfied (judged to be of limited maturity). For example, one parameter called "functional completeness" required that 90 percent of the system requirements be met. According to the test results, release 1 exceeded this requirement, meeting 100 percent of the requirements. Other examples of parameters that were fully met are "fault closure rate" and "fault severity/safety," meaning that defect density is decreasing and no priority 1 and 2 defects exist, respectively. According to the test results and our analysis of defects (discussed in the next section of this report), both were met.

For the five parameters that were not fully satisfied and thus rated as limited maturity, we analyzed the reasons provided for these determinations, and believe that the parameters were sufficiently satisfied to mitigate any concerns about whether the parameter was sufficiently satisfied. For example, one of the five is "key performance parameters" which actually consists of nine performance requirements that must be met. Of these nine, test results show that eight were met and one was not. However, the one that was not met is actually a performance requirement for release 2 and not release 1. Similarly, one of the five is "system availability," which for CHCS II is 99 percent system availability. According to the test results, this parameter was not met because a

[14] Alerts, allergies, appointments/scheduling, assessment plan, clinical notes, consult tracking, encounter coding, encounter documentation, external interfaces, forms/reports, immunizations, medications, order entry, order sets, patient demographics, patient disposition, patient search, patient self-assessment tools, problem list, results retrieval, screening, security, summary of care, telephone consults, template management, templates, user preferences, and wellness.

[15] Configuration management, data recovery and restoration, fault closure rate, fault severity, functional baseline, functional completeness, installation, interchangeability, key performance parameters, network design, reliability, software, system availability, test environment, and safety.

scheduled equipment replacement at the Defense Information Systems Agency computing center caused the system to not be operational while the replacement occurred. However, as we have previously reported,[16] system availability is generally regarded as the time that a system is operating satisfactorily, expressed as percentage of the time that the system is required to be operational (i.e., excluding the time that scheduled system maintenance is occurring). Thus, the down time associated with the scheduled equipment replacement should not have been used in measuring system availability during the acceptance test, and according to the test report, if the equipment replacement had occurred during nonclinic hours, the system would have met the 99 percent requirement.

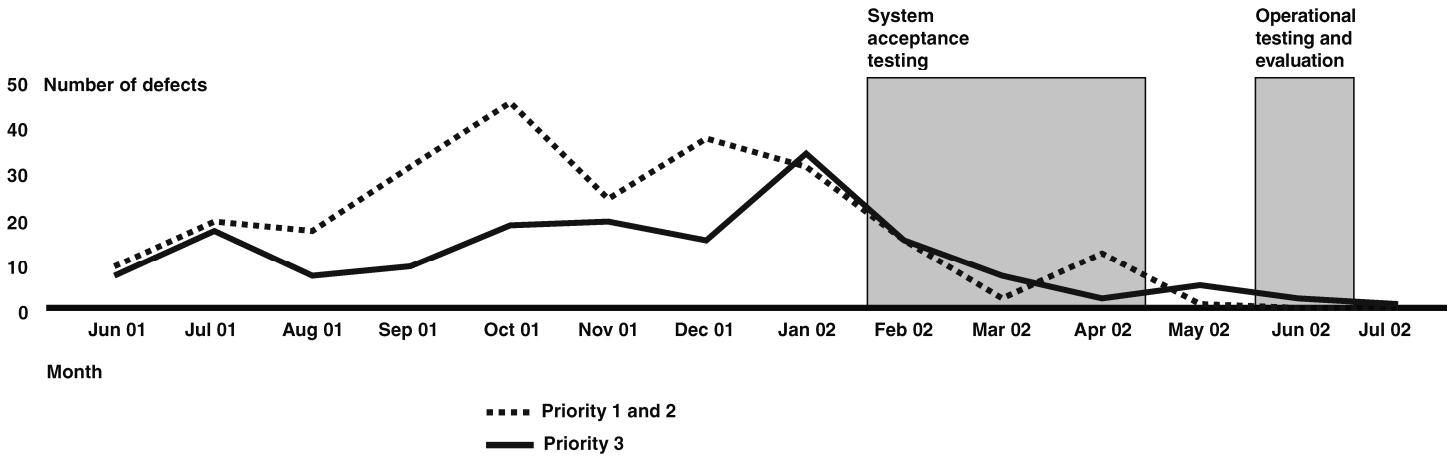
On the basis of the 15 maturity parameter/indicator ratings, the project office determined that release 1 was mature, meaning that the testers had high confidence that the system was ready for the final phase of testing—operational testing and evaluation.

Trends in System Defects

Another indicator of system maturity and quality is defect density, which can be measured in a number of ways, including the trend in the number of defects being reported and the trend in the number of unresolved (uncorrected) defects. Available data on these measures show a generally positive maturity trend, although issues of system efficiency and progress relative to defect expectations exist. For example, after adding requirements in June 2001, the number of defects opened each month began to rise, as shown in figure 5. By January 2002, however, this number began to drop and by the end of July 2002 was about zero for priority 1, 2, and 3 defects combined.

[16] See, for example, *Weather Forecasting: Radar Ability Requirement Not Being Met*, GAO/AIMD-95-132 (Washington, D.C.: May 31, 1995) and *Air Traffic Control: FAA Plans to Replace Its Host Computer System Because Future Availability Cannot Be Assured*, GAO/AIMD-98-138R (Washington, D.C.: May 1, 1998).

Figure 5: Number of Priority 1, 2, and 3 Defects Opened June 2001 through July 2002

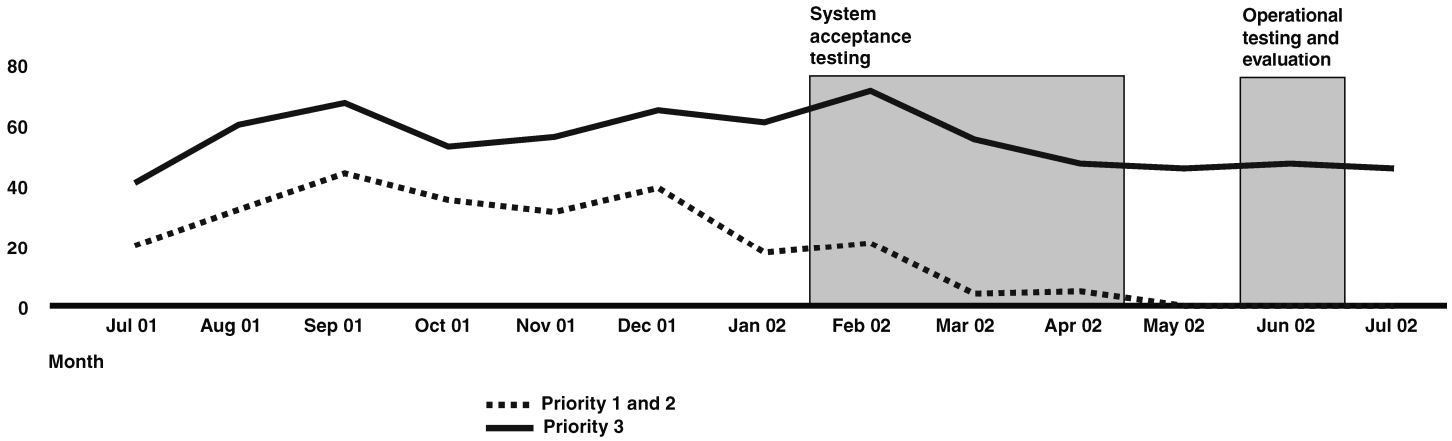


Source: GAO based on DOD data.

The number of unresolved defects (or defects open each month) also began to rise after last June, as shown in figure 6. Since February, however, this number, especially for priority 1s and 2s, has dropped. As of the end of July 2002, all priority 1 and 2 defects had been resolved, but 46 priority 3 defects remained open.

While not as serious as priority 1s and 2s, priority 3 defects are still detrimental because they require workarounds of some sort, which by definition decrease system efficiency. For example, one unresolved priority 3 defect is when CHCS II prevents terminal access because the user had not employed the workstation within the required time limit. When this happens, reentering the user password should allow renewed access, but does not. This means that the workstation is unusable until it can be restarted, resulting in lost work time. The test plan only requires priority 1 and 2 defects to be resolved before moving on to operational testing and deployment. However, according to DOD officials, they plan to correct all defects identified prior to July 31, 2002, before deploying release 1, except for 11 that are embedded in vendor commercial-off-the-shelf software packages and thus must be corrected by the respective vendors.

Figure 6: Unresolved Priority 1, 2, and 3 Defects Opened April 2001 through July 2002



Source: GAO based on DOD data.

DOD Has Not Adequately Justified Investments in CHCS II Releases, but Improvements Are Under Way and Planned

Between the project's start in 1997 and April 2002, MHS invested hundreds of millions of dollars in CHCS II without following all IT investment best practices and related federal guidance that call for separating large systems into smaller increments and making informed return-on-investment decisions based on reliable estimates of incremental project costs, benefits, and risks. Instead, MHS has justified its past and ongoing investment in releases 1, 2, and 3 using an outdated analysis of costs and benefits that, until recently, did not reflect material changes to cost and benefit assumptions. Moreover, MHS did not treat investment in releases 2 and 3 as separate decisions, instead viewing these releases as being justified as part of MHS's economic analysis of the entire CHCS II system (all releases). Such a monolithic approach to analyzing and justifying a system's return on investment has been abandoned by successful organizations as inherently unreliable because it relies on predictions of many variables over many years. According to CHCS II project officials, they will adopt an incremental approach to investing in releases from this point forward.

