SAMPLE FOR DEMONSTRATION PURPOSES

Technology Support Division
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U.S. Army Medical Materiel Agency
U.S. Army Medical Research and Materiel Command
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TARA

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Glossary Of Abbreviations

ACH	Army Community Hospital
ACN	acquisition control number
ACNP	American College of Nuclear Physicians
ACR	American College of Radiology
ADSL	asymmetric digital subscriber line
AMEDD	Army Medical Department
AMEDDPAS	Army Medical Department Property Accounting System
ATM	asynchronous transfer mode
BAMC	Brooke Army Medical Center
BPR	Business Process Reengineering
BRI	basic rate interface
CAT-1, CAT2	category 1, category 2
CCD	charge-coupled device
CEEP	Capital Expense Equipment Program
CHCS	Composite Health Care System
CME	continuing medical education
CPT	current procedural terminology
CR	computed radiography
CT	computed tomography
DBSS	Defense Blood Supply System
DICOM	Digital Imaging and Communications in Medicine
DOD	Department of Defense
DRMO	Defense Reutilization Marketing Office
DSL	digital subscriber line
EBCT	electron beam computed tomography
EPI	echo planar imaging
FDA	Federal Drug Administration
FTE	full-time equivalent
GI	gastrointestinal
GME	graduate medical education
HDSL	high-bit rate digital subscriber line
HIS	hospital information system
ISDN	Integrated Services Digital Network
ISO	independent service organization
JCAHO	Joint Commission on the Accreditation of Hospital Organizations
JHMET	Joint Healthcare Management Engineering Team
JPEG	Joint Photographic Experts Group
kbps	kilobits per second
LAN	local area network
MB	megabytes
Mbps	megabits per second
MEDCEN	medical center
MEDDAC	medical activity

Glossary (cont.)

MEDCASE	Medical Care Support Equipment
MEPRS	Medical Expense Performance Reporting System
mini-PACS	mini-picture archiving and communication system
MMCN	medical materiel control number
MPR	MEDCASE program requirement
MRI	magnetic resonance imaging
MQSA	Mammography Quality Standards Act
MTF	medical treatment facility
MUGA	multigated cardiac analysis
NCO	noncommissioned officer
NCOIC	noncommissioned officer-in-charge
NEMA	National Electronics Manufacturers Association
O&M	operations and maintenance
OEM	original equipment manufacturer
OIC	officer-in-charge
OTSG	Office of The Surgeon General
PACS	picture archiving and communication system
PET	positron emission tomography
PMT	photomultiplier tube
PRI	primary rate interface
PTP	proficiency testing program
QA/QC	quality assurance/quality control
R/F	radiographic/fluoroscopic
RMC	Regional Medical Command
R/T	radiographic/tomographic
RIS	radiology information system
SCP	service class provider
SCU	service class user
SONET	synchronized optical network
SPECT	single photon emission computed tomography
STCPC	Strategic Technology and Clinical Policies Council
TARA	Technology Assessment and Requirements Analysis
TIMPO	Tri-Service Information Management Project Office
TDY	temporary duty
USAMMA	U.S. Army Medical Materiel Agency
USAMEDCOM	U.S. Army Medical Command
UTP	unshielded twisted pair
VA	Veterans Affairs
WAN	wide area network

This report mentions various brand and trade names. Mention of any brand or trade names is not an endorsement of the product. Medical treatment facilities should evaluate all products comparable to those mentioned in this report when making procurement decisions and choose the product that best suits the needs and budget of the facility.

TARA

SAMPLE FOR DEMONSTRATION PURPOSES

TECHNOLOGY ASSESSMENT AND REQUIREMENTS ANALYSIS

ARMY COMMUNITY HOSPITAL

EXECUTIVE SUMMARY

An assessment of diagnostic imaging, radiation therapy, and clinical laboratory technology was conducted at Army Community Hospital (ACH). ACH has a number of departments and clinics that provide diagnostic imaging services. Within the radiology department, the timeliness and quality of services are good. Image availability and accountability, fetch time for images, and unread film rate are excellent. However, ACH has a significant number of diagnostic imaging systems that are reaching their life expectancy or changes in technology for that modality have occurred, and those systems need to be evaluated for replacement or upgrade. Within the clinical laboratory, the services are excellent.

ACH is well prepared for digital radiology and picture archiving and communications systems (PACS) with the Medical Diagnostic Imaging Support (MDIS) system. Although the primary option for creating digital images was to use computed radiography (CR) as an intermediate step, digital radiography (DR) x-ray systems are now available. Currently, the cost of analog systems that use the CR reader and image plates and the cost of networking the CR reader combined are less than the cost of DR systems. CR and DR perform nearly duplicate functions, and the extra expense of DR may not be justified for some facilities. In addition, once CR is established in a facility, details of workload and workflow will need to be assessed to determine if cost benefits for DR systems can be justified. However, DR systems are a new technology still being investigated. As a result, we will recommend DR systems for some facilities because of the Army Medical Department's (AMEDD) need to evaluate clinical effectiveness and cost efficiency, and ACH is one of the facilities for which we are recommending DR systems.

We recommend installation of a DR system in both the radiology core and orthopedics clinic. DR systems have digital detectors in the table to capture images electronically without the use of CR plates. The image can be sent to a workstation for immediate viewing, a digital archive, or a printer if viewing on hard copy is wanted. There is no intermediate data- or film-processing step. In the case at ACH, a DR system will help to relieve the burden on the CR readers in the core area.

Issues the Command group at ACH may want to note or further evaluate include the following:

- Patient appointment backlogs for screening mammography, ultrasound, magnetic resonance imaging (MRI), and computed tomography (CT) exceed waiting periods at similar civilian facilities. The mammography backlog in particular should be reduced. The department's decision to perform screening exams every other Saturday should help reduce this backlog.
- Radiographic and fluoroscopic services are split. One of the radiographic/fluoroscopic (R/F) systems should be removed from service and the remaining two be moved to the core radiology area.
- The transcription service is overwhelmed, and ACH should consider the use of a voice recognition system

that uses software to automatically transcribe reports. Voice recognition software for dictating reports may help to significantly reduce delays in transcription.

INTRODUCTION

A Technology Assessment and Requirements Analysis (TARA) was conducted at ACH, from 21 to 15 April 2000 at the request of the U.S. Army Medical Command (USAMEDCOM). The on-site evaluation of current technology and management operations within the radiology, nuclear medicine, and laboratory departments was performed by the radiology, nuclear medicine, and laboratory consultants from the Office of The Surgeon General (OTSG) and personnel of the Materiel Acquisition Directorate, U.S. Army Medical Materiel Agency (USAMMA). The TARA team gathered information and validated previously submitted data. The purpose of the site visit was to interview departmental staff, observe scheduling and patient flow patterns, and evaluate quality of service and the condition and utilization of existing equipment.

This TARA provides an unbiased review of the clinical processes, requirements, operations, and equipment for diagnostic imaging at the facility. Our goal is to provide senior decision makers with the management information needed to make informed decisions on the clinical and technological resources required to accomplish business plan missions and to develop acquisition strategies that ensure optimal clinical outcomes. Our mission is to ensure that diagnostic imaging and laboratory equipment within the Army Medical Department (AMEDD) is state-of-the-art technology. Although state-of-the-art technology is expensive, its benefits generally exceed the acquisition cost over the life expectancy of equipment.

The on-site TARA visit consists of four major components.

1. Assessment of clinical operations: The assessment is a clinical functional review by the OTSG specialty consultant or a senior clinician. The functional review generally focuses on staffing, customer service, quality and risk management, patient flow and management, appropriate functional task performance, and integration with other care issues/areas. This review incorporates clinical input from the assessed facility with respect to workforce design, functional success, and mission and compares the functional operation to accepted practice models. As a full AMEDD functional review, this evaluation also addresses leader development, training, and other military-relevant management issues.

2. Assessment of requirements: Commercial, for-profit equipment utilization factors tempered by contingency issues unique to military hospitals are applied to the facility's workload to determine how ACH compares with commercial counterparts. This comparison does not imply that ACH should be held to commercial standards. However, these utilization factors provide benchmarks with which the TARA team can begin the evaluation process.

3. Assessment of operations: This includes an evaluation of procedural mix, staffing, work schedule, patient flow and throughput, and quality assurance/risk management to the extent that these factors apply to the acceptability and appropriate use of existing equipment.

4. Assessment of equipment: This evaluation assesses whether the facility's existing equipment uses abandoned or obsolete technology and whether the equipment meets standards for acceptability (Figure 1). The assessment includes a market survey of current technology, a comprehensive evaluation of existing equipment, an evaluation of trends and developments that will affect diagnostic imaging requirements at ACH, and contract information when pertinent. This evaluation includes the telecommunications network to determine if the existing infrastructure will support new teleradiology initiatives. For the telecommunications network, hardware, bandwidth capacity on and off post, digital technology, and access to data transfer protocols are reviewed.

A TARA provides a snapshot of the facility's diagnostic imaging processes for the period during which the site survey was conducted. However, the TARA is not intended as a substitute for the facility's own routine evaluation of their operations. Because changes in a facility's strategic vision could alter diagnostic imaging requirements, we recommend that the requirements for ACH be periodically reevaluated, especially in the event of a major change in mission.

Using the data collected from site visits and from Medical Care Support Equipment (MEDCASE) program requirements, the TARA team has constructed a database to assist in providing guidance for approving future MEDCASE requests. The TARA database is used to front-load MEDCASE requirements for routine replacement of diagnostic imaging systems. MEDCASE requirements may be centrally generated by USAMMA or generated by the MTF (see Figures 2 and 3 for MEDCASE process).

In a USAMMA-generated MPR, the USAMMA Materiel Acquisition Directorate assigns an asset control number (ACN) and generates a transmittal to be sent to the MRF and RMC for approval. Once approved by the MTF and RMC, the requirement receives 1A approval when the transmittal is returned to USAMMA. After 1A approval, funding is allocated from the USAMEDCOM at two levels: high-dollar value (currently those MEDCASE requirements greater than $350,000) and medical-dollar value (those between $100,000 to $350,000). The USAMEDCOM is responsible for approving requirements and funding all high-dollar value items, and funding is sent to the RMCs for medical-dollar value items.

On allocation of funds, the RMC must have the Program and Budget Advisory Committee determine which of these MEDCASE items will be funded. Once the system is

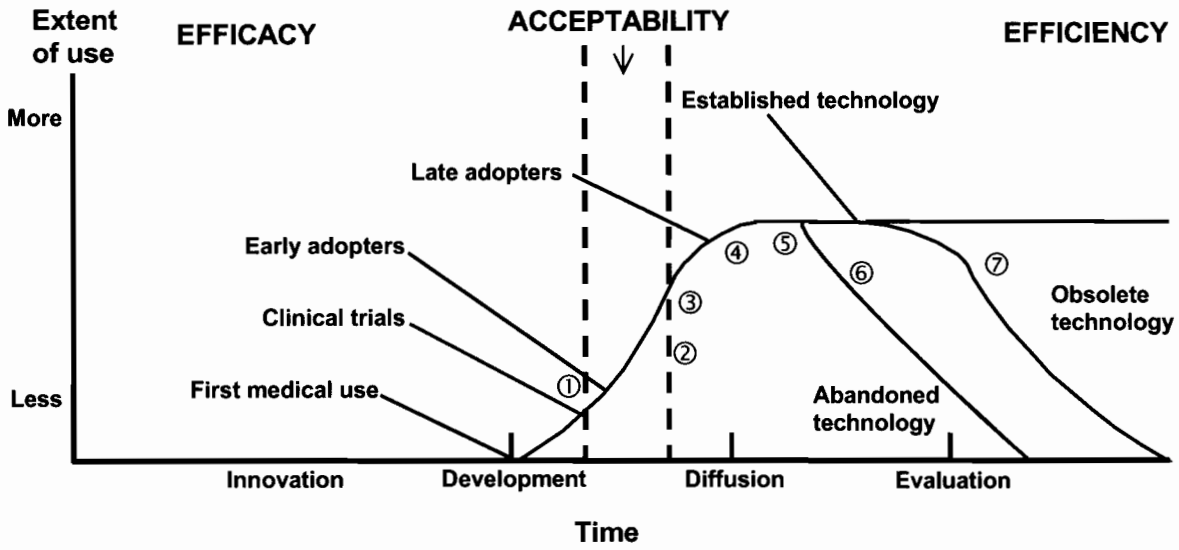

Figure 1. Technology life-cycle curve for medical equipment. 1, Promising clinical reports; 2, professional and organizational adoption; 3, public acceptance and third-party payer endorsements; 4, standard procedures and observation reports; 5, randomized clinical trials; 6, professional denunciation; and 7, erosion and professional discreditiation. (Source: Center for Health Economics and Policy Analysis, McMaster University)

funded, a requisition (Form 1348-6) and quotes from the MTF for the system wanted (may be the MTF's vendor of choice with proper justification) must be sent to USAMMA for final approval. Once USAMMA concurs with the quoted system, they forward the quote to the Department of Veterans Affairs (VA)-National Acquisition Center or the Defense Support Center Philadelphia (DSCP) for purchase off their schedules. This streamlining has expedited the procurement process by 3 to 7 months (Figure 4).

Complete MPR packages submitted for changing mission requirements or expanded business opportunities still require that the facility submit a MEDCASE requirement. The information for the justification on the DA Form 5027-R should answer the following questions:

- What is the item to be used for?
- Why is the item needed?
- How will the item be used with other equipment?
- What are the advantages of the item compared with equipment currently in use or available?
- Why are these advantages needed?
- Have specific details been presented regarding cost-benefits, personnel savings or productivity, the enhancement or curtailment of services, frequency or duration of breakdown, or other specific factors that may be relevant?
- What will be the impact on mission accomplishment if the requested item is not acquired?
- Is the anticipated workload provided?
- Has consideration been given to the use of available excess assets to satisfy this requirement?