Reliable Economic Analysis and Incremental Investment Are Tenets of Effective Investment Management

The Clinger-Cohen Act of 1996 and OMB guidance[17] provide a framework for IT investment management that comports with recognized best practices. Together, they set requirements for (1) economically justifying proposed projects on the basis of reliable analyses of expected life-cycle costs, benefits, and risks; (2) using these analyses throughout a project's life cycle as the basis for investment selection, control, and evaluation decisionmaking; and (3) doing so for large projects (to the maximum extent practical) by dividing them into a series of smaller, incremental subprojects or releases. By doing so, the tremendous risk associated with investing large sums of money over many years in anticipation of delivering capabilities and expected business value far into the future can be spread across project fragments that are smaller, of shorter duration, and capable of being more reliably justified and more effectively measured against cost, benefit, and risk expectations. DOD policy also reflects these investment principles by requiring that investments be justified by an economic analysis and, more recently,[18] that investment decisions for major projects such as CHCS II be made incrementally to better ensure that each increment delivers measurable benefit, independent of future increments.

DOD Did Not Economically Justify Past, Ongoing Investments in CHCS II, But Has Taken Steps to Do So

IT investment management best practices and federal guidance advocate economically justifying proposed investments on the basis of a net present value benefit-to-cost ratio that is greater than 1, basing that ratio on reliable analyses of expected life-cycle benefits, costs, and risks, and updating the analysis when significant system changes occur. MHS has not followed this practice. It originally justified its investment in CHCS II in 1998, with an economic analysis that showed a 1.14 to 1 benefit-to-cost ratio for the total program and a 1.09 to 1 ratio for the initial increment (based on present value adjustments to 1998 dollars). However, in January 1999 the DOD Inspector General reported that the cost estimate was based on assumptions that could be flawed and result in estimate inaccuracies, and that the analysis did not disclose this or its return-on-investment implications.[19] Moreover, since this analysis was developed, the project has

[17] Clinger-Cohen Act of 1996, Public Law 104-106; OMB Circular A-130 (Nov. 30, 2000).

[18] DOD Interim Regulation 5000.2-R and DOD Instruction 5000.2, Change 1, *Operation of the Defense Acquisition System* (Jan. 4, 2001).

[19] Office of the Inspector General (OIG), Department of Defense, *Acquisition Management of the Composite Health Care System II Automated Information System*, report number 99-068 (Jan. 21, 1999).

undergone a number of changes affecting its cost and benefits profile, as previously discussed.

MHS prepared two draft updates to its 1998 economic analysis (January and August 2000), but it did not approve an update until May 2002. According to project officials, the approved version was delayed because system requirements were in a state of flux and did not become stable until late 2000. Project officials also stated that the draft updates, which had benefit-to-cost ratios greater than 1, provided them with sufficient assurance that continued investment in CHCS II (releases 1, 2, and 3) was justified. However, according to the project office's quarterly reports during 2000, CHCS II was still in a state of change during and after the time of these updates. As stated in the October 2000 quarterly report, the economic analysis required revision to reflect recent project developments and a change in the system release strategy.

The May 2002 economic analysis estimates life-cycle benefits and costs for the entire CHCS II system, including benefits of about $6.5 billion and costs of about $4.3 billion (both in 1998 dollars).[20] When converted to present values, these estimates are approximately $4.6 billion and $2.8 billion, respectively, producing a benefit-to-cost ratio of 1.63 to 1 and a net present value of about $1.78 billion.[21] However, this analysis is still undergoing review by DOD stakeholders. For example, the analysis's life-cycle cost estimate, which was developed by MHS, is currently being validated by the Naval Center for Cost Analysis. Because this analysis is still being reviewed, we did not evaluate it.

Incremental Justification Planned for Future CHCS II Investments

Incremental investment management involves three fundamental components: (1) acquiring a large system in a series of smaller increments; (2) individually justifying investment in each separate increment on the basis of costs, benefits, and risks; and (3) monitoring actual benefits achieved and costs incurred on ongoing increments. MHS has structured CHCS II into a series of seven increments (releases). However, until

[20] The cost estimate appropriately does not include the about $320 million already spent on CHCS II because this constitutes a sunk cost and thus is not relevant to determining current net present value.

[21] The life-cycle benefits estimate includes benefits resulting from improvements in MHS processes ($4.4 billion) and benefits from replacing existing MHS systems with CHCS II ($2.1 billion).

recently it had not followed best practices in incrementally justifying investments in all system releases. More specifically, it did not treat releases 2 and 3 as separate investments. Further, it has yet to determine whether actual benefit and cost expectations are being met by the first release. According to project officials, this is because DOD policy did not require them to do so, and the DOD CIO, who is the project's milestone decision authority, approved the 1998 economic analysis and granted approval to proceed.

Nevertheless, the May 2002 economic analysis, which was developed during the course of our review and is currently under review within the department, does define release 1 and 2 costs and benefits. The release 1 analysis reports life-cycle benefits and costs of $3.4 billion and $2.8 billion, respectively (in 1998 dollars). When converted to present values, these estimates are approximately $2.4 billion and $2.1 billion, respectively, producing a benefit-to-cost ratio of 1.12 to 1 and a net present value of about $255 million. The release 2 analysis reports life-cycle benefits and costs of $509 million and $103 million, respectively (in 1998 dollars). When converted to present values, these estimates are approximately $359 million and $84 million, producing a benefit-to-cost ratio of 4.25 to 1 and a net present value of about $275 million. The analysis does not, however, address release 3.

According to project officials, they have recently decided to economically justify all future system releases as separate investments based on updates to the CHCS II economic analysis, and they plan to determine whether return-on-investment expectations for deployed releases are being met. The officials also stated that they would analyze the benefits and costs of all future releases during MHS's annual IT investment portfolio reviews and decide whether to fund them. Further, they stated that actual benefits and costs from deployed releases will be measured for each release, starting in February 2003 for release 1, and the CHCS II investment strategy will be updated to reflect these changes.

Important Technical and Management Controls Now Being Followed, but Opportunities Exist for Further Use of Best Practices

MHS has generally established technical and management control best practices in key areas: requirements management, test management, architecture development and alignment, and risk management. This has not been the case throughout the project's life, but project officials said that they have devoted considerable management attention and given priority to applying lessons learned and acting on the results of our work, and they have made improvements to apply best practices. Nevertheless, the CHCS II project office can improve its risk management efforts, and it is still not following performance-based contracting best practices. According to project officials, they did not know how to apply such contracting practices to a system acquisition, but have recently begun to develop this expertise. By not following these practices, MHS risks paying more and taking longer to acquire CHCS II than necessary.

Key Requirements Management Controls Have Recently Been Established

Effectively managing requirements involves establishing and maintaining agreement among the project team—including end users and contractors—on what the system is to do (functionality), how well it is to do it (performance), and how it is to interact with other systems (interfaces). Best practices[22] for managing requirements include (1) adhering to a documented requirements management plan, (2) establishing a validated set of requirements that serves as the baseline against which changes are made, (3) controlling changes to the baseline, (4) maintaining traceability among requirements and related project deliverables, and (5) involving end users in developing and changing requirements.

For CHCS II, MHS has defined products and processes that meet each of these tenets of effective requirements management. First, there is a documented CHCS II requirements management plan with specific written steps governing development and maintenance of requirements. Second, the requirements for release 1 have been validated and approved by CHCS II users, and a baseline requirements set exists. Third, a formal change control process has been put in place, which requires change control board approval for baseline modifications based on the changes's impact on the project. Fourth, a procedure exists for tracking requirements to other work products by allowing changes to the contractor's requirements database only from DOD's requirements database. Last, the process

[22] See, for example, *Software Acquisition Capability Maturity Model* SM (CMU/SEI-99-TR-002, April 1999).

provides for end user participation in both developing and approving changes to existing requirements and addition of new requirements.

To confirm that established requirements management controls were being followed, we reviewed requirements for two CHCS II capabilities–clinical practice guidelines, which were defined in 2000, the first year the current management controls were put in place, and patient index, which were defined in 2001. In both cases, we determined that defined process controls were being followed. For example, in both cases, users were involved in developing and changing requirements and requirements were baselined and put under change control. Also in both cases, changes to requirements were assessed in terms of costs, benefits, and risks before being accepted.

According to project officials, they did not effectively manage requirements until 2000. A 1999 DOD Inspector General report affirms early problems with requirements management,[23] as does a report in October 1999 from a CHCS II test team concluding that the lack of complete requirements caused test problems. In response, MHS redefined how requirements would be managed, adopting the current process during the 2000-2001 timeframe. By doing so, the risks associated with defining complete and correct system requirements, and preventing uncontrolled changes, commonly referred to as "requirements creep," have been mitigated.

Key System Acceptance Testing Management Controls in Place

Complete and thorough testing is essential to providing reasonable assurance that systems perform as intended. Testing a system is not a one time event, but rather is a series of test events throughout the systems development and maintenance cycle, each of which addressing different levels and aspects of the system and building on the results of previous tests. Among the types of tests are (1) tests of small units of software, known as unit testing; (2) tests of whether an integrated version of the system meets defined requirements (functional, performance, and interface), referred to as acceptance testing; and (3) tests of whether the system meets the needs of users in an operational setting, called operational testing.

[23] Office of the Inspector General (OIG), Department of Defense, report number 99-068 (Jan. 21, 1999).

Best practices including our own guidance[24] recommend that organizations implement a structured and disciplined approach to managing each type of tests. DOD policy requires a similar approach. In general, effectively managing a test event, such as system acceptance testing, entails (1) developing a test plan that defines, for example, test objectives, scope, schedules, resource needs, locations, and documentation and reporting requirements; (2) preparing test procedures, based on the plan, that specify test cases, steps, data, inputs, and expected outputs, and that are traceable to requirements; (3) defining test exit criteria, which establish the requirements that must be met to successfully complete testing; (4) executing tests in accordance with plans and procedures; (5) documenting test results in accordance with plans and procedures; (6) identifying, prioritizing, and correcting defects, and re-testing defect corrections; (7) comparing test results with exit criteria to ensure that specified requirements are met; and (8) reporting test results to management in accordance with plans and procedures.

Between January and April 2002, MHS conducted system acceptance testing. Our analysis of the management of this test event showed that key tenets of effective test management were met. For example, MHS prepared test plans that addressed test objectives, scope, schedules, resource needs, locations, and documentation and reporting requirements. Also, MHS developed detailed test procedures that included, among other things, test steps, cases, data, inputs, and expected outcomes. Further, our analysis showed that test procedures were directly linked to functional, performance, and interface requirements. Specifically, we analyzed a statistically valid sample of 59 requirements against the test procedures[25] and found that 57 were traceable to specific test procedures. With respect to the two other requirements, one was a duplicate, and the other was not a CHCS II requirement but rather a requirement for an interfacing system that was inadvertently associated with CHCS II.

Additionally, the test plan defined acceptance test exit criteria as closing all priority 1 and 2 defects, developing workarounds for priority 3 defects, freezing the system baseline, and demonstrating system interoperability and stability. Further, MHS executed the acceptance test between January and April 2002 and documented the results in an acceptance report.

[24] See, for example, *Year 2000 Computing Crisis: A Testing Guide* (GAO/AIMD-10.1.21, November 1998).

[25] See appendix I for statistical sampling methodology.

During and after the test, DOD identified, prioritized, and corrected defects, closing all priority 1 and 2 defects. Finally, in the acceptance report, DOD compared test results with exit criteria and provided the test results to management.

CHCS II and MHS Architectural Alignment Is Occurring

Developing, maintaining, and using architectures, or blueprints, is a best practice in engineering both individual systems and entire enterprises.[26] Requirements for having and using architectures to guide and constrain IT investment decisionmaking are also addressed in federal law and guidance,[27] and in DOD policy.[28] When acquiring or developing new IT systems or maintaining existing systems, these sources recognize that it is very important to ensure that systems are built and modified (i.e., "architected") within the context of the architecture for the enterprise that the system supports. To do less risks having systems that are, for example, duplicative and not integrated. In the case of CHCS II, we found that the system and the MHS enterprise architecture are generally aligned.

MHS Enterprise Architecture

An enterprise architecture is a systematically derived snapshot—in useful models, diagrams, and narrative—of a given entity's operations (business and systems), including how its operations are performed, what information and technology are used to perform the operations, where the operations are performed, who performs them, and when and why they are performed. The architecture describes the entity in both logical terms (e.g., interrelated functions, information needs and flows, work locations, systems, and applications) and technical terms (e.g., hardware, software, data, communications, and security). Enterprise architectures provide these perspectives for both the entity's current, or "as is" environment, and for its target, or "to be" environment; they also provide a high-level capital investment roadmap for moving from one environment to the other.

[26] Enterprises can be single organizations or business/mission areas that transcend more than one organization (e.g., financial management, combat system identification, or medical health care).

[27] Clinger-Cohen Act of 1996, P.L. 104-106; OMB Circular A-130 (Nov. 30, 2000); *A Practical Guide to Federal Enterprise Architectures*, *Version 1.0*, Chief Information Officers Council (February 2001); *Federal Enterprise Architecture Framework*, Version 1.1, Chief Information Officers Council (September 1999).

[28] February 28, 1998, memorandum – jointly signed by the Under Secretary of Defense for Acquisition and Technology; the Acting Assistant Secretary of Defense for Command, Control, Communications, and Intelligence, ASD(C3I); and the Director for Command, Control, Communications, and Computer Systems, Joint Chiefs of Staff.

Managed properly, an enterprise architecture can clarify and help optimize the interdependencies and interrelationships among a given entity's business operations and the underlying systems and technical infrastructure that support these operations.[29] Our experience with federal agencies has shown that attempting to define system-level architectures (e.g., develop requirements and design specifications) and use these systems architectures to build systems without having an enterprise architecture and aligning its systems' architectures with the enterprise architecture often results in systems that are duplicative, not well integrated, unnecessarily costly to maintain, and limited in terms of optimizing mission performance.

MHS has developed an initial version of an enterprise architecture.[30] We analyzed this architecture against the requirements for an enterprise architecture as defined by the DOD architecture framework,[31] which specifies the requirements that all DOD enterprise architectures are to meet. As we have previously reported, this framework is consistent with commercial architecture frameworks.[32] According to the DOD framework, enterprise architectures must have seven essential products, including a high-level operational concept graphic, information exchange matrix, and technical architecture profile. Our analysis shows that the current version of the MHS enterprise architecture has each of these products (see table 3).

[29] For additional information on enterprise architectures, see *Information Technology: Enterprise Architecture Use across the Federal Government Can Be Improved*, GAO-02-6 (Feb. 19, 2002).

[30] DOD has recently initiated a program to develop and implement a DOD-wide financial management enterprise architecture, which is to include each DOD business area that triggers a financial event. MHS is participating in this DOD-wide architecture effort, including providing MHS architecture products and staff.

[31] DOD's architecture framework is called the Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance Architecture Framework.

[32] GAO-01-631.

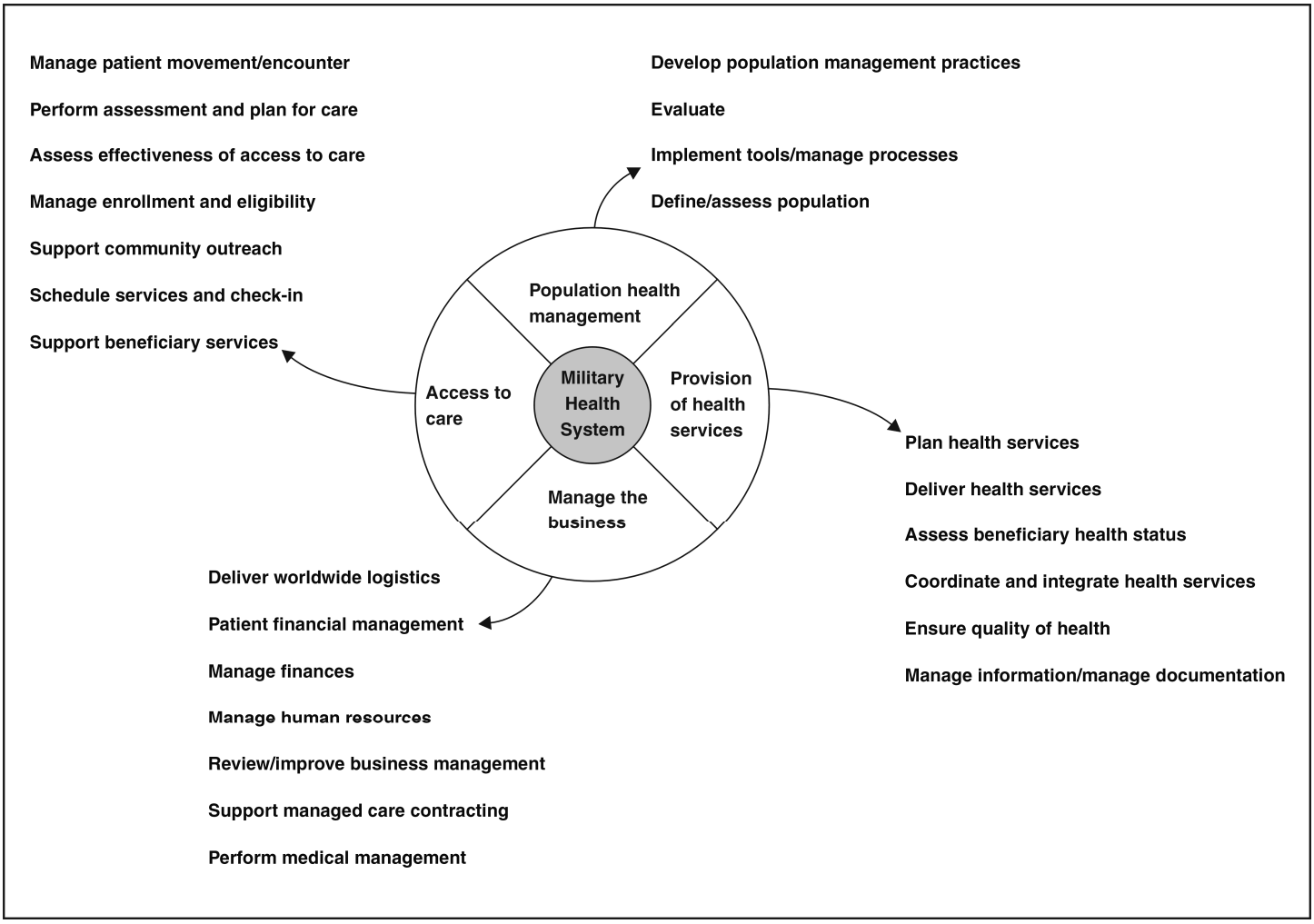
Table 3: MHS Enterprise Architecture Satisfaction of DOD Architecture Framework Essential Products