BACKGROUND AND FUTURE DIRECTIONS

The TARA program originated with a 1992 tasking by the Corporate Information Management group (later designated the Medical Functional Information Management group) to evaluate commercial capabilities for technology assessment and capital equipment asset management. This tasking led to the award of a pilot contract to MetriCor Corporation (formerly the technology management cell of the Humana Hospital Corporation) in January 1993 to conduct an initial evaluation of Ireland Army Community Hospital, Fort Knox, Kentucky, in the areas of diagnostic imaging and laboratory. The MetriCor product fell short of our program goals, and we made the decision, with the concurrence of the OTSG radiology consultant, to develop a program in-house. During the remainder of 1993, we queried the technology assessment and asset management capabilities of several other hospital systems, including Kaiser Permanente, Columbia-HCA, and Sun-Health, and developed a composite program for AMEDD use, later designated the TARA program, which was first implemented at Walter Reed Army Medical Center in April 1994. The Strategic Technology and Clinical Policies Council (STCPC) formally adopted the TARA program in January 1995, directing full integration of clinical consultants and requiring a TARA visit to every AMEDD medical activity and medical center on a 3-year basis.

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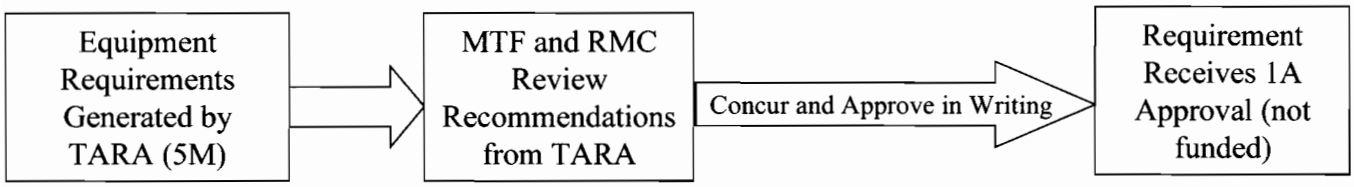

Figure 2. Centrally generated MEDCASE Program requirements and process as of January 1998 (continued in Figure 4).

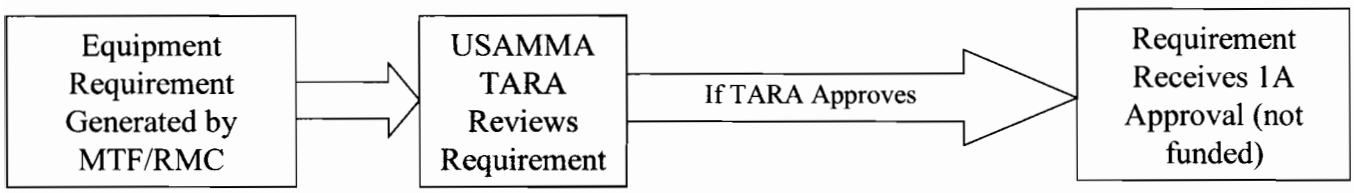

Figure 3. MTF generated MEDCASE Program requirements and process as of January 1998 (continued in Figure 4).

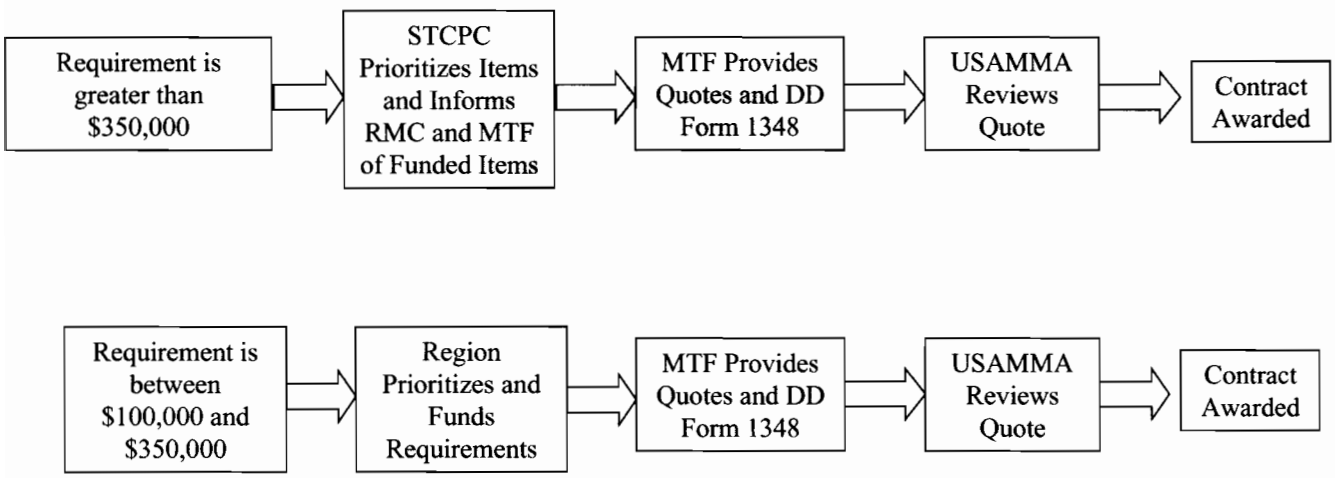

Figure 4. Flowchart of funding process for 1A approved requirements. HDV, high-dollar value equipment $350,000 or greater.

The radiology model of the TARA program has resulted in process improvements for generation of requirements and delivery of services, expedited modernization of diagnostic imaging systems, and generated a cost avoidance of about $1.6 million per facility since 1997. To continue the success of the TARA program, value-added processes continue to be developed and refined.

The TARA program has continuously evolved since its inception and will continue to evolve as mission needs dictate. What began as a high-technology, high-dollar equipment management program has developed into a powerful tool for process reengineering and change management. Today's process and functional orientation provides a mechanism for commanders at all levels to optimize their major diagnostic service areas for success.

CLINICAL REVIEW FOR DIAGNOSTIC IMAGING SERVICES

The diagnostic radiology section at ACH is a spacious department with most equipment midway or toward the end of its life cycle. The department is highly productive and continually striving to provide high-quality patient care.

A variety of data is used to measure the performance of a radiology department. These performance measures are then compared with established data to determine degrees of compliance and expected goals.

The radiology department performs about 135,000 examinations per year. Workload data for 1995 from the Medical Expense and Performance Reporting System (MEPRS) summary indicate graduate medical education (GME) sites currently average 8,803 procedures per radiologist. The current workload therefore, calls for slightly more than 15 radiologists. With 12 military and 3.2 civilian radiologists, current staffing is precisely matched for the workload. Workload for a typical day in diagnostic imaging at ACH is listed in Table 1.

The Joint Healthcare Manpower Standards Study developed by the Joint Healthcare Management Engineering Team (JHMET) in 1994 estimates that six technologists and support personnel are required per radiologist. Current staffing levels are at 99 technologists and support personnel for 15.2 radiologists for a ratio of 6.5 to 1.

Image availability and accountability were virtually 100 percent each. The fetch time for images on MDIS is 2 minutes, and for hard copy film, 5 minutes. These levels of performance are far ahead of all but a few AMEDD radiology departments.

The unread film rate was 0.05 percent (14 of 27,076 exams), which is far below the Department of Defense (DOD) average of 4.4 percent. The film repeat rate is about 6.5 percent, which is greater than the DOD average of 4.3 percent. Although this higher rate may in part be attributable to the training of phase II students, efforts should be made to lower the film repeat rate.

Table 1. Workload for a Typical Day Reading Diagnostic Images at ACH

Modality	Studies per Day
Plain Film	100
Fluoroscopy	10
Mammography (screening and diagnostic)	20
Ultrasound	22
Nuclear Medicine	11
Computed Tomography	12
MRI	2
Orthopedics	4
GI Clinic	15
Urology	4
Cardiac Catheterization	2
Total	**202**

A review of film badge exposure records reveals no episodes of exposure above normal rates. Radiation exposure levels do not exceed 10 percent of maximal limit. Safety precautions for patients and staff appear to be in place and being followed.

The transcription service is overwhelmed. Report turnaround can be up to 16 days for certain studies. The DOD average for report turnaround is 2.5 days with community standards being 48 hours. Several short-term measures to help with this problem were discussed with the leadership of the radiology department. A viable solution is acquiring a voice recognition system (e.g., Dragon Speak) whereby the radiologist's dictation is automatically transcribed by a software program. Members of the department were given points of contact if the command wishes to pursue this alternative.

Patient appointment backlogs for screening mammography, ultrasound, magnetic resonance imaging (MRI), and computed tomography (CT) exceed the average waiting periods at comparable civilian institutions but, with the exception of mammography, are within TRICARE guidelines. Patient appointment backlogs for all modalities are listed in Table 2.

Although most providers appear to be generally pleased with the level of service provided by the radiology department, several issues stand out. Wait times for patients once they have arrived may be excessive, especially for emergency room patients and possibly for patients of certain other services. These times need to be measured, and correc-

tive action must be initiated. The patient representative received 62 written comments about radiology during the past year. Twelve were complimentary, but 50 were critical. The most frequent complaints concerned delays in obtaining appointments or written reports and waiting at the department for the examination to be performed.

The hospital risk management coordinator stated that three claims involving radiology reached settlement during the past 5 years. In two of these cases, evaluation indicated that standard of care was not met. In the remaining case, standard of care was met. One case is pending and currently undergoing internal review. This measurement is an indirect reflection of the diagnostic accuracy of the department, and this litigation rate is about average for an institution of this size.

The radiology department at ACH is one of three departments that originally lead the Army in the migration to digital radiology. In the long term, major upgrades are planned for the MDIS equipment, and functionality will be well maintained with the current service contract that extends until 2004. However, interim upgrades will need to be made to the long-term archive and several diagnostic workstations provided to MRI to enable the department to continue until a major system upgrade.

The radiology department at ACH has the potential to be one of the best in the USAMEDCOM. Although a great deal of focus is given to equipment acquisition, personnel issues seem to have the largest impact on the current operation of the department. There is a pervasive lack of confidence and little job satisfaction demonstrated by the staff. The new Chief of Radiology will need time and command support as she deals with previously existing departmental and interdepartmental issues. These issues include, but are not limited to, the proliferation of ultrasound equipment, the performance of ultrasound examinations by varied departments, equipment for angiography, and the performance of peripheral angiography. Opinions of the OTSG Consultant for Radiology were shared during the outbrief and are available on request.

Table 2. Patient Appointment Backlogs for Diagnostic Imaging at ACH

Modality	Wait Time
Plain Film	same day
Fluoroscopy	14 days
Mammography (screening)	2 weeks
Mammography (diagnostic)	2 weeks
Ultrasound	1 weeks
Nuclear Medicine	< 1 week
Computed Tomography	2 weeks
MRI	3 weeks
Orthopedics	< 1 week
GI Clinic	9 days
Urology	< 1 week
Cardiac Catheterization	< 10 days

TECHNOLOGY ASSESSMENT AND RECOMMENDATIONS FOR DIAGNOSTIC IMAGING

X-ray

The ACH radiology department continues to be a well-run operation. Because of changes in the patient population and a subsequent decrease in workload since the hospital opened, this department has become overequipped. The primary hours of operation are from 0730 to 1630 with second and third shifts that allow for 24-hour x-ray coverage. The fluoroscopy hours of operation are currently from 0800 to 1600. The radiology department has seven general-purpose rooms, one radiographic/tomographic (R/T) room, and three R/F rooms. These systems see about 62,000 patients per year for general radiography and about 2,900 patients per year for fluoroscopy, which equates to utilization factors of 5.25 or 6 general-purpose systems and 1.7 or 2 fluoroscopy systems. Workload per shift for general radiology is shown in Table 3.

Equipment utilization factors for all modalities at ACH are in Table 4. Equipment recommendations for ACH are in Table 5, and a MEDCASE submission plan for FY 2001 through FY 2006 is in Table 6. ACH has a few diagnostic imaging systems that can be removed or not replaced because of excess capacity or changes in technology. We estimate that by removing and not replacing this equipment the AMEDD can realize a cost avoidance of about $4,805,000 (Table 7), and ACH can realize an additional cost avoidance of about $480,500 in maintenance and operating costs. The layout of the radiology core, fluoroscopy and mammography sections, and part of the ultrasound imaging area at ACH is shown in Figure 5.

General Purpose

The x-ray clinic has seven General Electric Medical Systems (GE) MVP 80 general-purpose systems (one with tomography) and one GE MVP 45 general-purpose system. Four additional rooms have been converted for other purposes. Room 1 is used as a sleep room, and clinical engi-

neering and radiology use room 7 as a storage room. Clinical engineering uses room 9 as a work area, and room 16 is a break room. Because the current utilization factor for ACH is for six general-purpose rooms, our recommendation will be to remove and not replace two of the eight rooms (currently occupied with radiographic equipment). All processing of cassettes is accomplished digitally by using one of two Fuji 5000 CR readers located in the radiology core area.

The GE MVP 80 R/T system in room 2 was installed in 1992 and has a GE Monitrol 15 90/15 table with floating top, overhead suspension, and angulating wall Bucky. The primary general-purpose exams performed in this room include chest and extremity studies. It also is the primary room for doing weight-bearing feet, ankle, and knee studies, and there is a specially built stair system for these exams. Total workload for the first shift is about 15 patients, although the room is used 24 hours per day. Although this room has tomographic capabilities, only one intravenous pyelogram (IVP) study has been performed in this room during the past 2 years, and IVPs are performed in either the urology or CT sections. There were no significant maintenance issues with this system, although the technologists mentioned that the table is nonelevating and that the x-ray cabinets make it nearly impossible to perform cross-table lateral exams. This system was 1A approved for replacement in FY 2001 (the old ACN has been deleted, and a new CAN has been generated). We now recommend that this system be replaced in FY 2003 with a general-purpose radiographic system with a 60-kW high-frequency generator, overhead suspension, nonangulating wall Bucky, and elevating table with floating top and without tomographic capabilities.

The GE MVP 80 in room 3 was installed in 1992 and has a GE Monitrol 15 90/15 tilting table with floating top, an overhead suspension, and an angulating wall Bucky. The primary exams performed in this room include chest and extremity studies. The total patient volume per first shift is 15, although this room is in use 24 hours per day. The only significant maintenance issue mentioned was that the automatic collimator fails to work on occasion. Clinical engineering is aware of this and has been working to correct the problem. There currently is a 1A-approved and funded requirement (originally intended for orthopedics) to replace the system in this room.

The GE MVP 80 in room 4 was installed in 1992 and has a GE Monitrol 15 90/15 tilting table with floating top, overhead suspension, and angulating wall Bucky. The primary general-purpose exams performed in this room include chests and extremity studies. The patient workload per first shift is about 15 with the room available for use 24 hours per day. Significant issues with this system include the table, which does not elevate, and problems with maneuvering gurneys through the hallways outside the room. We recommend this system be replaced in FY 2003 with a 60-kW high-frequency generator, overhead suspension, nonangulating wall Bucky, and elevating table with floating top.

The GE MVP 80 in room 5 was installed in 1992 and has a Raytheon EXT-600 elevating table with a floating top, an overhead suspension for the x-ray tube assembly, and an angulating wall Bucky. The primary general-purpose exams performed in this room include chest, extremity, and most other general radiology studies. The total patient volume per first shift is 30. This room is used 24 hours per day and is one of the two primary trauma rooms used in the department. Cross-table procedures are difficult in this room, because there is limited space for the movement of gurneys, and when attempting to do a cross-table lateral exam with the patient on a gurney using the chest Bucky, the x-ray transformer gets in the way. For tall patients, this type of procedure is limited to cervical spines because of space limitations. Cross-table lateral studies with the patient on the x-ray table are not an option if the technologist wants to use a Bucky. Maintenance problems include dirty and worn collimator switches that cause the collimator to not work or move erratically. Some of the touch screens on the control panel are worn out, and the free-float locking mechanisms do not work. The clinical engineering department is aware of these problems and continues to correct them as they come up. This system has a 1A-approved replacement. We recommend this system be replaced in FY 2002 with a 60-kW high-frequency generator, overhead suspension, nonangulating wall Bucky, and elevating table with floating top. We recommend a heavy-duty table for both rooms 5 and 6, as it is not unusual for 500-pound patients to be imaged in these rooms.

The GE MVP 45 in room 6 was installed in 1992 and has a Raytheon EXT-600 elevating table with floating top, an overhead suspension for the x-ray tube assembly, and an angulating wall Bucky. The primary general-purpose exams performed in this room include chests, extremity, and most general radiology studies. The total patient volume per first shift is about 30. This room is used 24 hours per day and is one of the two trauma rooms. This room has the same problems as room 5 with performing cross-table procedures and similar maintenance issues. Although this room currently has a 1A-approved replacement, that ACN will be deleted. We recommend this room be replaced in FY 2003

DR systems have digital detectors in the table to capture images electronically without the use of CR plates. The image can be sent to a workstation for immediate viewing, a digital archive, or a printer if viewing on hard copy is wanted. There is no intermediate data- or film-processing step. Fluoroscopy systems will eventually be located in rooms 1 and 7 in the radiology core area. The combination of six radiography rooms and two fluoroscopy rooms will overwhelm the capabilities of the two Fuji CR readers in the radiology core. We expect the use of DR in room 6 will reduce the overload on the CR readers. Additional discussion of DR systems is in the next section.

The GE MVP 80 in room 11 was installed in 1992 and

Table 3. Workload Per Shift for General-Purpose Radiology Systems

Shift	Ideal Studies per Month per Shift	Workload	Percentage of Workload	Utilization
First shift (0731 to 1130)	340	1,747	34	5.25
First shift (1131 to 1600)	330	1,430	27	4.3
Second shift (1601 to 2400)	670	971	19	1.5
Third shift (0001 to 730)	670	404	8	0.6
Weekends	770	643	12	0.8
Total		5,195	100	

has a GE Monitrol 15 90/15 tilting table with floating top, an overhead suspension for the x-ray tube assembly, and an angulating wall Bucky. The primary general-purpose exams performed in this room are joint studies. This room is typically used only on Wednesday mornings to help with orthopedic overflow work. Additionally, this unit is used to scavenge parts for systems in the other rooms when parts are unavailable. However, because of the workload, we recommend this system be removed and not replaced.

The GE MVP 80 in room 13 was installed in 1992 and has a GE Monitrol 15 90/15 tilting table with floating top, an overhead suspension for the x-ray tube assembly, and an angulating wall Bucky. The primary general-purpose exams performed in this room include chest, extremity, and most other general radiology studies. This room is used as a backup room for the orthopedic section and also used periodically for weight-bearing ankle, feet, and knee studies. When Reserve Officer Training Corps (ROTC) cadets require chest exams, this system and the system in room 15 are used. This room is only used for the first shift, seeing about 15 patients per day. The only significant issue raised about this system is that the table does not elevate. Maintenance problems were minor. As with the system in room 11, we recommend this system be removed and not replaced because of the workload.

The GE MVP 80 in room 15 was installed in 1992 and has a GE Monitrol 15 90/15 tilting table with floating top, an overhead suspension for the x-ray tube assembly, and an angulating wall Bucky. The primary general-purpose exams performed in this room include chest, extremity, and most other general radiology studies. This is the other room used when ROTC cadets require chest exams. This room also is only used for the first shift, seeing about 15 patients per day. The table for this system does not elevate either. Maintenance problems also were minor for this system. This system has a 1A-approved replacement, which will be deleted. We recommend that replacement of radiographic systems be spread over several years; replacing all systems in the same year is not optimal and more than likely will not occur because of availability of funding. We recommend this room be replaced in FY 2004 with a 60-kW high-frequency generator, overhead suspension, nonangulating wall Bucky, and elevating table with floating top.

Digital Radiography

During the past 2 years, several medical device vendors have introduced DR systems that replace the radiographic film or CR phosphor plate with a digital detector permanently housed within the Bucky of the radiographic table or chest unit. These systems allow digital acquisition (as CR readers do) and eliminate the need for technologists to load, remove, and process film or phosphor plates (as they do with CR readers). Whereas the CR reader is a replacement for film and film processors, a DR system replaces the radiographic unit, film, and film processors *or* CR plates and CR readers.

Vendors providing DR systems include Hologic, Canon, GE, and Swiss-Ray. Hologic and Canon provide cheaper DR systems that are cost-comparable to CR reader and a general-purpose radiography unit together. Only Hologic, however, currently has a direct digital detector, in which x-ray photons are captured directly in a layer of amorphous selenium, producing a latent electronic image. All other vendors use indirect detection techniques, in which x-ray photons captured in a scintillator give rise to visible light photons that in turn produce the latent electronic image. The direct digital detector has better spatial resolution capability. DR detectors and overall systems are still evolving, however, and a consensus on the best overall system has not emerged.

In general, a CR reader and a general-purpose radio-

(Continued on page 12)

SAMPLE FOR DEMONSTRATION PURPOSES

Table 4. Equipment Utilization, Radiology, ACH

Equipment	MTF Hours per Year	Ideal Studies per Hour	Ideal Studies per Year	Current ACH Studies per Year	Utilization[1]
Radiology Shift 1 (43%)	1,000	4	4,000	21,000[2]	5.25[3]
Fluoroscopy	1,250	1.33	1,662	2,900	1.7
Portable Systems	2,000	4	8,000	16,000	2.0
Mammography	2,000	2	4,000	8,700	2.2
Ultrasound	2,000	1.33	2,660	8,500	3.2
Ultrasound (Antenatal Diagnostic Center)	2,000	1.33	2,660	8,000	3.0
Nuclear Medicine[4]	1,800	0.6	1,150	6,300	5.5
Computed Tomography[5]	4,800	2	9,600	13,300	1.4
MRI[4]	4,800	1	4,800	8,400	1.8
Orthopedics	2,000	4	8,000	9,800	1.2
Gastrointestinal Clinic	2,000	1	2,000	350	0.2
Urology	2,000	1.33	2,660	1,000	0.4
Cardiac Catheterization	2,000	0.5	1,000	620	0.6

[1]Utilization factors have been based on management engineering time studies; each procedure has been assigned room productivity times based on industry information tempered by unique aspects of the DOD's medical operations and the operation of the local facility. The following example shows how this method was used to derive the equipment utilization factor for ultrasound.

Equipment	*General Diagnostic Ultrasound*
Hours available per year	*8 hours/day × 5 days/week × 50 weeks = 2,000 hours/year*
Productive time	*1.33 studies/hour (45 minutes/study for MEDDAC/MEDCEN)*
Ideal studies per year	*1.33 studies/hour × 2,000 hours/year = 2,660 ideal studies per year*
ACH studies per year	*5,300 studies/year*
Percentage utilization	*5,300 ÷ 2,660 studies/year = 2*

[2]Workload for all shifts for general radiology is 53,000.

[3]Reflects utilization for workload of busiest shift.

[4]See text for discussion of nuclear medicine workload and utilization.

[5]MTF hours of operation and number of studies per hour for CT and MRI are based on DOD standards.

Table 5. Equipment Recommendations, Radiology, ACH

Equipment (Room No.)	Manufacturer	Model	Date in Service	Recommendation
		X-ray		
Radiographic/ Tomographic (2)	GE	MVP 80	9204	Replace in FY 2003 with general-purpose system
General-purpose (3)	GE	MVP 80	9201	1A funded (3246-00-999)
General-purpose (4)	GE	MVP 80	9203	Replace in FY 2003
General-purpose (5)	GE	MVP 80	9202	Replace in FY 2002 (1A approved)
General-purpose (6)	GE	MVP 45	9202	Replace in FY 2003
General-purpose (11)	GE	MVP 80	9206	Remove and do not replace
General-purpose (13)	GE	MVP 80	9207	Remove and do not replace
General-purpose (15)	GE	MVP 80	9202	Replace in FY 2004
Radiographic/ Fluoroscopic (14)	Philips	Super 80	9212	Replace in FY 2002. Place new system in the radiology core
Radiographic/ Fluoroscopic (18)	Philips	Super 80	9212	Remove and do not replace
Radiographic/ Fluoroscopic (23)	Philips	Super 80	9201	Replace in FY 2002. Place new system in the radiology core
Portable	GE	AMX 4	9112	Replace at end of useful life (CEEP funds)
Portable	GE	AMX 4	9112	Replace at end of useful life (CEEP funds)
Portable	GE	AMX 4	9112	Replace at end of useful life (CEEP funds)
Portable	GE	AMX 4	9112	Replace at end of useful life (CEEP funds)
Portable	GE	AMX 4	9112	Replace at end of useful life (CEEP funds)
Portable	GE	AMX 4	9112	Replace at end of useful life (CEEP funds)
Portable	GE	AMX 4	9112	Replace at end of useful life (CEEP funds)
Full-size C-arm	GE/OEC	Stenoscope	9702	Do not replace in next 5 years unless software upgrade is required
Full-size C-arm	GE/OEC	Stenoscope 9000	9405	Replace in FY 2004
Full-size C-arm	GE/OEC	9600	9606	Do not replace in next 5 years unless software upgrade is required

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Table 5 (continued). Equipment Recommendations, Radiology, ACH

Equipment	Manufacturer	Model	Date in Service	Recommendation
		X-ray (cont.)		
Mini-C-arm	XiTech	XiScan 1000	9104	Replace at end of useful life (CEEP funds)
Mini-C-arm	Fluoroscan	50700	9709	Replace at end of useful life (CEEP funds)
Mini-C-arm	Fluoroscan	QES 115	0012	Replace at end of useful life (CEEP funds)
Mini-C-arm	Fluoroscan	50700	9610	Replace at end of useful life (CEEP funds)
Dry laser printer (Ortho)	Fuji	FM-DP 2636	9904	Do not replace in next 5 years
Dry laser printer (Ortho)	Fuji	FM-DP 3543	9904	Do not replace in next 5 years
Dry laser printer (urology)	Fuji	FM-DP 2636	9904	Do not replace in next 5 years
Dry laser printer (fluoroscopy)	Fuji	FM-DP 2636	9904	Replace in FY 2006 (CEEP funds)
Dry laser printer (core)	Fuji	FM-DP 2636	9904	Do not replace in next 5 years
Dry laser printer (core)	Fuji	FM-DP 3543	0009	Do not replace in next 5 years
Dry laser printer (MRI)	Kodak/Imation	8700	9609	Replace in FY 2004 (CEEP funds)
Dry laser printer (nuclear medicine)	Helios	810	9603	Replace in FY 2004 (CEEP funds)
Dry laser printer (nuclear medicine)	Kodak/Imation	8300	9808	Replace in FY 2006 (CEEP funds)
Dry laser printer (ultrasound)	Kodak/Imation	8700	9611	Replace in FY 2004 (CEEP funds)
Dry laser printer (ultrasound)	Kodak/Imation	8700	9611	Replace in FY 2004 (CEEP funds)
Laser print manager (ultrasound reading)	Kodak/Imation	8800	9611	Replace in FY 2004 (CEEP funds)
Laser print manager (MRI)	Kodak/Imation	8800	9607	Replace in FY 2004 (CEEP funds)