Product	Description	MHS architecture satisfies?
Enterprise view and summary information	Serves as planning guide and summarizes "who, what, when, why, and how" for architecture to be developed	Yes
Integrated dictionary	Provides a central source for definitions of all terms used in all architecture products	Yes
High-level operational concept graphic	Shows a high-level graphic description of operational concept, including organizations, missions, and geographic distribution of assets	Yes
Operational node connectivity description	Identifies organizational elements that produce, process, and consume information; need to exchange information between elements; and characteristics of information exchanged (content, media, volume requirements, security classification, timeliness, and interoperability requirements)	Yes
Operational information exchange matrix	Provides information exchange requirements, identifying who exchanges what information with whom, why information is necessary, and how it is needed	Yes
System interface description	Links operational and systems architecture views by depicting information systems and their interfaces to organizational elements that produce, process, and consume information	Yes
Technical architecture profile	Establishes a set of rules governing system implementation and operation; references existing technical guidance and discusses how that guidance has been or needs to be implemented	Yes

Source: GAO based on DOD data.

For example, MHS's operational high-level graphic illustrates four business areas: access to care, provision of health services, population health management, and manage the business. (See fig. 7 for a simplified version of the operational high-level graphic.) These business areas are then decomposed into activities. The activities, in part or whole, are carried out by MHS systems.

Figure 7: A Simplified Operational High-Level Graphic



Source: GAO based on DOD data.

As another example, DOD's framework requires an information exchange matrix that identifies who exchanges what information with whom, why the information is necessary, and how it is needed. The MHS enterprise architecture has this matrix, and for each information exchange, it identifies the information source and destination, criticality and timeliness, and frequency and format requirements. (See table 4.)

Table 4: Simplified Part of Information Exchange Matrix

Information exchange	Who?		Why?		How?	
	Source	Destination	Timeliness	Criticality	Frequency	Media type
Eligibility determination	Enrollment/ eligibility management staff	Enterprise-wide registration staff	Seconds- hours-days	Critical	Event- driven	Data, text
Customer data release agreement	Enrollment/ eligibility management staff	Primary care manager	Seconds- hours-days	High	Event-driven	Data, text
Encounter (administrative) data	Enterprise-wide registration staff	Enterprise-wide scheduling staff	Seconds-minutes	Routine	Event-driven	Data

Source: GAO based on DOD data.

A third example pertains to DOD's requirement that component architectures contain a profile of related DOD technical standards.[33] MHS's enterprise has such a standards profile, and this profile is aligned with the relevant DOD technical standards. For example, DOD requires a standard graphic data interchange, specific Windows management standards, and use of the federal information processing standard for password usage. The MHS architecture specifies each of these standard requirements in its standards profile.

CHCS II System Architecture

MHS has also developed a CHCS II architecture to define a level of system detail and specificity that is not found in an enterprise architecture, but which is needed in order to build the system. The system architecture is articulated in a number of system engineering documents, such as the system requirements document, the system design specifications, a data dictionary and database description, and commercial-off-the-shelf application and system software descriptions. According to MHS officials, the CHCS II architecture is fully aligned with the MHS architecture. They attributed this alignment largely to the fact that the two architectures were developed at the same time by the same individuals.

To verify this alignment, we compared the two architectures at both the logical and the technical levels. Our analysis showed that the CHCS II system architecture is aligned with the MHS enterprise architecture. At the logical level, we identified 52 capabilities that CHCS II is to perform in support of the MHS mission. Of these 52 capabilities, we judgmentally selected 13, or 25 percent, from 3 of the 4 MHS business areas that relate

[33] Department of Defense, Joint Technical Architecture, version 3.1, March 31, 2000.

to CHCS II, and compared them with activities defined in MHS's enterprise architecture. All 13 were aligned with the MHS enterprise architecture. (See table 5 for three examples.)

Table 5: Examples of MHS and CHCS II Mapping

MHS business area	MHS activity	CHCS II capability
Access to Care	Check-in patient	Patient registration
Population Health Management	Educate patients concerning new practices	Patient education
Provision of Health Services	Document care plans and delivery	Clinical documentation

Source: GAO based on DOD data.

At the technical level, we compared the MHS technical standards profile and the CHCS II system architecture to determine if they specified the same standards. MHS's profile identifies 61 technical standards that are appropriate for CHCS II. Of the 61 technical standards, 59 are specified in the CHCS II system architecture. For instance, DOD requires that medical systems conform to the defense information infrastructure common operating environment. MHS and CHCS II plans show that CHCS II is to be compliant with this standard in release 2. In addition, DOD requires that medical systems follow certain file transfer standards, and CHCS II architecture documentation specifies these standards. Further, DOD requires that a standard database language be used for medical systems, and CHCS II architecture documentation specifies this standard language.

The two standards in the MHS standards profile that are not specified in the CHCS II system architecture relate to document interchange. These standards are not currently applicable because the interfaces they apply to are for future releases.

Risk Management Controls in Place, but Application of Controls Can Be Improved

Managing project risk means proactively identifying facts and circumstances that increase the probability of failing to meet project commitments, and taking steps to prevent this from occurring. Best practices and federal guidance[34] advocate risk management. To be effective, risk management activities should be (1) based on documented policies and procedures and (2) executed according to a written plan that

[34] See, for example, *Software Acquisition Capability Maturity Model* SM (CMU/SEI-99-TR-002, April 1999); OMB Circular A-130 (Nov. 30, 2000).

provides for identifying and prioritizing risks, developing and implementing appropriate risk mitigation strategies, and tracking and reporting on progress in implementing the strategies. By doing so, potential problems can be avoided before they manifest themselves into cost, schedule, and performance shortfalls.

MHS has largely implemented a process for managing CHCS II risks that meets risk management best practices. Using a documented risk management policy and associated procedures, project officials have developed and are implementing a written plan for managing CHCS II risks. Under this plan, identified risks are captured in a database, and each risk is assigned a priority of 1 to 5, with 1 being the most serious and the highest priority.[35] Further, a strategy for mitigating each risk is defined and its implementation is managed, including assigning accountability for the risk, tracking status of the risk, and reporting on progress in implementing the risk mitigation strategy.

Using its risk management approach, MHS has identified 99 risks over the life of the project, including 27 priority 1 and 2 risks for release 1 and release 2. To verify that the established risk management approach was being followed, we reviewed the history and status of these priority 1 and 2 risks and found that they were generally being managed in a manner consistent with the process. For example, of the five open priority 1 and 2 risks associated with release 1 of the system, all had risk mitigation strategies that were being implemented and tracked through formal status reporting. However, of the five priority 1 and 2 risks associated with release 2, four were being reported as active but no mitigation actions were being reported over the last year for any of the four. According to project officials and documentation, this was because the four were actually inactive but the risk database had not been updated. The project office has since updated the database.

In addition, our analysis led us to question why one priority 1 risk—user acceptance of the system—had been closed and was no longer being actively managed since user acceptance is a common risk of commercial-off-the-shelf-based system solutions and, given the status of CHCS II

[35] In MHS's risk management plan, priority 1 risks require immediate project changes to eliminate or reduce the risk and management attention; priority 2 risks require some project changes, mitigation strategies, and careful monitoring; priority 3 risks require mitigation strategies and careful monitoring; and priority 4 and 5 risks do not require mitigation activities.

deployment, user interaction with the system to date has been extremely limited (i.e., confined largely to only the approximately 100 medical personnel who have participated in system acceptance testing). In response, the project office returned this risk to active status, and it is now being formally managed using a mitigation strategy and tracked via formal reporting.

Project officials attributed these instances to lapses in updating the risk database. The quality of this database is important, as it defines where limited resources will be focused to thwart the emergence of real problems with real consequences. Without an accurate and complete inventory of risks, their status, and the progress of strategies to address them, the chances of system cost, schedule, and performance problems occurring are increased.

Performance-based Contract Management Practices Not Being Used

Performance-based contracting is a recognized best practice that federal procurement policy reflects.[36] Specifically, this policy requires agencies to use performance-based contracting methods to the maximum extent practicable when acquiring services. Moreover, the CHCS II acquisition strategy calls for performance-based contracting practices.

To qualify as performance-based under federal regulations, an acquisition should have (1) requirements that define the work to be performed in measurable terms; (2) standards (quality or timeliness) that are tied to performance requirements; (3) a quality assurance plan that describes how the contractor's performance in meeting requirements will be measured against standards; and (4) positive and negative incentives.