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Table 5 (continued). Equipment Recommendations, Radiology, ACH

Equipment	Manufacturer	Model	Date in Service	Recommendation
		Computed Radiography		
Radiology Core (QC area)	Fuji	5000	0003	Do not replace in next 5 years
Radiology Core (Trauma area)	Fuji	5000	0009	Do not replace in next 5 years
Fluoroscopy Core	Fuji	7000	9008	Do not replace. Radiology core CR readers will provide CR processing for fluoroscopy after core consolidation
Orthopedics	Fuji	AC-2	9110	Funded for replacement but put replacement in urology section. A DR system is recommended for orthopedics
Urology	Fuji	AC-2	9110	Delete ACN 3188-00-004. The orthopedics CR reader will replace this AC-2
		Mammography		
Upright (2)	GE	Senographe 600T	9209	Funded for FY 2001 replacement
Upright (1)	Lorad	M-III	9303	Replace in FY 2002 with system without stereotactic biopsy capability
Upright (3)	GE	Senographe DMR	9411	Replace in FY 2003 with system without stereotactic biopsy capability
Biopsy table with digital spot (19)	Lorad	Stereoguide	0009	Do not replace in next 5 years
Ultrasound System (19)	Acoustic Imaging	Performa	9508	Replace in FY 2002 with system with tissue harmonic imaging and power Doppler
Wet film processor	Kodak	M6B		CEEP funded for replacement

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graphic system together still cost less than a single DR system. One CR reader can serve multiple radiographic rooms, and overall, CR readers provide digital radiography more cost-effectively. Because the Army has already invested heavily in CR readers at most sites, we advise Army facilities to continue using CR readers that are in service until the end of their life expectancies. Current indications are that CR readers will continue to be used for many years (e.g., portable exams when a phosphor plate can be easily carried to the patient). However, DR systems will in the long term ultimately replace standard fixed radiographic units. The Army will continue to monitor the evolution of DR systems and prudently consider a few sites where we can fully assess their changing clinical and technical capabilities. However, we will continue to use technology development, relative costs, workload, throughput requirements, and utilization of current CR readers as criteria for recommending and approving DR systems.

(Continued on page 19)

Table 5 (continued). Equipment Recommendations, Radiology, ACH

Equipment	Manufacturer	Model	Date in Service	Recommendation
		Ultrasound		
General-Purpose	Acuson	Sequoia	9804	Do not replace in next 5 years
General-Purpose	Acuson	Aspen	0005	Do not replace in next 5 years
General-Purpose	Acuson	128 XP-10	9408	Procure new system for general radiology in FY 2003 and move A6122 to family practice clinic
General-Purpose (	Acuson	128	8811	Replace in FY 2002
General-Purpose (Angiography Corridor)	ATL	Ultramark 9 HDI	9202	Remove from service and do not replace
General-Purpose (Corridor 5)	ATL	Ultramark 9 HDI	9203	Remove from service and do not replace
Portable System (Radiology core)	Bruel & Kjaer	Leopard	9811	Do not replace in next 5 years
Portable System (Radiology core)	Sonosite	180	0010	Do not replace in next 5 years
Image Management System (1-37-12)	Acuson	KinetDx	0102	Do not replace in next 5 years
OB/GYN	ATL	Ultramark 4+	9405	Remove from service and do not replace
OB/GYN	ATL	Apogee 800+	9605	Do not replace in next 5 years
Antenatal Diagnostic Center	Acuson	128 XP-10 OB	9604	Do not replace in next 5 years
Antenatal Diagnostic Center	Acuson	128 XP-10 OB	9604	Approved and funded replacement; use as trade in
Antenatal Diagnostic Center	ATL	HDI 3000	9606	Do not replace in next 5 years
Antenatal Diagnostic Center	Acuson	Aspen	0005	Do not replace in next 5 years
Antenatal Diagnostic Center	Acuson	Aspen	9911	Return to Acuson (loaner)

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Table 5 (continued). Equipment Recommendations, Radiology, ACH

Equipment	Manufacturer	Model	Date in Service	Recommendation
		Ultrasound (continued)		
Antenatal Diagnostic Center Image Management system	Acuson	Aegis	9501	Approved requirement
Portable (Labor and Delivery)	GE	Logic 500 MD	9801	Do not replace in next 5 years
Portable (Labor and Delivery)	Hitachi	EUB	9610	Do not replace in next 5 years
Family Practice	ATL	Ultramark 4	8810	Remove from service and do not replace
Family Practice	ATL	Ultramark 9	9103	Remove from service and replace with Acuson 128XP from radiology
Emergency room	PIE Medical	Scanner 240	9807	Evaluate need for ultrasound system for ER. If not justified remove from service and do not replace
Surgery	ATL	HDI 3000	9606	Do not replace in next 5 years
Portable (Surgery)	Sonosite	180	0010	Do not replace in next 5 years
Anesthesia	ATL	HDI 5000 CV	9909	Do not replace in next 5 years
Catheterization Laboratory	Hewlett Packard	M2400A	9512	Do not replace in next 5 years
Echocardiology	Hewlett Packard	Sonos 2500	9606	Remove from service and do not replace
Echocardiology	Hewlett Packard	Sonos 5500	0006	Do not replace in next 5 years
Echocardiology	Hewlett Packard	Sonos 5500	9811	Do not replace in next 5 years
Vascular laboratory	ATL	HDI 3000	9605	Do not replace in next 5 years
Vascular laboratory	ATL	HDI 5000	0011	Do not replace in next 5 years

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Table 5 (continued). Equipment Recommendations, Radiology, ACH

Equipment	Manufacturer	Model	Date in Service	Recommendation
		Nuclear Medicine		
Single-head gamma camera	Siemens	Diacam	9207	Replace with dual-head SPECT gamma camera in FY 2002
Dual-head gamma camera	Siemens	Wholebody	9303	Replace with dual-head SPECT gamma camera in FY 2003
Dual-head gamma camera	SMV	DST-XL	9803	Replace with a dual-head, SPECT gamma camera in FY 2006
Single-head gamma camera	Siemens	Orbiter	9410	Funded requirement to replace with a dual-head SPECT camera in FY 2001
Triple-head gamma camera	Picker	3000XP	9603	Replace with a triple- or dual-head gamma camera in FY 2004
Single-head gamma camera	Siemens	Orbiter	9207	Replace in FY 2002
Image management system	SMV	Image management system	9808	Replace in FY 2004
Bone densitometer	Lunar	DPX-L Bone Densitometer	9706	Replace in FY 2004 (CEEP)
Color printer	Codonics		9808	Replace at end of useful life (CEEP)
		Computed Tomography		
CT	GE	Hi Speed	1992, upgraded 1997	Approved, funded requirement to replace in FY 2001
CT	GE	Hi Speed	1992, upgraded 1997	Replace in FY 2004
		MRI		
MRI	GE	1.5-T Horizon LX EchoSpeed	9010, up-graded 1995 and 2000	Replace in FY 2005 with short-bore MRI

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Table 5 (continued). Equipment Recommendations, Radiology, ACH

Equipment	Manufacturer	Model	Date in Service	Recommendation
		Orthopedics		
General-purpose	Fischer	6700	9201	Replace with a DR system in FY 2002
		Gastrointestinal Clinic		
Radiographic/ Fluoroscopic	Picker	MTX	upgraded in 1997	Replace in FY 2006
		Urology		
Radiographic/ Fluoroscopic/ Tomographic (Urology room 1)	Liebel-Flarsheim	Hydr-X CP80/ Hydrajust III	9203	Remove and do not replace
Radiographic/ Fluoroscopic/ Tomographic (Urology room 2)	Liebel-Flarsheim	Hydr-X CP80/ Hydrajust III	9201	Replace in FY 2002. Unfunded requirement exists
Radiographic/ Fluoroscopic/ (Urology room 5)	Liebel-Flarsheim	Hydr-X CP80/ Hydrajust III	9201	Remove and do not replace
Radiographic/ Fluoroscopic/ (Urology room 4)	Medstone	UroPro-2000	0103	Do not replace in next 5 years
Radiographic/ Tomographic (Urology room 3)	Ziehm	Exposcop 7000 mobile C-arm	0101	Do not replace in next 5 years.
		Cardiac Catheterization		
Biplane system	Siemens	Coroskop C/ Coroskop L/XRE Table (biplane system)	8807	1A approved and funded for replacement in FY 2001
Single-plane system	GE	Advantx (single-plane system)	9302	Remove from service after new system is installed and accepted in room 2

Any equipment on Table 5 that is not listed on Table 6 or recommended for replacement after FY 2006 must be reevaluated before final disposition

Table 6. Five-year MEDCASE Submission Data for Unfunded Requirements, ACH

FY	Priority for Replacement within FY	Department/Equipment
2001	*	X-ray: Replace GE MVP 80 in room 3
2001	*	CR: Replace Fuji A-2 in orthopedics
2001	*	Mammography: Replace GE Senographe 600T with upright system (1A approved and funded)
2001	*	Ultrasound: Replace Acuson 128 XP OB with system with color and power Doppler (1A approved and funded)
2001	*	Nuclear Medicine: Replace Siemens Orbiter single-head camera with a dual-head SPECT camera (1A approved and funded)
2001	*	CT: Replace GE HiSpeed with similar system
2001	*	Cardiac catheterization: Replace Siemens Coroskop biplane with single-plane system (1A approved and funded)
2002	5	X-ray: Replace GE MVP 80 in room 5 with a general-purpose radiographic system with a 60-kW high-frequency generator, overhead suspension, non-angulating wall Bucky, and elevating heavy-duty table with floating top (1A approved)
2002	2	R/F: Replace Philips Super 80 in room 14 with an R/F system with an overhead suspension, tilting table, non-angulating wall Bucky, 80-kW high-frequency generator and digital spot capabilities
2002	3	R/F: Replace Philips Super 80 in room 23 with an R/F system with an overhead suspension, tilting table, non-angulating wall Bucky, 80-kW high-frequency generator and digital spot capabilities
2002	15	CR: Procure small CR reader with printer for OR
2002	9	Mammography: Replace Lorad M-III with upright system without stereotactic biopsy capability
2002	13	Ultrasound: Replace Acoustic Imaging Performa in mammography section with system with tissue harmonic imaging and power Doppler capabilities
2002	11	Ultrasound: Replace Acuson 128 XP with a system with color and Doppler capabilities
2002	16	Ultrasound: Replace Acuson Aegis image management system with a similar system
2002	10	Nuclear Medicine: Replace Siemens Diacam single-head camera with a dual-head SPECT camera
2002	12	Nuclear Medicine: Replace Siemens Orbiter with a single-head gamma camera
2002	8	MRI: Replace Siemens 1.5-T Magnetom with short-bore, actively shielded MRI system

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Table 6 (continued). Five-year MEDCASE Submission Data for Unfunded Requirements, ACH

FY	Priority for Replacement within FY	Department/Equipment
2002	1	Orthopedics: Replace Fischer 6700 with a DR system
2002	14	Urology: Replace Liebel-Flarsheim Hydr-X CP 80 in uro room 2 with a system with pulsed fluoroscopy, a high-frequency or constant potential generator capable of 30 to 60 kW, a tomographic attachment, a DICOM 3 interface, and a 90/15 table (1A approved)
2003	1	X-ray: Replace GE MVP 80 in room 2 with a general-purpose radiographic system with a 60-kW high-frequency generator, overhead suspension, non-angulating wall Bucky, and elevating table with floating top
2003	2	X-ray: Replace GE MVP 80 in room 4 with a general-purpose radiographic system with a 60-kW high-frequency generator, overhead suspension, non-angulating wall Bucky, and elevating table with floating top
2003	6	X-ray: Replace GE MVP 80 in room 6 with a DR system with a 60-kW high-frequency generator, overhead suspension, non-angulating wall Bucky, and elevating table with floating top
2003	3	Mammography: Replace GE Senographe DMR with an upright system without stereotactic biopsy capability
2003	7	Ultrasound: Replace Acuson 128 XP10 with a system with color and Doppler capabilities
2003	4	Nuclear Medicine: Replace Siemens Wholebody with dual-head SPECT camera
2004	4	X-ray: Replace GE MVP 80 in room 15 with a system with a 60-kW high-frequency generator, overhead suspension, nonangulating wall Bucky, and elevating table with floating top
2004	6	X-ray: Replace GE/OEC Stenoscope 9000 with a similar C-arm system
2004	5	Nuclear Medicine: Replace Picker 3000XP with a triple- or dual-head camera
2004	1	Nuclear Medicine: Replace SMV image management system
2004	2	CT: Replace GE HiSpeed with a high-end (multi-slice) CT scanner
2005	1	MRI: Replace GE 1-5-T Horizon LX ES with a short-bore MRI system
2006	1	Nuclear Medicine: Replace SMV DST-XL with a dual-head SPECT camera
2006	2	GI Clinic: Replace Picker MTX (MMCN with a similar system

Asset control numbers (ACNs) have been generated for replacement or upgrade of equipment listed here. The facility will not be required to submit MEDCASE Program Requirements (MPRs). The facility should obtain quotes for desired system configuration and submit to USAMMA with the requirement when funding is available.