In the delivery orders that it has executed to date with the CHCS II integration contractor, the project office has not fully satisfied any of these tenets. First, the delivery orders contain performance requirements and the requirements are written in measurable, mission-related terms. However, the terms are allowed to change with each delivery order modification without holding the contractor accountable for performance up to the point of the modification. Instead, both the requirements and performance prior to the modification are supplanted by the modified requirements, and contractor performance begins anew. In light of the number of modifications that have accompanied CHCS II delivery orders,

[36] Federal Acquisition Regulation, Part 37.

this results in considerable contractor activity not being managed on the basis of performance. For example, one delivery order was modified 19 times during its 30-month life, and the contractor's performance was started anew five times, although work was behind schedule each time.

Second, the CHCS II delivery orders contain timeliness, but not quality, performance standards for each requirement. More specifically, each order has a defined delivery date for each deliverable, but does not specify standards governing the quality of each deliverable. Third, CHCS II project management does not have a quality assurance plan defining how it will apply standards to measure contractor performance in meeting requirements. Fourth, the orders do not specify incentives for either positive or negative contractor performance.

According to project officials, performance-based contracting practices have not been employed because these practices have traditionally not been used for IT services contracts, and they did not know how to successfully do so for a system acquisition like CHCS II, where the government is acquiring a product rather than a service. The officials also stated that the multi-agency contract vehicle they chose to use offered them flexibility and was immediately available, and they have not viewed performance-based contracting as a priority.

By not using performance-based contracting practices on CHCS II, the project office lacks an effective means for ensuring that it pays a fair price for what it receives. To illustrate, three times in 2001 the project office agreed to a schedule delay for release 2 deliverables because the contractor was not able to meet the release 1 schedule. In each instance, the release 2 work was also behind schedule. Nevertheless, in both instances, release 2 delivery dates were changed and the contractor's performance was shown as being on schedule.

Project officials stated that they recognize the value of performance-based contracting. To prepare them for applying these best practices on future CHCS II releases, they stated that they have recently awarded a performance-based contract for help-desk services for a number of MHS systems, including CHCS II, and that another MHS project is currently negotiating a performance-based contract for software development. They said that they intend to use these experiences to assist them in negotiating a performance-based contract for CHCS II release 3.

Conclusions

Owing largely to the absence of the kind of management and technical controls that are hallmark qualities of system investment and acquisition best practices, CHCS II's early years produced little more than lessons learned. Since then, the project's management team has recognized the need to change and given priority attention to doing so. As a result, they introduced key missing best practices and made other improvements to the project, some of which have occurred during the course of our review. These needed practices and improvements have contributed to where MHS stands today: in the latter stages of having an initial version of CHCS II that shows signs of maturation and operational readiness, although questions about operational efficiency due to unresolved defects remain a concern.

A larger concern, however, are unanswered questions about CHCS II's investment value. These questions exist because the project's management and oversight teams, to include both the MHS and DOD CIOs, have not given implementation of incremental investment management practices adequate priority and attention. Consequently, MHS has continued to invest in CHCS II without sufficient economic justification for doing so. The prospects for this changing are encouraging, given statements by project officials, but until defining and implementing processes for incremental investment, the risk of DOD's spending more on the system than it will return in measurable benefits is increased. Opportunities also exist for increasing the effectiveness of ongoing risk management activities by ensuring that the risk database is complete and correct, thereby heading off problems before they occur. Further, opportunities exist for adopting performance-based contracting best practices to better ensure that DOD pays a fair price for contractor deliverables.

Greater use of best practices in the areas of investment, risk, and contract management will better position CHCS II management to ensure that it will not only be investing in the right vehicle but that it will be investing the right way, meaning that it will be following the kind of proven management practices that increase the probability that required system capabilities and expected benefits will be delivered on time and within budget.

Recommendations for Executive Action

To strengthen CHCS II investment, risk, and contract management practices, and thereby increase the chances of the department's investment in CHCS II's producing mission value commensurate with system costs, we recommend that the Secretary of Defense, through the Assistant Secretary of Defense for Health Affairs, direct the MHS CIO to give expanded use of best practices in managing CHCS II the attention and

priority they deserve. At a minimum, the Assistant Secretary should direct the MHS CIO to take the following actions:

- As part of CHCS II deployment decisions, including any request to the DOD CIO for deployment approval, consider the aggregate impact on defense health affairs mission performance caused by the workarounds needed to compensate for all unresolved defects affecting the system's operational efficiency.

- Define and implement incremental investment management processes to include (1) modifying the CHCS II investment strategy to define how this approach will be implemented; (2) justifying investment in each system release before beginning detailed design and development of the release; (3) requiring that such justification be based on reliable estimates of costs, benefits, and risks; (4) measuring whether actual return-on-investment for each deployed release is in line with justification forecasts; and (5) using actual return-on-investment results in deciding whether to begin detailed design and development of the next system release.

- Verify that the CHCS II inventory of risks is complete and correct, and report this to the Assistant Secretary for Health Affairs every 6 months, along with a report on the status of all top priority risks, including each risk's probability of occurrence and impact on mission.

- Employ performance-based contracting practices on all future CHCS II delivery orders to the maximum extent possible, including (1) defining performance standards against which deliverables can be judged, (2) developing and using quality assurance plans that describes how contractor performance against the standards will be measured, and (3) defining and using contractor incentives and penalties tied to the quality plan.

Additionally, we recommend that the Secretary of Defense direct the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence, who is the designated approval authority for CHCS II, to monitor the project's use of best practices, including implementation of each of the above recommendations, and use this information to oversee the project's movement through its acquisition cycle. To this end, we also recommend that the Assistant Secretary, or other designated CHCS II approval authority, not grant any request for deployment approval of any CHCS II release that is not justified by reliable analysis of the release's costs, benefits, and risks.

Agency Comments and Our Evaluation

DOD provided what it termed "official oral comments" from the Assistant Secretary of Defense for Health Affairs on a draft of this report. In its comments, DOD stated that it agreed with our report's overall message of expanding the department's use of acquisition management best practices on CHCS II. Further, it agreed with two of our three primary recommendations and associated findings, and it partially agreed with the third, taking exception only to two of this recommendation's component elements. Each of these two elements is discussed below.

First, DOD disagreed with the recommendation calling for using actual return-on-investment results from an implemented system release in deciding whether to begin detailed design and development of the next system release, citing the impact on the product delivery cycle (i.e., schedule). Instead, DOD stated that it would use "post-deployment findings and lessons learned for a given release to minimize risks associated with future release development." Assuming that DOD's reference to "post-deployment findings" includes having at least preliminary information on cost and benefit accrual, we do not disagree with DOD's proposed alternative and do not believe that it is inconsistent with our recommendation. If it does not, we do not believe that the proposed alternative adequately positions the department to make informed investment decisions on future releases because it does not provide for knowing, at least preliminarily, whether a prior release's mission value is being realized. Given that producing mission value is a paramount reason for investing in technology, such information about prior system releases is essential in making prudent decisions about further investment in the system

Moreover, by not having at least preliminary information about actual return-on-investment, DOD would not be able to accomplish its stated goal of using "post-deployment findings . . . to minimize risks associated with future release development" because it would not have any indication about whether release return-on-investment expectations are accruing. On the contrary, DOD's approach would expose the program to unnecessary risk in the name of meeting a scheduled milestone. Restated, it would increase the chances of doing the wrong thing faster. The intent of our recommendation is to prevent this by ensuring that DOD has an adequate understanding of returns from prior investments before choosing a course of action on subsequent investments. Accordingly, we have not modified our recommendation.

Second, DOD disagreed with the recommendation element calling for reporting on CHCS II program risks to the Assistant Secretary for Health

Affairs every 6 months, instead stating that the timing of its reporting would comply with DOD internal milestone review requirements, which based on program plans would result in annual reporting. We do not believe that DOD's proposed alternative provides for adequate disclosure of those items that have a high probability of significantly affecting delivery of promised system capabilities on time and within budget to the executive leadership sponsoring CHCS II. As our research of leading organization IT investment management practices shows, awareness of program risks, particularly the top priority risks covered by this recommendation, are fundamental to ongoing investment control activities and, among other things, should be frequently disclosed to investment executives. Further, over extended periods of time, such as 1 year, these risks can manifest themselves into material program cost, schedule, and performance shortfalls. For these reasons, 6-month reporting on these risks should be viewed as the minimum acceptable frequency. Thus, we have not modified our recommendation.

DOD also provided a comment on our recommendation for the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence to only approve deployment of a CHCS II release if it is justified by reliable analysis of the release's cost, benefits, and risks. Specifically, DOD stated that while the Assistant Secretary was currently the approval authority for CHCS II deployment and related milestone decisions, this decision authority could be delegated in the future. We have adjusted our recommendation to recognize this possibility.

We are sending copies of this report to the Chairman and Ranking Minority Members of the Senate Committee on Armed Services; House Committee on Armed Services; Subcommittee on Defense, Senate Committee on Appropriations; the Subcommittee on Defense, House Committee on Appropriations; the Subcommittee on Military Readiness, House Committee on Armed Services; Senate Committee on Government Affairs; and House Committee on Government Reform. We are also sending copies to the Secretary of Defense and the Director, Office of Management and Budget. Copies will be available upon request and will also be available without charge at our Web site at www.gao.gov.