**Approved and funded*

Table 7. Estimated Cost Avoidance Gained from Removing and Not Replacing Equipment, ACH

Type of Equipment	Equipment	Room	Replacement Cost
General-purpose x-ray	GE MVP 80	9	$135,000
General-purpose x-ray	GE MVP 80	19	$135,000
Radiographic/Fluoroscopic	Philips Super 80	32	$360,000
Ultrasound	ATL Ultramark 9	Angio corridor	$200,000
Ultrasound	ATL Ultramark 9 HDI	Corridor 5	$200,000
Ultrasound	ATL Ultramark 4+	OB/GYN	$100,000
Ultrasound	ATL Ultramark 4	Family Practice	$100,000
Ultrasound	ATL Ultramark 9	Family Practice	$100,000
Ultrasound	HP Sonos 2500	Echocardiology	$250,000
Urology R/F/T	Liebel-Flarsheim Hydr-X CP 80	Uro room 1	$375,000
Urology R/F	Liebel-Flarsheim	Uro room 5	$350,000
Angiography (replace bi-plane system with single-plane system)	Siemens Angiostar	Room 25	$500,000
Cardiac Catheterization	GE Advantx	Level 7	$1,500,000
Linear Accelerator	Varian 600C	NA	$500,000
Total			**$4,805,000**

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Fluoroscopy

The x-ray clinic has three Phillips Super 80 CP fluoroscopy systems. Because the current utilization factor for ACH is for two fluoroscopic systems, our recommendation is to remove and not replace one of the three systems. We also recommend that the two remaining rooms be moved to rooms 1 and 7 of the radiographic core area when they are replaced (Figure 5). Normally, we would recommend staggering replacement of systems, but this move will allow the general radiography and fluoroscopy rooms to be collocated. Fluoroscopy is currently collocated with ultrasound and mammography in a separate area. As a result, we recommend the systems in rooms 14 and 23 both be replaced in FY 2002. Moving the fluoroscopy rooms will decrease the requirement for one CR reader and will allow ultrasound services to be consolidated in one area rather than being segmented throughout the department. The current backlog for fluoroscopy is 10 to 14 days. There are only two fluoroscopy technologists assigned to this area. All processing of fluoroscopy cassettes is currently accomplished digitally with the use of a Fuji 7000 CR reader in the fluoroscopy core area.

The Philips Super 80 CP in room 14 was installed in 1992 and has an overhead suspension and a 90/30 Phillips Diagnost 76 tilting table. This system sees six to eight patients per day with most of the fluoroscopy procedures being performed in the mornings (a few patients are scheduled in the afternoons). Procedures performed include barium enemas, barium swallows, endoscopic retrograde cholangio pancreatongraphies (ECRPs), upper gastrointestinal (GI) series, arthograms, and mylograms. The system has digital photospot capabilities. Overall, the technicians are satisfied with this system. The one complaint the technologist had concerning maintenance was that the locking mechanism on the fluoroscopy tower occasionally did not work, which prevented the entire system from working. We recommend that medical maintenance be contacted regarding this issue. A limitation with the system is that the cross-table lateral Bucky can only use 14×17 films. The technologist also felt that in-wall oxygen lines need to be provided for the fluoroscopy rooms. We recommend this system be replaced in FY 2002, and the replacement system installed in the core radiographic area.

The Philips Super 80 CP in room 18 was installed in 1992 and has an overhead suspension and a 90/30 Phillips Diagnost 76 tilting table. This system is not normally used as there are only two fluoroscopy technologists and they prefer to use rooms 14 and 23. Procedures performed can include barium enemas, barium swallows, ECRPs, upper GI

series, arthograms, and mylograms. The system has digital photospot capabilities. There were no maintenance complaints with this room. Because of the workload, we recommend that this system be removed and not replaced when it becomes a maintenance burden.

The Philips Super 80 CP in room 23 was installed in 1992 and has an overhead suspension and a 90/30 Phillips Diagnost 76 table. This system sees six to eight patients per day with most of the fluoroscopy procedures being performed in the mornings and a few patients scheduled in the afternoons. Procedures performed include barium enemas, barium swallows, ECRPs, upper GI series, arthograms, and mylograms. The system has digital photospot capabilities. The technologists are satisfied with this system, and there were no significant maintenance concerns. This room has the same issue with 14×17 cross-table lateral exams, and there is a strong desire to have in-wall oxygen lines. We recommend this system be replaced, and the room moved to the core radiographic area in FY 2002.

Portable X-ray and C-arm Systems

ACH has seven portable radiography systems (all GE AMX4s) and seven mobile C-arm systems (four mini- and three full-size C-arms) that are used throughout the facility. ACH performs about 16,000 exams per year using the portable systems, which equates to a utilization factor of 2.0 systems.

The portable systems are stationed in the operating rooms (ORs), near the intensive care units (ICUs) on the second floor, near the neonatal ICU, on nursing floor Seven North, and in the main radiology department. Each of these items is CEEP equipment.

The utilization of portable radiographic equipment is associated with ensuring patient access to care, and healthcare organizations tend to have an excess number of systems, often lightly used, to support widely distant service areas. We recommend that ACH review their maintenance costs for portable radiographic systems, which currently are not significant, in FY 2005 and consider a planned replacement program at that time.

The mini-C-arms are located in the orthopedic clinic and in the ORs and are CEEP items (three Fluoroscan models and one XiTech). Two GE/OEC full-size systems support surgical procedures, and an OEC 9600 is in the radiology department. The full-size C-arms are MEDCASE items, and unless upgrades to vascular software require their replacement, we recommend these systems not be replaced during the next 5 years, except for the GE Stenoscope 9600, which we recommend be replaced in FY 2004.

Dry Laser Printers

The facility has 11 laser printers. Five of these are direct connected to the CR readers for use during PACS failover. The five direct-connected laser printers support the CR readers located throughout the facility. There are two laser printers in the orthopedics section. The Fuji FM-DP 2636 (installed in April 1999) is direct connected to the Fuji AC-2 CR reader and should not be replaced in the next 5 years. The second printer in orthopedics, Fuji FM-DP 3543 (installed April 1999) is currently not connected, and its future use was unclear, although it would be a better choice for orthopedics as it is a larger format printer. It also should not be replaced in the next 5 years. A Fuji FM-DP 2636 (installed April 1999) is connected to the Fuji AC-2 in the urology section and should not be replaced in the next 5 years. Another Fuji FM-DP 2636 (installed in April 1999) is direct connected to the Fuji 7000 in the fluoroscopy area and should not be replaced until FY 2006. In the radiology core work area, two Fuji dry laser printers are connected to the two Fuji 5000 CR readers. The unit closest to the PACS QC workstation is a Fuji 2636 (installed April 1999) and should not be replaced in the next 5 years. The other printer is a Fuji 3543 (installed September 2000) and should not be replaced in the next 5 years. In addition, a Kodak/Imation 8700 (installed in September 1996) is connected to a Kodak/Imation 8800 in the MRI building and provides coverage for both MRI systems. It should be replaced in FY 2004.

The remaining laser printers are used as network printers. Two are in the nuclear medicine department. A Helios 810 (installed March 1996) should be replaced in FY 2004. The other printer in this department is a Kodak/Imation 8300 (installed August 1998) that should be replaced in FY 2006. The final two laser printers connect to the 8800 print manager in the ultrasound reading room. The first is a Kodak/Imation 8700 (installed November 1996) next to the 8800 that should be replaced in FY 2004. The other printer is a Kodak/Imation 8700 (installed November 1996) and is located in the x-ray film library room. It serves as the networked PACS printer and should be replaced in FY 2004.

ACH also has two Kodak/Imation 8800 laser print managers. One of the Kodak/Imation 8800s (installed November 1996) is located in the ultrasound reading area within the radiology department. The two CT scanners, the PACS, both angiography rooms, and two laser printers are connected to this print manager, which should be replaced FY 2004. The other Kodak/Imation 8800 (installed July 1996) is in the fixed MRI building. This system supports both MRI systems and one printer and should be replaced FY 2004. All dry laser imagers should be procured with CEEP funds unless they are bought as a system with another modality.

Computed Radiography

Currently, ACH operates five CR readers: two in the radiology core, one in fluoroscopy, one in orthopedics, and one in urology. An old Fuji AC-2 that was initially considered for use in the OR suites is used for replacement parts

(Continued on page 22)

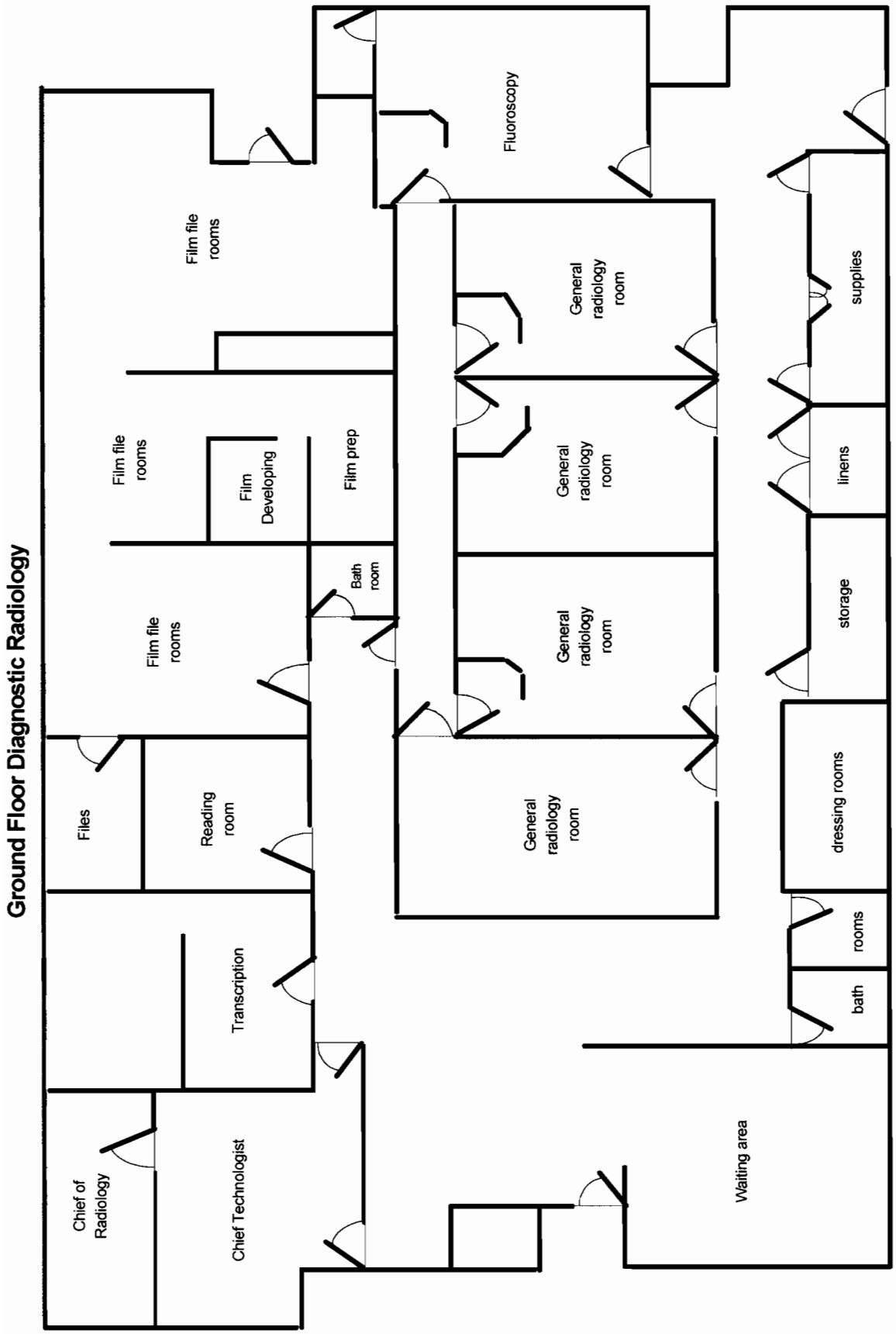

Figure 5. Layout of radiology department, ACH.

(Continued from page 20)

for CR readers currently in operation. Our strategy to replace or supplement these CR readers relies on two main criteria:

- The number of CR readers required should be based on the *peak* workload that the CR readers are expected to process.
- Each installed CR reader is expected to have a *nominal* lifetime of 10 years, based on the current information in the AMEDDPAS database. However, we also take into account the current operational and maintenance status of the installed CR readers.

A review of CHCS workload information shows that ACH's plain radiology workload is about 78,000 exams annually. This total consists of 62,000 exams conducted in rooms in the radiology department and about 16,000 exams conducted on portable systems around the hospital. The department of radiology has two core areas: radiology and fluoroscopy core (the latter also includes the mammography suite and ultrasound exam rooms).

Radiology Core

The radiology core has two Fuji 5000 CR readers. The one near the centralized quality control (QC) area was put into service in March 2000 (date of manufacture August 1999), according to AMEDDPAS information. The one near the trauma x-ray rooms 5 and 6 was put into service in September 2000 (date of manufacture January 2000). Both CR readers share a Fuji CR QAWS771 workstation, where technologists occasionally QC images. The standard approach is to have the Fuji workstation automatically send the images to the MDIS QC workstations, where two technologists provide centralized final QC for all CR images except from fluoroscopy overheads. Two MDIS QC workstations are at different locations within the radiology core.

The CR readers serve seven operational radiology rooms (rooms 2, 3, 4, 5, 6, 13, and 15; room 11 is occasionally used but is also used for scavenging replacement parts for other systems). These CR readers also process plates from portable exams. The CR reader near the trauma rooms appears to be used significantly more than the CR reader near the QC area because it is closest to the busiest rooms.

For this assessment, we assume that the two Fuji 5000 CR readers are expected to serve seven general-purpose radiology rooms. CHCS workload information indicates that the peak workload for these rooms and for portable exams is about 40 exams per hour. Assuming three plates per exam, there is a need to process 120 plates per hour during peak workload. The Fuji 5000 CR reader can process more than 100 plates an hour. At a nominal value of 75 plates an hour per CR reader (to account for entry of patient demographic information and QC), the 120 plate per hour translates to a peak utilization factor of 1.6 readers. Two CR readers, therefore, are adequate to handle the peak workload in the radiology core.

The Fuji CR QAWS771 workstation provides DICOM Store output for both CR readers. This output interfaces with a DICOM Gateway on the MDIS system. When the MDIS system gets upgraded, the Fuji workstation will provide compatibility with a fully DICOM-compliant PACS.

Each of the two readers is provided with a Fuji dry printer. The trauma area CR reader has a FM-DP 3543 printer and the QC area reader has a FM-DP 2636 printer. These dry printers provide failover capability to ACH in the event the MDIS system is down for an extended period.

The new Mitra broker on the MDIS system provides a DICOM Modality Worklist to the CR readers. However, technologists have been vigorously trained not to pick the patient/exam from the worklist. Currently, technologists type in the CHCS accession number for the exam and then query the worklist for that exam. This has been done to alleviate the large number of errors that technologists were making in accidentally picking the wrong patient/exam from the worklist.

The CR readers have been reliable. Occasionally, the CR reader in the QC area needs rebooting to clear errors, and the CR reader near the trauma rooms had an extended downtime of about 2 weeks while waiting for a replacement circuit board. Apart from these instances, the technologists rate the readers as having high uptime. Both readers are still under warranty, so there were no maintenance expenses. At some point, ACH should consider rotating the CR readers to balance the usage of the two readers. Neither of these CR readers will need replacing during the next 5 years.

Fluoroscopy

A Fuji 7000 CR reader (date of manufacture August 1990) serves the north core. This reader was purchased as part of the MDIS system, and as such AMEDDPAS information is not available for this CR reader. The fluoroscopy core has three R/F rooms (rooms 14, 18, and 23). Rooms 14 and 23 get the heaviest use. Room 18 is used occasionally whenever there is a need for additional patient privacy.

CHCS workload indicates about 2,900 fluoroscopy exams for the past year. This equates to 10 to 11 exams per day. Because the average fluoroscopy exam lasts 45 minutes, we assume two busy rooms allow 2.7 or about 3 exams per hour. If we assume a worst-case scenario in which 10 plates for overhead exposures have to be processed for each exam, we need to process about 30 plates an hour. Because the Fuji 7000 CR reader can process about 50 plates an hour, the reader is deemed to have a utilization of 0.6, so one CR reader meets ACH's needs for fluoroscopy.

Workflow with this CR reader is adequate given the current status of the MDIS system. The experienced fluoros-

copy technologists perform quality control (QC) on the images they have acquired, as they need quick review of these with the radiologists. A Fuji FM-DP2636 in the fluoroscopy core area is intended to provide failover capability in case the MDIS system goes down, although it was not fully connected at the time of our visit.

The Fuji 7000 reader is 10 years old and ready for replacement. Although it works adequately, replacement parts for this reader are hard to obtain. In addition, the reader and its MDIS CR acquisition workstation (CRAW) are not DICOM compliant, so any upgrade of the MDIS system would make this CR reader unusable.

However, we do not recommend replacement of this CR reader. The TARA team recommends ACH consolidate the fluoroscopy rooms into the radiology core where the CR readers in the radiology core will support CR for fluoroscopy. Adding the 1.6 utilization for radiology exams to the 0.6 utilization for fluoroscopy exams, there would be a total of 2.2 or 3 CR readers required in the radiology core. We recommend that ACH continue operating only the two Fuji 5000 CR readers that are already in the core and replace one of its existing general radiology rooms with a DR room. The high-throughput DR room will reduce the CR workload on the Fuji 5000 readers, allowing fluoroscopy overheads to be processed on these readers as well. Some of the radiographic systems are ready for replacement anyway and consolidating fluoroscopy within the radiology core would have required a replacement CR reader. Rather than a replacement room and a replacement CR reader, we recommend ACH procure a DR system.

Orthopedics

A Fuji AC-2 CR reader (date of manufacture October 1991) serves a general-purpose radiographic system in the orthopedics department. A full-time radiology technologist is assigned to orthopedics to conduct imaging exams.

During peak workload times, the technologist often has as many as 12 patients in 1 hour waiting for their exams. Some times the technologist does 10 to 12 noncomplex exams per hour. As a result, patient wait times of 1 hour or more are not unusual.

If one assumes 4 images per exam, the peak plate throughput required is 48 plates an hour. The Fuji AC-2 can comfortably handle about 30 plates an hour, and this reader does not meet the peak imaging needs of the orthopedics section.

The technologist reports only an average maintenance history for this CR reader. Downtimes of 3 hours to 1 day are common at least once per month. Radiologists complained about technical artifacts on high-contrast studies. These artifacts are apparent only under large magnification and appear as "zippered pixels" at the high-contrast edge. However, no one claimed that diagnostic quality is being affected.

The workflow with this CR reader is as streamlined as it can be given the reader's processing limitations. The focus in orthopedics is fast throughput, so QC technologists in the radiology core provide final QC. Although this streamlines the work of the orthopedics technologist, it may result in significant delays when QC is backed up. The patient then has to be tracked down or rescheduled for a repeat image.

There are two Fuji dry printers in the orthopedic section: a Fuji FM-DP 2636 that is connected to the Fuji AC-2 reader for failover needs and a Fuji FM-DP 3543 that is sitting unconnected in the radiographic room. Orthopedics has a need for the larger format film, so we recommend that, at least temporarily, ACH consider installing the FM-DP 3543 printer as the failover printer.

Because of the age and maintenance status of the Fuji AC-2 reader, there is already an approved and funded requirement for a replacement Fuji 5000 reader. An approved and funded requirement for a replacement radiographic system in orthopedics also exists.

Although the Fuji 5000 CR reader will meet the peak *plate processing* needs of orthopedics, the problem of long patient wait times will not be eliminated. This is because the technologist is already conducting 10 or more exams per hour at peak times. The issue remaining is the need to provide higher *patient* throughput. With an annual workload of 9,800 exams per year, ACH needs a second radiographic room for orthopedics. (Current utilization for radiographic studies in orthopedics is 1.2.) An alternative solution is to replace the current radiographic system with a system that, on its own, provides higher patient throughput. A DR system offers the potential to achieve this. We recommend that ACH replace the current radiographic system in orthopedics with a DR system. Because the justification for this proposed DR system is patient throughput, we will not require, in this case, the DR system to be cost competitive with a new CR reader and a new radiographic room.

The replacement radiographic system (ACN 3246-00-999) that is on order should be used as a replacement system in radiology. The incoming Fuji 5000 CR reader should ultimately be directed to the urology section, where, as discussed below, there is a need for a replacement CR reader, which is not yet funded. The timing of these replacement items is important. We recommend that, until the digital radiology replacement is installed, the Fuji 5000 CR reader should be used in orthopedics. However, after that the Fuji 5000 reader should be moved to the urology section.

Urology

The urology section has a Fuji AC-2 CR reader (date of manufacture October 1991). It serves radiographic systems in five urology rooms. However, CHCS data indicate that

only about 1,000 exams are performed annually.

Personnel in the urology section reported that up to three rooms are being used simultaneously for x-ray studies. Typical studies are IVPs, retrograde urethrograms, and voiding cystourtherograms. At peak workload, three exams per hour are conducted. If each exam requires 10 plates to be used, 30 plates per hour must be processed. Although the Fuji AC-2 just meets this requirement, urology exams often necessitate that four or five plates be processed immediately before the rest of the images can be acquired. Thus, the urology section would benefit from having a multistacking CR reader.

As with the Fuji AC-2 in the orthopedic section, the workflow with this reader is adequate. There is a Fuji FM-DP 2636 dry printer for failover and to meet the needs of urology personnel for in-room hardcopy images. A minor inconvenience reported to us was printing off the MDIS network being enabled only on printers in the radiology core. This means that, unless the nurse or technologist was aware of the need for printing film prior to processing the plate, all print output was directed to the core area. Part of this limitation is that the Fuji FM-DP 2636 printer cannot be used as a network printer. Unless the department procures a network printer, urology personnel will have to specify print output at the CR reader.

This CR reader has no reported significant maintenance problems. Although it is about 10 years old now, it is still usable. Occasional problems experienced by urology staff have more to do with the MDIS system than the CR reader (e.g., sometimes patient demographics information and images do not match on the MDIS QC workstation). Given the relatively good performance of this CR reader, we recommend that the urology section continue using it until the Fuji 5000 reader from orthopedics replaces the Fuji AC-2. We expect that to be about 1 year. There is an approved requirement for a separate replacement Fuji 5000 reader in urology (ACN 3188-00-004). Based on our recommendation for a digital radiology system in orthopedics, making its Fuji 5000 available for urology, we recommend deletion of this approved requirement.

Operating Rooms (ORs)

ACH has 14 ORs that frequently are in use simultaneously. Two portable x-ray units are stationed in the area. Currently, ACH uses plain film to meet the radiographic needs of the ORs. A wet film processor (Kodak M6B, date in service March 1992) is use exclusively by the ORs. To capture all plain x-ray images on the MDIS system, the site exposes a CR phosphor plate and wet film simultaneously in a film cassette. The phosphor plate is processed in the radiology department, whereas the film is processed in the OR for immediate use by surgeons in the OR.

We recommend ACH begin using a CR reader in the OR. A dry film printer should be used with it until the site decides on the best way of displaying softcopy images in the OR. Because only two to three surgeries at any time need portable x-ray images and only about two images per surgery are taken, there is no need to process more than six plates per hour. A small, single-plate CR reader (such as the Fuji SmartCR, Kodak CR800, or Agfa Solo) would make a good choice. The CR reader should be capable of DICOM print, allowing a suitable DICOM printer can be used with it. We recommend procurement of a small CR reader with a small, low-capacity dry printer for 2002. In the interim, ACH may temporarily wish to use the AC-2 reader in orthopedics in the OR.

Mammography

The mammography department at ACH has three upright mammography systems, one dedicated prone stereotactic biopsy table with digital spot imaging, one ultrasound scanner, and a Kodak M6B film processor. Routine hours of operation are from 0730 to 1600, Monday through Friday and every other Saturday. The department is staffed with four full-time and one part-time radiology technologists, one full-time and one part-time health technologists, and five full-time and one part-time administrative staff. All radiology technologists are mammography-certified civilian employees.

Reports from CHCS show that ACH conducted about 8,700 x-ray exams and 1,600 ultrasound exams. The x-ray exams include screening, diagnostic, needle localization, and core biopsy procedures. The utilization factor for x-ray equipment is 2.2 or 3 systems. CHCS trend information shows an average annual increase of about 5 percent. The excess capacity will allow ACH to handle the workload increases expected during the next 5 years.

The department sees about 36 patients in a typical day: about 20 patients for screening and 16 patients for diagnostic exams. On average, the workload comprises 55 percent screening and 45 percent diagnostic. For the year, about 200 x-ray stereotactic needle localizations and biopsies and 130 ultrasound biopsy procedures were performed.

Screening exams are scheduled for 20 minutes, diagnostic exams for 30 minutes, and needle localizations for 60 minutes. Stereotactic breast biopsy is scheduled for 120 minutes. Ultrasound biopsies are scheduled on Tuesdays, and about five patients per day can be accommodated. Thursdays are reserved for x-ray stereotactic biopsies and needle localizations, and generally three patients can be scheduled each Thursday. Based on the current workload and scheduling blocks, there appears to be sufficient capacity to handle the increase in ultrasound biopsies during the past few years at ACH. However, additional scheduling blocks may be needed for x-ray stereotactic needle localizations and biopsies.

Currently, there is a backlog of 4 weeks for screening exams and 2 weeks for diagnostic exams, although callbacks are accommodated within 1 week. The site has recently began seeing patients for screening exams every other Saturday to reduce the backlog. The site may also wish to consider longer hours on some days if the backlog cannot be reduced during the next few months.

The mammography service at ACH is certified through the Mammography Quality Standards Act (MQSA). The facility is due for reinspection in June 2001, with in-house physics support. The department has a Mammography Reporting System (MRS), but it is not in use yet. The site intends to use it only to manage biopsy patient information because it duplicates some information in CHCS and because of a perceived administrative staff shortage.

The lead technologist is tasked for managing quality control of the mammography services. The repeat rate is about 2.5 percent on average, with positioning accounting for the largest component of the repeats.

Radiologists read all mammography exams in the mammography reading area. Health technologists assist with hanging and taking down the films. Most exams acquired during the day are read by the evening or next morning. Patients with suspicious lesions are then contacted for callback diagnostic exams, which are conducted within about 1 week of the screening exam. Report turnaround is 7 to 10 days, largely because of transcription delays that affect the entire radiology department. A voice-recognition system that interfaces directly to CHCS is an option that ACH should consider to reduce report turnaround time. USAMMA has contact with an Air Force radiologist who has developed such a system, and it is being used in several military facilities. This interim solution could be tried until the AMEDD-wide Dictaphone contract can be used for voice-recognition directly into CHCS. However, ACH tentatively is scheduled to get a Dictaphone system by the end of FY 2002.

There is an education room available for mammography patients, and the waiting area is spacious. Each imaging room has its own changing and waiting area. The education area meets the requirements of the MQSA.