Should you have any questions on matters discussed in this report, please contact me at (202) 512-3439 or by e-mail at HiteR@gao.gov. Key contributors to this report are listed in appendix VI.

Randolph C. Hite
Director, Information Technology Architecture
and Systems Issues

Appendix I: Objectives, Scope, and Methodology

The objectives of our review were to determine (1) what progress the Department of Defense (DOD) has made against the Composite Health Care System (CHCS) II project commitments, (2) whether DOD has economically justified its investment in CHCS II, and (3) whether DOD has effective technical and management controls in place for acquiring the system. Project commitments included in our scope of work were required system capabilities, promised system benefits, and estimated project costs and milestones; controls included requirements management, test management, architecture development and alignment, risk management, and contract management.

To determine the progress made against commitments, we reviewed relevant project management documents, such as acquisition strategy and program baseline documents, acquisition decision memoranda, and quarterly Defense Acquisition Executive Summary reports, and we interviewed CHCS II project, military health system (MHS) program, and DOD oversight officials, to determine original and revised system capabilities, expected benefits, estimated costs, and project milestones for both system increments and the entire system. We then reviewed program management reports and briefings and system documentation (e.g., cost reports, defect reports, and test results), and interviewed project, program, and oversight officials, to determine actual (as reported) system capabilities, costs, and schedules, as well as accrued benefits. Comparing the two, we identified variances and, through document review and interviews, identified the causes of the variances. We did not independently validate the status information obtained.

To determine whether DOD had economically justified CHCS II, we reviewed best practices governing system investment management, including those pertaining to incremental investment practices, and we reviewed relevant legislative requirements and federal guidance.[37] We then analyzed the available economic justification for the project, an April 1998 economic analysis.[38] We compared this analysis to the best practices and federal guidance, and discussed with project, program, and oversight officials, as well as CHCS II contractor officials to determine how the analysis was prepared, including the basis for cost and benefit estimates and assumptions. We also requested updates of this analysis, and reviewed draft updates provided to determine whether these updates were

[37] Clinger-Cohen Act of 1996, Public Law 104-106, and OMB Circular A-130 (Nov. 30, 2000).

[38] CHCS II Milestone I Economic Analysis, April 15, 1998.

approved. Using data from approved and updated draft analyses, we also calculated net present values for CHCS II. In addition, we reviewed available documentation and interviewed CHCS II project officials on its portfolio-based investment analysis process and how this process was applied to CHCS II.

To determine whether DOD has effective technical and management controls in place for acquiring the system, we focused on whether best practices were being employed in five key areas: requirements management, test management, architecture development and alignment, risk management, and contract management. We reviewed these areas because they are critical to successfully acquiring systems. Among other sources, these practices were derived from the work and research of Carnegie Mellon University's Software Engineering Institute (SEI),[39] as well as our own research.[40] Where appropriate, we also applied relevant legislative requirements and federal guidance that embody these best practices.[41] We also interviewed MHS officials, CHCS II project officials, and contractor staff from Integic, Incorporated, the CHCS II integration contractor. More detailed description of our scope and methodology in each control area is provided below.

Requirements Management: To evaluate requirements management controls, we reviewed the current CHCS II requirements management process and compared it to best practices. We then evaluated the project's compliance with its established process by analyzing selected sets of requirements that were managed under the current process. Since the current process was not in place until 2000, we judgmentally selected one of the three requirements sets that were added in 2000, and one of the five that were added in 2001. Requirements documentation that we reviewed also included requirements descriptions, cost and impact estimates, and the related 2000 and 2001 budget analysis documents. We also interviewed project and MHS officials responsible for requirements management.

[39] See, for example, *Software Acquisition Capability Maturity Model* SM (CMU/SEI-99-TR-002, April 1999).

[40] See, for example, *Year 2000 Computing Crisis: A Testing Guide* (GAO/AIMD-10.1.21, November 1998); *Information Technology Investment Management: A Framework for Assessing and Improving Process Maturity*, Exposure Draft, GAO/AIMD-10-1.23, version 1 (Washington, D.C.: May 2000).

[41] Clinger-Cohen Act of 1996, Public Law 104-106; OMB Circular A-130, (Nov. 30, 2000); *A Practical Guide to Federal Enterprise Architectures*, *Version 1.0*, Chief Information Officers Council (October 2000).

Test management: To evaluate test management controls, we reviewed the CHCS II master test plan to determine the overall test approach and scope, including the types of testing performed and planned. Because system acceptance testing was being planned, conducted, and completed during the course of our review, we focused on this test event. Specifically, we analyzed acceptance test planning documents, including test procedures, and the actual test results, and we compared the practices defined and followed to relevant best practices to identify whether any variances existed. We also analyzed the scope of the test by selecting a statistically valid sample of 59 requirements and analyzing test procedures to determine if each requirement was addressed. This sample size provided us with a 95 percent confidence level. Additionally, we analyzed test results to determine whether defined system maturity parameters were met, and if not, analyzed the variance to determine the significance of the variance.

Architecture development and alignment: To evaluate these controls, we first focused on the MHS enterprise architecture, determining what the architecture framework is based on and whether the framework used is consistent with recognized commercial frameworks. We then compared the MHS enterprise architecture to the framework to determine if essential architectural artifacts had been developed, and where applicable, whether the MHS architecture was consistent with DOD-wide architecture requirements, such as whether the technical standards profile in the MHS architecture was consistent with the DOD Joint Technical Architecture.[42] Next, we obtained relevant CHCS II architectural documents, such as requirements documents and design specifications, and traced selected CHCS II architecture characteristics to the MHS architecture to determine alignment. At the business or logical level of the architecture, we compared 13 release 1 system capabilities (categories of requirements) to the business areas and activities in the MHS architecture. We selected 13 of the 52 release 1 capabilities (25 percent) to ensure that we included capabilities covering all MHS business areas relevant to CHCS II. We did not plan to select more than the 13 capabilities unless we were unable to trace any of the 13. At the technical level, we compared all of the CHCS II technical standards to the MHS technical standards profile. In conducting our analysis, we also interviewed MHS and project officials and reviewed architecture development plans to determine how the respective

[42] Department of Defense, Joint Technical Architecture, version 3.1, March 31, 2000.

architectures were developed, who developed them, and how they ensured alignment between the two.

Risk management: To evaluate risk management controls, we reviewed the CHCS II risk management process and compared it with best practices. To determine whether the process was being followed, we analyzed all priority 1 and 2 risks for release 1 and release 2, including determining whether defined steps were performed and criteria for reporting on and closing risks were met. Additionally, we used the results of review of CHCS II to determine whether additional risks should be added to the existing risk inventory. In conducting our analysis, we interviewed project officials and reviewed relevant documentation, such as the risk management plan, risk mitigation strategies, and risk status reports.

Contract management: In evaluating contract management controls, we discussed with project officials their criteria and approach for defining contract deliverables and measuring contractor performance, and whether they had plans for changing from past practices. We also reviewed the 11 1999 to 2001 release 1 contract delivery orders with the CHCS II integration contractor and compared them with tenets of performance-based contracting, which are defined in federal acquisition regulations.[43] Additionally, we reviewed internal reports, such as earned value management system summary reports, which described progress against delivery order schedules and budgets to obtain data on contractor performance.

We conducted our work at offices of the Military Health System in Falls Church, Virginia, and at Integic, Incorporated, offices in Chantilly, Virginia, from August 2001 through July 2002, in accordance with generally accepted government auditing standards.

[43] Federal Acquisition Regulation, Part 37.

Appendix II: Comparison of CHCS and CHCS II Capabilities

Capability	Provided by CHCS?	Provided by CHCS II release 1?	Provided by CHCS II when all releases complete?
Access to Care			
Bed Availability Reporting	Yes	No	Yes
Case Management	No	No	Yes
Enrollment/Eligibility	Yes	Yes	Yes
Enterprise Member/Patient Index	No	No	Yes
Enterprisewide Registration	No	No	Yes
Enterprisewide Scheduling	No	No	Yes
Evacuation Requests	Yes	No	Yes
Global Clinical Data Repository	No	No	Yes
Referral Management	Yes	No	Yes
Triage and Demand Management	No	No	Yes
Provision of Health Services			
Alerts and Reminders (including Allergies and Drug Interactions)	No	Yes	Yes
Centralized Health Record Repository	No	Yes	Yes
Clinical Decision Support	No	No	Yes
Clinical Documentation	No	Yes	Yes
Dental Charting and Documentation	No	No	Yes
Discharge Planning	No	No	Yes
Encounter Coding	No	Yes	Yes
Enterprise Health Record	No	Yes	Yes
Home-based Monitoring	No	No	Yes
Inpatient Order Entry/Management (Laboratory, Pharmacy, Radiology)	No	No	Yes
Operating Room Management	No	No	Yes
Optometric Documentation/Order Entry	No	No	Yes
Outpatient Order Entry/Management (Laboratory, Pharmacy, Radiology)	Yes	No	Yes
Patient Education	No	No	Yes
Patient Health History	No	Yes	Yes
Pharmaceutical Profiling	No	No	Yes
Results Reporting (Ancillary Services)	Yes	Yes	Yes
Role-Based Security	No	Yes	Yes
Telemedicine	No	No	Yes
Theater Integration Related to Provision of Health Service	No	Yes	Yes
Transcription Services Interface	No	Yes	Yes
Voice Recognition	No	No	Yes
Population Health Management			
Clinical Enterprise Member/Patient Index	No	No	Yes
Clinical Look-back	No	No	Yes
Clinical Outcomes Reporting	No	No	Yes
Clinical Registries	No	No	Yes

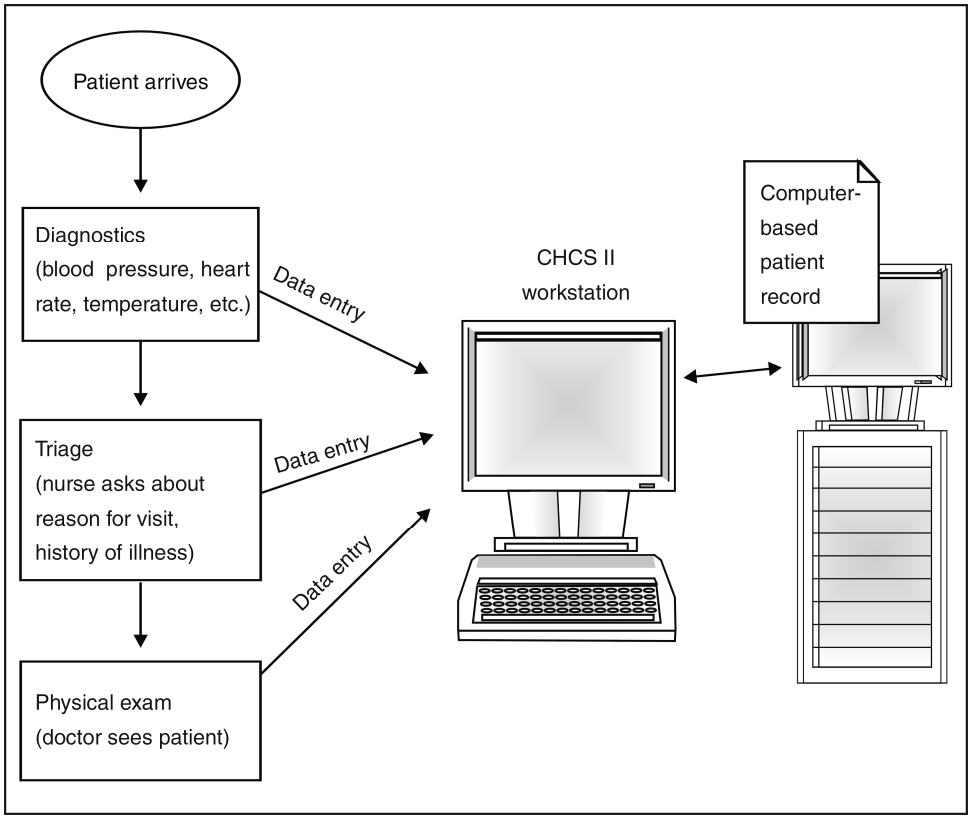
Capability	Provided by CHCS?	Provided by CHCS II release 1?	Provided by CHCS II when all releases complete?
Demand Material	No	No	Yes
Health Plan Employer Data and Information Set Reporting	No	No	Yes
Health Risk Assessment	No	Yes	Yes
Health Surveillance Monitoring/Reporting	No	No	Yes
Immunization Tracking	No	Yes	Yes
Individual Medical Readiness Status Reporting	No	No	Yes
Interface to VA Mail Order Pharmacy	No	No	Yes
Occupational Health Monitoring	Yes	No	Yes
Patient Satisfaction Reporting	No	Yes	Yes
Patient Self-assessment Data Entry	No	Yes	Yes
Population Utilization Management	No	No	Yes
Provider Profiling	No	Yes	Yes
Radiation Health Monitoring and Reporting	Yes	No	Yes
Rules-based Clinical Protocols	No	No	Yes
Theater Integration Related to Population Health Material	No	Yes	Yes

Source: GAO based on DOD data.

Appendix III: Detailed Explanation of How CHCS II Will Operate

The initial version (release 1) of CHCS II is a medical information system that combines existing MHS systems with commercial software to provide a computer-based patient record (CPR) of treatment provided to DOD health-care beneficiaries in DOD medical treatment facilities (MTF). CHCS II is intended to allow a provider (physician, nurse, technician, etc.) to record information gained from a patient's visit to the MTF in the patient's CPR, as shown in figure 8.

Figure 8: Creating a Computer-based Patient Record



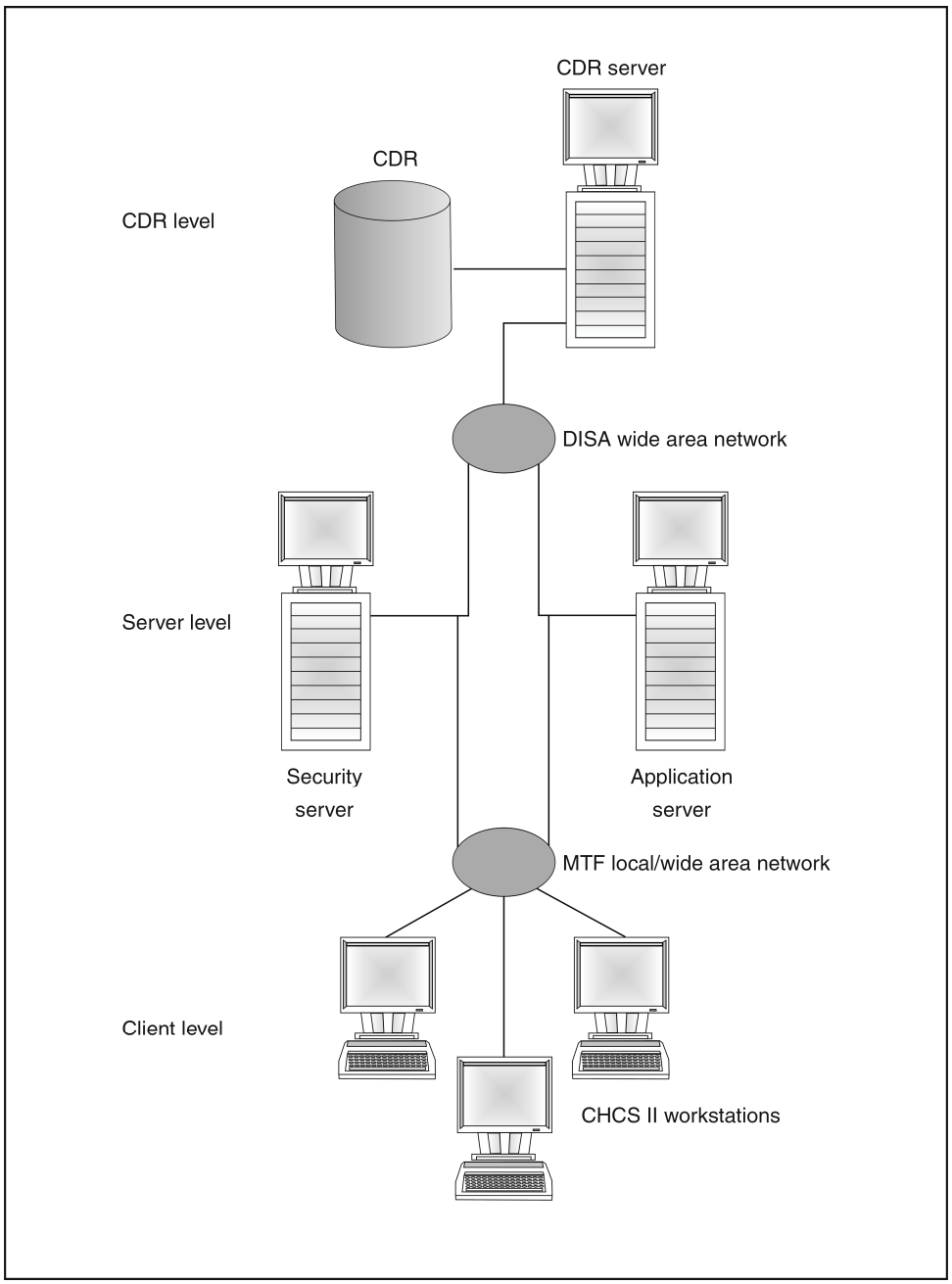
Source: GAO based on DOD data.

CHCS II's architecture is an open system, client-server design of three levels: the user (client) workstation at various MTF locations, the MTF computers' (servers') operating system and storage hardware and software, and a clinical data repository at a remote computing center where the CPR is stored. DOD plans to connect all workstations at an installation's hospital or clinics to the servers through the installation's local or wide area network. DOD also plans for each installation to be

connected, via the Defense Information Systems Agency's (DISA) unclassified wide area network,[44] to the Montgomery, Alabama, computing center, where the CPRs will be stored in a database known as the clinical data repository (CDR). Figure 9 shows how the three CHCS II levels are connected.

[44] The network is the Unclassified but Sensitive Internet Protocol Router Network.