The GE Senographe 600T in room 2 was put into service in September 1992. About 10 patients per day are examined in this room. The Senographe 600T is one of the older systems at ACH, and this room is not used for more sophisticated exams because the system does not have a rhodium anode and filter. In addition, there is no automatic release or manual fine-tuning of compression. Reliability on the system is about average, but technologists claim that repairs take longer on this system than on others. Replacement of this system has already been 1A-approved and funded for FY 2001. The incoming system is expected to be a Lorad M-IV with high-transmission cellular (HTC) grids, which will provide improved contrast compared with standard grids at near or equivalent dose. Hologic (the parent company for Lorad products) claims that the Lorad M-IV will be able to accept a full-field digital receptor, once it is approved by the FDA.

The Lorad M-III in room 1 was put into service in March 1993; 12 to 13 patients per day are imaged in this room. Technologists rate this system good for meeting their clinical and technical needs. However, it does not have a rhodium anode and filter. Maintenance records show the system had 12 unscheduled maintenance visits in 4 months. Although the problems are broad, as indicated in the maintenance history, the technologists report frequent problems with C-arm movement. There are some concerns about the Lorad M-III being able to meet MQSA performance requirements that come into effect in October 2002. Hologic is still in the process of verifying these concerns, and it has released no statement. However, based on the maintenance experience with this system, we recommend replacement in FY 2002. This will also ensure that potential issues with MQSA 2002 requirements can be avoided. We recommend a system with screening and diagnostic imaging capabilities only, although it should be upgradeable to digital imaging when that becomes available. A stereotactic biopsy attachment is not necessary.

The GE Senographe DMR in room 7 was put into service in November 1994. Twelve to 13 patients per day are seen in this room. This system has a rhodium anode and filter and is the most sophisticated system in the department. The system is only used for implant and specimen imaging and for patients who have undergone radiotherapy treatment. Overall, technologists are happy with the performance of this system. Maintenance records show 12 unscheduled maintenance visits during a 5-month period. However, most problems are minor and mechanical in nature (e.g., Bucky tray edges are broken). This system should be able to see another couple of years of service. Although GE has yet to confirm the DMR's potential compliance with MQSA 2002 requirements, most experts believe it will pass. We recommend replacement of this system in FY 2003. The replacement system should be capable of digital upgrade, when it is available, and should be purchased without a stereotactic biopsy attachment.

A Lorad Stereoguide prone table with digital spot capability is in room 8. This system was put into service in June 2000. It replaced another Lorad prone table system that had reached its life expectancy, according to physicians using the system. The staff believes the system meets their clinical and technical needs. About three stereotactic biopsies are conducted every Thursday. The site also undertakes stereotactic needle localizations, although only two or three patients are seen per month. Specimens from this system are imaged on the GE DMR or the Lorad M-III mammography systems. Workflow is facilitated in this large room, as there is adequate space. The system was under warranty at the time of our visit and users reported no significant problems. The system should not be replaced in the next 5 years.

An Acoustic Imaging Performa ultrasound scanneris

used in room 19. It was put into service in August 1995. It has two probes (7.5 MHz and 10 MHz) and is used for diagnostic imaging and for ultrasound-guided biopsy. About 10 patients per day are seen in this room for diagnostic imaging, except for Tuesdays when 5 patients are seen for biopsies. There is a small printer used for documentation prints. The system meets the needs of the section, although the radiologists believe image quality and diagnostic capabilities is significantly less than achievable with present-day ultrasound technology improvements. Technology developments, such as native tissue harmonic imaging, should be incorporated. The 5-year-old system does not have color or harmonic imaging, which are increasingly used more in mammography support for tumor characterization. As this system was acquired with CEEP funds, ACH may wish to acquire a system with harmonic imaging capabilities within the next 2 years as its mammography program is reportedly growing.

The film processor in the mammography section is a Kodak RP X-OMAT M6B with daylight Kodak Multiloader 700. The system has apparently had problems and already been funded for replacement. The replacement system was to be installed around the time of the TARA visit. There is no backup film processor for mammography films in radiology. Based on the downtime of the mammography film processor, ACH may want to reconsider the need for a backup processor.

All mammography equipment (except that under warranty) is being maintained by the biomedical maintenance shop at ACH. Technologists and administrators are happy with the service.

Ultrasound

Ultrasound services are provided by the radiology, labor and delivery, vascular, echocardiography, emergency, surgery, and anesthesia departments; the orthopedic, family practice and obstetrical/gynecological (OB/GYN) clinics; and the antenatal diagnostic center. The radiology department at ACH provides ultrasound services between 0730 and 1600, Monday through Friday; patient examinations are scheduled every 15 minutes on three ultrasound systems. Radiology residents provide after-hours support. Annual workload for ultrasound is about 8,500 studies; 91 percent of those are for outpatients. There is a 2-week backlog for patient appointments. Ultrasound is currently staffed with four sonographers with a fifth position not filled. Of the four sonographers, two are civilian, one is military, and the fourth is a student.

General Radiology

The radiology department has an ultrasound workload of 8,500 studies per year, which equates to a utilization factor 3.2 or 4 systems. Currently, they have nine systems: one in mammography and six general-purpose and two portable systems in the ultrasound section. We recommend that only two of these systems be removed and not replaced.

Although the radiology department has nine systems, most of its studies are performed on three systems, and among those three, the Acuson Sequoia is preferred. The 3-year-old Sequoia is equipped with eight transducers and has harmonic imaging and color capability; it is networked to the KinetDx mini-PACS. The sonographers indicated that the spatial resolution on this system is superior to all others within the department and that all procedures are performed on this system when possible because the system has harmonic imaging. Harmonic imaging produces images with greater contrast resolution and is becoming the standard of care for ultrasound examinations. Nearly all pelvic examinations, which account for about 30 percent of department examinations, all small parts examinations, and at least 80 percent of department-based vascular work are performed on the Sequoia. This system should not be replaced during the next 5 years.

The newest system in the department is the Acuson Aspen, which was installed in May 2000. The Aspen is networked with the KinetDx mini-PACS; it also has color and harmonic imaging capabilities, but its spatial resolution reportedly does not match that of the Sequoia. Physically large patients are not imaged with this system as the staff feels the resolution is inadequate for internal organ studies. The sonographers indicated that patients scanned on the Aspen often have to be reexamined on the Sequoia to achieve the necessary resolution. Although the resolution may not be suitable for certain examinations, the technology associated with the Aspen system should be suitable for most ultrasound procedures. We recommend that this system not be replaced during the next 5 years.

The Acuson 128 XP-10 is 7-years old and equipped with color and three-dimensional (3D) imaging capabilities; it does not have harmonic imaging. There is also a 13-year-old Acuson 128 XP in the department. Both of these systems are networked with KinetDx but are not current state-of-the-art ultrasound technology, although they can perform routine work such as abdominal studies. We recommend that the 128 XP-10 be relocated to the family practice clinic, a new system for general radiology be procured in FY 2003, and the 128 XP be replaced in FY 2002.

The two ATL Ultramark 9 HDI systems are not networked with the KinetDx mini-PACS and are used to support the angiography suites and as backup for the other systems. With the addition of the Sonosite 180 portable system, which can support the angiography suites, we recommend that these systems be removed from service. Consequently, ACN 3157-00-999 (approval code 1A), which has been generated to replace one of the UltraMark 9 HDI systems, will be deleted.

The ultrasound service within the department uses the Acuson KinetDx ultrasound mini-PACS. Currently four sys-

tems are integrated with the KinetDx. ACH should ensure that appropriate upgrades to this system are implemented so that, when appropriate, ultrasound images are integrated with the department-wide PACS system in place.

OB/GYN Clinic and Antenatal Diagnostic Center

There are seven ultrasound systems within the OB/GYN clinical service at ACH: two systems in the clinic and five systems in the antenatal diagnostic center. All systems are networked in some manner to the department-based Acuson Aegis mini-PACS. The clinic performs routine OB examinations (e.g., crown-rump length or transvaginal studies), and the antenatal diagnostic center provides a wide range of services for advanced or high-risk pregnancies. Physicians perform 8 to 10 examinations per day in the clinic. The antenatal diagnostic center has three sonographers (one is funded through a research grant) who perform about 16 scans per day on average, allotting 30 minutes per scheduled examination.

The ATL Ultramark 4+ and Apogee 800+ are used in the clinic on the ground floor. The Ultramark 4+ is used sparingly and is not networked to the Aegis system. The Apogee system is networked with the Aegis mini-PACS and is the primary scanner in the clinic. Because of the limited number of average daily procedures reported, we recommend that the Ultramark 4+ be removed from service and not replaced. The Apogee should be maintained for routine OB/GYN examinations.

The antenatal diagnostic center reported that it performed 8,000 examinations annually, not including infertility-related examinations. The antenatal diagnostic center has five systems in use, one of which is used exclusively to support the infertility clinic, and another on loan from Acuson. The infertility clinic office is located on the same floor of the main tower as the other antenatal diagnostic services. All these systems are networked with the Aegis system, whose review stations are situated on the same floor of Nursing Tower 3. A utilization analysis, assuming an average of 40 minutes per average procedure, 40 hours of available scan time per week, and 8,000 annual exams, indicates that only three scanners are necessary to meet demand. However, because it is common to have lengthy procedures in this area and because some research examinations are funded through grant money, four systems may be necessary to support antenatal diagnostic services.

The two Acuson 128 XP-10s were acquired at the same time and have the obstetric software package. Both of these systems are similarly equipped with transducers and integrated with the Aegis. Neither reportedly has incurred any unusual or higher than expected repair costs; one system has incurred $29,842 in parts costs, and the other system, $21,050; each has experienced less than 80 man-hours in scheduled and unscheduled maintenance during the past 5 years. An ACN (approval code 1A) has been generated to replace one system, which will be traded in. It was reported that the other system does not produce quality images and that the antenatal diagnostic center wants to replace it. However, the new approved system is an Acuson Sequoia which should meet advanced imaging needs. We recommend that ACH reevaluate the need to replace the system with resolution problems after resolution testing has been conducted. Unless the spatial resolution can be shown to be inferior through testing using phantoms or clinical comparison, we do not believe this system needs to be replaced during the next 5 years.

The ATL HDI 3000 was also installed in 1996. This system is equipped with three transducers and is used for all antenatal diagnostic procedures. It also does not need to be replaced in the next 5 years unless 3D reconstruction develops into an antenatal requirement.

The Acuson Aspen currently is dedicated to support of the infertility service, which was estimated to generate 500 scans annually. We recommend that this system be relocated to the primary antenatal diagnostic examination area as it is nearby and that it replace the loaner Acuson Aspen. The system from the infertility clinic could handle both the current workload of the loaner and the 500 studies being conducted in the infertility clinic.

The antenatal diagnostic center uses the Acuson Aegis system for archiving images. There are two review stations on the third floor of the nursing tower; however, physicians do not have access to the Aegis if they are not in the department (i.e., via a teleultrasound or web-based image network). The antenatal diagnostic center has asked to replace this system because of its slow processing speed and its limited reporting package; staff members had also indicated that Acuson has stated that it will not support the Aegis system after December 2001. There is an approved requirement (ACN 3000-01-998) to replace this system. However, we recommend that ACH evaluate whether economies of scale may be achieved by integrating the storage of all ultrasound-based images on one ultrasound mini-PACS. This will require collaboration between radiology, cardiology, and OB/GYN but could result in lower acquisition and maintenance costs and decreased demands on information technology resources.

Labor & Delivery

The labor-and-delivery suites share two ultrasound systems between eight labor, delivery, and recovery rooms and four evaluation rooms. Both systems connect to the Aegis system in antenatal diagnostic center via Aegis interface boxes. The GE Logic 500 MD is 3-years old, and the Hitachi EUB is nearly 5-years old. Both of these systems should meet the needs of labor and delivery during the next 5 years.

Family Practice

The family practice clinic has two ultrasound systems: a 12-year-old ATL Ultramark 4 and a 10-year-old ATL Ultramark 9. The Ultramark 4 is used infrequently mostly as a backup system for determining fetal age and position because of clinical limitations. The Ultramark 9 is the primary system within the clinic, but reportedly even it is not used frequently as the department averages only eight examinations per month. (Clinic procedural volumes were not available for review.) We recommend that ACH remove the Ultramark 4 from service and that it replace the Ultramark 9 with an Acuson 128 XP-10 from the main radiology department, once they have a replacement.

Emergency Room

The emergency room (ER) has one ultrasound system that is used by ER physicians and residents: a 3-year-old PIE Medical Scanner 240. The system has two transducers and a videocassette recorder but is not integrated with any electronic archival system. This system is used infrequently as only one physician in the ER has the credentials to use the system; it is stored in the ER chief's office rather then in the patient care area. ACH should review the utilization of this system; if it is not justified, we recommend that it be removed. As long as a system is used, we recommend that credentials and competency should be continuously reviewed.

Surgery and Anesthesia

The operating rooms (ORs) are supported by two systems; surgery has a 5-year-old ATL HDI 3000 and anesthesiology has a 1-year-old ATL HDI 5000 CV. Both of these systems will meet the needs of the ORs during the next 5 years; however, ACH should monitor the use of smaller portable ultrasound systems such as the Sonosite system (CEEP item) that was recently purchased for the surgery department. In the future, large ultrasound systems may not be necessary for surgical and anesthesia support and may be removed from service.

Catheterization Laboratory

The personnel in the catheterization laboratory report that intravascular ultrasound studies are performed in about 10 percent of studies at ACH. The 5-year-old Hewlett-Packard M2400A intravascular ultrasound system currently in use will meet the needs of the catheterization laboratory during the next 5 years. However, ACH will have to monitor parts availability and training programs as Philips recent acquisition of Agilent (the medical device division of Hewlett Packard) creates uncertainty in the availability of support for Hewlett Packard products.