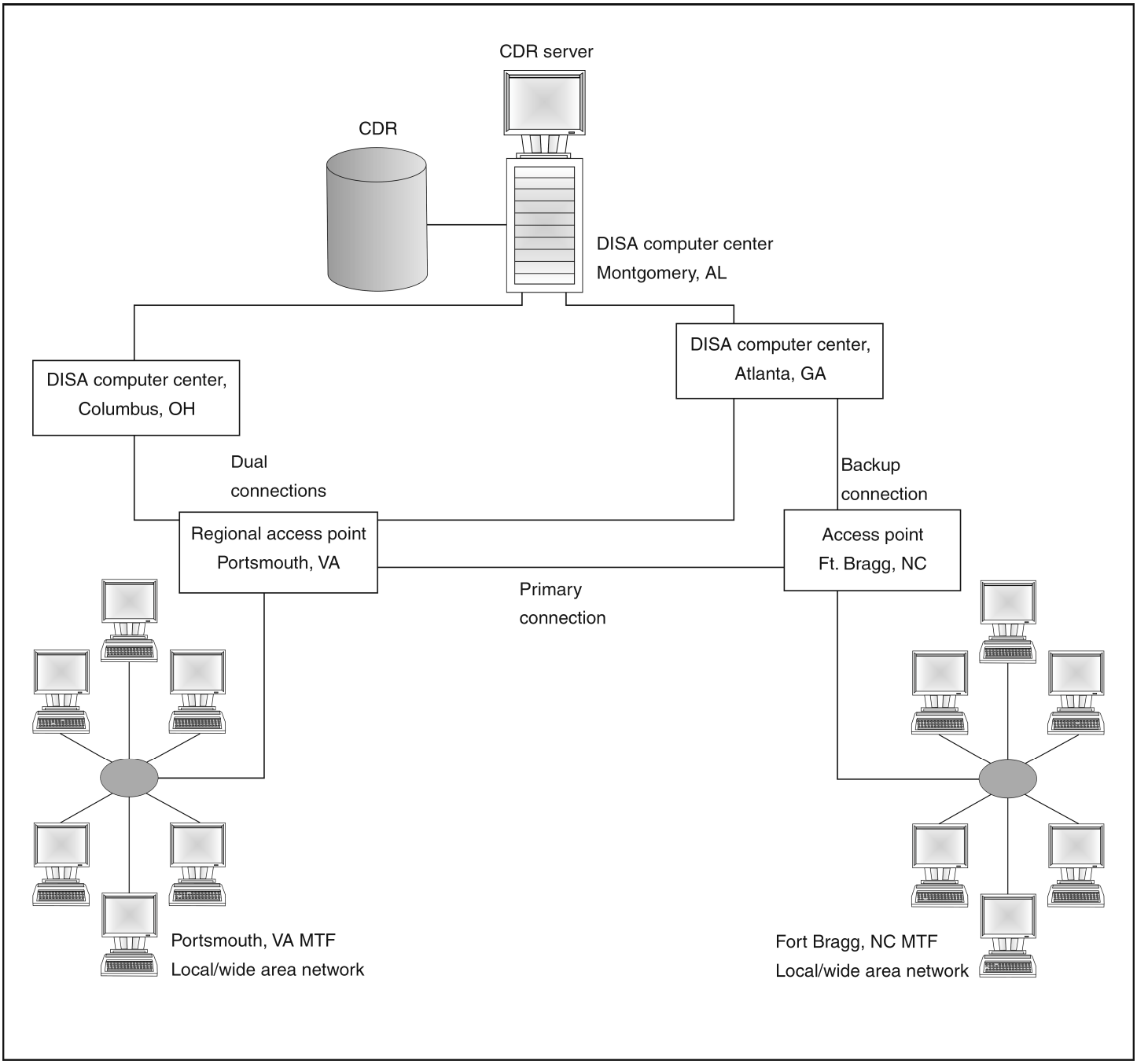
Figure 9: CHCS II Tri-level Architecture



Source: GAO based on DOD data.

DOD plans to deploy release 1 regionally, starting with all sites in MHS region 2 (Virginia and North Carolina). Communications between the MTFs and the CDR go through a single access point in each region (the regional hub). For region 2, the access point is planned for Portsmouth, Virginia, site of the Portsmouth Naval Hospital. The Portsmouth regional access point plan shows a primary and secondary (for redundancy and diversity) connection to the CDR through two separate DISA computing centers. The communication plan shows each installation in region 2 with an installation access point connected to Portsmouth, and a backup connection to the CDR through a DISA computing center. Figure 10 shows a typical communications setup for release 1, in this case for region 2. The figure uses the Ft. Bragg, North Carolina, MTF as an example of the nonregional hub.

Figure 10: Example of CHCS II Regional Communications



Source: GAO based on DOD data.

Appendix IV: CHCS II Release 1 Software Packages

Release 1 is composed of a number of commercial-off-the-shelf (COTS)[45] and government-off-the-shelf (GOTS) software packages, as shown in table 7. The core CHCS II functionality is provided by the existing CHCS application (nine GOTS packages), plus the two 3M software packages, MEDCIN charting software, data dictionary, and clinical data repository (five COTS packages). The packages are integrated by software developed by the CHCS II contractor. In addition to the core functionality, CHCS II is also composed of 16 other COTS packages that provide operating system, security, data exchange, and other system functions. The CHCS II software is located on hardware platforms at the 142 military treatment facilities (user workstations and application, security, interface, and CHCS servers) and the DISA computing center (clinical data repository and server).

Table 6: CHCS II Release 1 Software Packages by Location

Location	Product	Use	Type
Client Workstation	MEDCIN	Charting	Commercial
	Snareworks	Security	Commercial
	Adobe Acrobat Reader	Form viewer	Freeware
	Dimension 4	Time service	Freeware
	Windows 2000	Operating system	Commercial
	Problem Knowledge Couplers	Education	Commercial
	McAfee Netshield	Virus protection	Commercial
	PARS II Data Collector	Data collection	Government
Administrator Workstation	Problem Knowledge Coupler	Education	Commercial
	Adobe Acrobat Reader	Form viewer	Freeware
	McAfee Netshield	Virus protection	Commercial
	3M Clinical Workstation	User interface	Commercial
Clinical Data Repository / Enterprise Security Server	3M Software	Data dictionary, repository	Commercial
	SNOMED	Data dictionary	Commercial
	Netscape Unix	User registration	Commercial
	HP Distributed computing	Security	Commercial
	Snareworks	Security	Commercial
	Oracle	Database	Commercial
	Tuxedo	On-line transaction monitor	Commercial

[45] Some of the COTS packages are described as “freeware,” which can be used without charge, or “shareware” which, if you use it regularly, you’re required to register and pay for.

Location	Product	Use	Type
Military Treatment Facility Security Server	Enosis Connection Manager	Software management	Commercial
	Tardis	Time service	Shareware
	Windows NT 4	Operating system	Commercial
	Gradient	Middleware	Commercial
	Snareworks	Security	Commercial
Military Treatment Facility Application Server	Active X	Operating system component	Government
	Enosis Connection Manager	Data exchange	Commercial
	Snareworks	Security	Commercial
	Tardis	Time Service	Shareware
	Oracle	Database	Commercial
	Business Objects	Reports	Government
Interface Engine Server	Datagate	Operating system; Interface: 3M to CHCS II	Commercial
CHCS Server	CHCS	CHCS application	Government
	Fileman	CHCS application	Government
	GIS	Interface software	Government
	HL 7	Message software	Government
	OV MVS	Operating system	Commercial
	MUMPS	Programming language	Commercial
	M Adapter	Data exchange	Government
	M Functions	Data exchange	Government

Source: GAO based on DOD data.

Appendix V: CHCS II Capabilities Planned for Releases 3-7, and Expected Release Dates

Release number and expected release date	Capabilities
3 July 2004	Enterprise member/patient index Government computerized patient record (DOD–Department of Veterans Affairs clinical information exchange) Health risk assessment Health surveillance monitoring and reporting Individual medical readiness status reporting New eligibility system interface Patient self-assessment data entry (additional functionality) Referral management Replacement ancillary system–pharmacy Rules-based clinical protocols Theater integration
4 July 2004	Bed availability reports Cost accounting and patient accounting interfaces Dental imaging Enterprisewide registration Enterprisewide scheduling (includes operating room) Evacuation requests Operating room management Outpatient order entry and management Pharmaceutical profiling Replacement laboratory, pathology, radiology systems Theater integration Triage and demand management
5 July 2005	Assurance/safety Case management Inpatient order entry and management Patient education Patient safety reporting Population utilization management and quality Theater integration Voice recognition
6 July 2005	Clinical look-back Clinical outcomes reporting Discharge planning Enterprise health record Health plan employer data reporting Provider database interface Theater integration
7 July 2006	Home-based monitoring Nonradiation and nonlaboratory ancillary procedures interface Occupational health monitoring Radiation health monitoring and reporting Telemedicine Theater integration

Source: GAO based on DOD data.

Appendix VI: GAO Contact and Staff Acknowledgments

GAO Contact

Carl L. Higginbotham, (404) 679-1824

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In addition to the individual named above, key contributors to this report included Nabajyoti Barkakati, Harold J. Brumm Jr., Katherine I. Chu-Hickman, Michael P. Fruitman, Chetna Lal, and Keith E. Steck.

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