Echocardiography

Echocardiography services are provided with three systems. The two HP Sonos 5500 systems are used to perform nearly all examinations during regularly staffed hours of 0800 to 1730. One civilian echocardiographer is supported by military echocardiographers; currently one civilian echocardiographer position is not staffed. The third system, the HP Sonos 2500, is used as a backup system and by the residents during evening hours because they are reportedly more comfortable with this system.

The department staff reported that the department averages 12 to 18 patient examinations per day; the department performed about 2,000 procedures in the past year. In a few instances, procedures are performed elsewhere because of the inability to move patients (e.g., from the pediatric acute care unit)

There is no echocardiographic mini-PACS; all echocardiography images are currently stored on videotape. We recommend that ACH, as discussed previously, evaluate the feasibility of integrating ultrasound images in a single ultrasound mini-PACS.

We recommend that ACH remove the HP Sonos 2500 from service because it gets minimal use. The two HP Sonos 5500s will meet ACH's needs during the next 5 years, and we do not recommend replacement of these systems in this period.

Vascular Laboratory

Vascular ultrasound is provided as a separate service from both main Radiology and cardiology-based ultrasound. The section has two systems: a 5-year old ATL HDI 3000 and a new ATL HDI 5000. The vascular laboratory is staffed with two civilian registered vascular technicians, who perform between 10 and 14 examinations per day. Examinations are scheduled for 1 hour in duration.

Vascular ultrasound procedural volumes specific to the vascular laboratory were not available for review, but these two systems are technically adequate to meet the demands of ACH. We do not recommend any replacement of these systems during the next 5 years.

Nuclear Medicine

The nuclear medicine department has six gamma cameras, an image management system, a bone densitometer, and a thyroid uptake probe. Hours of operation for the department are 0730 to 1600, Monday through Friday, with on-call availability 24 hours per day, 7 days per week. The department performs about 6,300 diagnostic nuclear medicine procedures per year, 20 therapeutic procedures per year, and about 1,500 bone densitometry procedures per year. The diagnostic workload for the department break down as follows: 57 percent bone studies, 18 percent car-

diac studies, 6 percent tumor/infection studies, and all other studies comprise 19 percent of the total. Based on the complexity and variety of procedures, the nuclear medicine utilization factor for ACH is 5.5 or 6 cameras. The nuclear medicine department should be getting a dedicated positron emission tomography (PET) scanner in FY 2002 or FY 2003 (pending approval of USAMEDCOM and funding). The recommendations for replacements of their current equipment assume the addition of the PET scanner. The backlog for most procedures is less than 1 week, except for bone densitometry, which is 3 to 4 weeks.

The department has three board-certified nuclear medicine physicians (two military and one civilian). Depending on the clinic mission and case variety and complexity, the general guideline for nuclear medicine physician staffing is 2.2 to 3.3 for a department with a workload similar to that of ACH (0.4 to 0.6 physicians per camera; 1,150 procedures per camera per year). Because of the teaching mission (radiology and other residents) and high variety and complexity of procedures, the current staffing of three physicians is adequate and appropriate.

The department has six nuclear medicine technologists (four military and two civilian). As with determining the number of physicians, clinical mission and variety and complexity of procedures affects the requirements for technologists. In general, 8.2 to 11.0 technologists (including radiopharmacy support) are needed for a facility with a workload such as ACH (1.5 to 2.0 technologists per camera). Although there is separate staffing for the radiopharmacy, on the basis of the mission (including teaching phase II students) and high complexity and variety of procedures, ACH needs at least eight nuclear medicine technologists (two more than current staffing). If a dedicated PET scanner is added, two additional technologists (total of 10) will be needed.

The department has a radiopharmacy staffed with one full-time military radiopharmacist and one full-time civilian pharmacy technician. The pharmacy operates Monday through Friday from 0630 to 1700.

The single-head, single-photon emission computed tomography (SPECT) Siemens Diacam is about 9 years old (in room 3). This camera is capable of whole-body scanning. Maintenance is performed by Xpert, a third-party service organization, and this arrangement has been successful for the department. This camera is used for about five patients per day for studies that include three-phase bone scans, bone spot, blood, renal, and liver studies. We recommend that this system be replaced with a dual-head SPECT camera in FY 2002.

The Siemens Wholebody Scanner in room 3 is an opposed dual-head camera and is about 8 years old. Xpert also performs maintenance on this system. There were no significant problems reported with this camera except that it is not SPECT capable. The system is used for three-phase bone, whole-body bone, bone spot, renal, tumor, and I^{131} whole-body scans. We recommend this system be replaced with a dual-head SPECT camera in FY 2003.

The SMV DST XL in room 2 is a dual-head, variable angle camera that is SPECT-capable and has coincidence detection. The camera is about 3-years old. It has attenuation correction with a gadolinium source. The system is currently not capable of performing attenuation correction for coincidence detection because this has yet to be installed by SMV, which currently maintains this system. The department has had some problems with uptime that are mostly attributable to little problems (e.g., lost calibration tables). The system has low-energy high-resolution (LEHR), medium-energy all-purpose (MEAP), super high-energy general-purpose (SHEGP) collimators (used for fluorodeoxyglucose cardiac studies), and VCR-511 (used for coincidence detection scans). This system is used for a variety of studies including cardiac, whole-body bone, bone spot, blood, lung, renal, liver/spleen, medium-energy SPECT, cardiac PET, and oncology (coincidence detection). We recommend this system be replaced in FY 2006 with a dual-head, SPECT-capable gamma camera (assuming a dedicated PET camera is in place).

The single-head, SPECT-capable Siemens Orbiter in room 4 is 7 years old. Xpert also performs maintenance on this system. Some concern exists that the resolution is not very good because of the aging crystal. This system is used for multigated cardiac analysis (MUGA), bone (three-phase and spot), blood, lung, renal, thyroid/parathyroid, and liver/spleen studies for about three or four patients per day. Collimators available for this system include LEHR, low-energy all-purpose (LEAP), pinhole, MEAP, high-energy high-resolution (HEHR), and converging/diverging. A funded requirement exists to replace this system with a dual-head SPECT-capable camera in FY 2001.

The Picker 3000XP triple-head, SPECT-capable gamma camera (in room 1) is about 5 years old. This system is maintained via a contract with Marconi (formerly Picker). This system is not user friendly and more difficult to use for the technologists. This system is used for about five to seven patients per day. This camera is used for cardiac, MUGA, brain, renal, and thyroid/parathyroid studies, although the heads of the camera have a small field of view that limit its use. There is a treadmill located in the same room for the cardiac studies. We recommend this camera be replaced with a triple- or dual-head gamma camera in FY 2004. Because equipment needs may be affected by the presence of a PET scanner or changes in workload, ACH will need to evaluate their clinical need at that time.

The Siemens Orbiter in room 4 is a single-head, SPECT-capable gamma camera with whole-body scanning capability. The camera is about 9 years old. Xpert performs maintenance on this system. Concern also exists with this system that the resolution was not very good because of the aging crystal. This system is used for about five or six patients per day for cardiac (MUGA), bone (spot), lung, renal,

thyroid, gastric, and pinhole studies. We recommend that this system be replaced with a single-head gamma camera in FY 2002.

The Lunar DPX-L dual-energy x-ray bone densitometer is about 4 years old. The bone densitometer is maintained by Lunar under a maintenance contract. This system is used about seven or eight patients per day. The department has a technologist from x-ray assist for half a day, 4 days per week. The only complaint regarding this system is that it is slow. We recommend the bone densitometer be replaced in FY 2004 (CEEP requirement) or sooner if funding allows. Procuring a system with a faster scan time will save valuable technologist time.

The nuclear medicine department has an SMV image management system that is about 3 years old. This system has six SMV processing computers, servers, an archive, and three printers. All cameras in the department use the SMV processing stations except the Picker 3000XP. The images from the Picker camera are "pushed" to the SMV processing station in room 2 (via the Picker processing station) to be printed. The computer room has a SMV processing station and the SMV archive and server. This processing station is the gateway to the MDIS system. Because of incompatibilities between the SMV system and the GE MDIS system, a technologist must spend up to 1.5 hours per day preparing the image files to push the images to the MDIS system. This is a considerable addition to the technologist's workload.

The following printers are in the nuclear medicine department: a Codonics color printer, a black-and-white Imation Dryview 8300, and a black-and-white Helios 810. The Helios is used primarily as a backup for the Imation Dryview. The SMV processing station in room 2 is the print server for the Helios, and the SMV processing station in room 3 is the print server for the other printers. The physicians reading room has two SMV processing stations, a Picker processing station, and a MDIS display workstation. The physicians have the ability to access images at home with the use of SeeMor software and by dialing into the SMV processing station in the computer room. This capability is used several times per week. We recommend the image management system be replaced in FY 2004 and that the printers be replaced with CEEP funds at the end of their useful life.

Computed Tomography

ACH has two 9-year-old GE CT scanners. Hours of operation for the section are from 0800 to 2000, 5 days per week, plus on-call hours. The section conducted 13,300 CT exams in the past year, for a utilization factor of 1.4 or 2 CT systems. The section schedules 24 patients each day plus add-on patients and may see more than 40 patients on some days. Occasionally, the department will schedule patients on the weekends or every 30 minutes on one CT system to help keep the patient appointment backlog, which is about 2 weeks, manageable. There are eight full-time technologists (three military and five civilian), including the lead and NCO, although the NCO does not scan and performs only administrative work.

The breakdown in procedures is as follows: 37 percent head and neck, 24 percent abdomen, 18 percent chest, 16 percent pelvis, and 5 percent other studies. The systems are used for a variety of studies including trauma, head, spine, chest, abdomen/pelvis, extremities, oncology, vascular, pediatric, and biopsies.

The department has two identical 9-year-old GE HiSpeed Spiral CT systems; both were upgraded in 1997. A single processing station is used for both systems; each system has its own acquisition station. The processing station is located in the CT core area along with two CT reading areas (MDIS review stations) and an MDIS gateway. Currently, all studies are sent to the MDIS system. In the event that MDIS goes down, images are printed on the dry processor in the ultrasound section. There is an approved, funded requirement to replace one of the CT systems with a multislice system. The other CT should replaced in FY 2004.

Radiation oncology patients are scanned in the CT department. Studies are sent to the treatment planning system in the radiation oncology department via the CT processing station and a network.

The CT systems are maintained by GE under a maintenance contract. There have been no problems with this arrangement, and the CT systems have been reliable.

Magnetic Resonance Imaging

The MRI section at ACH has two MRI systems. There is a fixed GE Horizon LX EchoSpeed 1.5-T system housed in a separate building close to the radiology department in the main hospital and a mobile Siemens Magnetom 1.0-T system on a pad behind the fixed MRI system. On a weekday, the average number of MRI exams for the section is 25. The section has eight technologists (three military and five civilians) with an additional vacancy for a civilian technologist. Only two of the current technologists are MRI certified.

CHCS workload numbers indicate that about 8,400 exams were conducted during the past year. This equates to a utilization factor of 1.8 or 2 systems. Since the optimal utilization of a MRI system, under current guidelines of the STCPC, is when the system is used for two full shifts Monday through Saturday, some excess capacity exists with the two MRI systems at ACH. CHCS trends during the past 5 years show an overall increase, and the excess capacity should handle this increase in workload.

The workload breaks down to the following procedures: brain (32 percent), spine (31 percent), lower extremity (17 percent), upper extremity (10 percent), body studies, e.g. chest, heart, abdomen, and pelvis (8 percent), and other (2

percent). This is a typical procedure breakdown scenario for most Army sites. Workload is assigned between the two MRI systems with the more sophisticated exams being performed on the GE.

The GE MRI system was put into service in October 1990, but it was upgraded in 1995 and again in 2000 to keep the system to enhance technical capabilities and address clinical developments in MRI appropriate for a hospital of ACH's size and scope. The 2000 upgrade cost about $900,000. It consisted of replacing all major components except for the magnet (i.e., gradient and radiofrequency coils, amplifiers, power supply and control systems, pulse-sequence and processing software). Routine hours of operation for the GE MRI system are from 0630 to 2400, 7 days per week. About 16 exams per day conducted on this system. At all times, two technologists operate the GE MRI system, which is used for routine (e.g., brain, knees, and ankles) and most nonroutine exams (e.g., body exams and MR angiography). The GE MRI system does not have an uninterruptible power supply (UPS) but is connected to an emergency power supply. During a power outage, the system goes down but can then be repowered.

The Siemens 1.0-T MRI system was put into service in December 1994. The system had a minor upgrade in 1996 (stronger faster gradient sets were installed and additional radiofrequency coils provided). No upgrades have occurred since 1996. A programmed upgrade was planned for 1999 at an estimated cost of $700,000. However, this requirement has not yet been funded, and the need for upgrading or replacing this MRI system should be reconsidered. The Siemens MRI system is operated from 0800 to 1600, Monday to Friday. About nine exams per day are conducted on the Siemens system. One technologist operates the Siemens system, which is used exclusively for routine exams (e.g., brain, knees, and ankles). The Siemens system has a UPS. Despite recent power outages in some Seattle-Tacoma areas, no major power problems have been encountered.

Exam times are representative of those used at other sites (varies between 20 and 45 minutes depending on the procedure). However, all exams are scheduled in 1-hour blocks. The current backlog is long at about 4 weeks for outpatients and 1 week for inpatients. We suggest that ACH consider an extended shift for routine MRI exams on the Siemens MRI system. We also recommend that ACH consider 45-minute schedule blocks, at least for a short time to assess technologists' ability to handle a slightly higher volume of patients.

Although ACH has had the MDIS system for several years now, all MRI exams are read from hardcopy film. Although the GE system does at least send images to the MDIS system, the Siemens system is not interfaced with MDIS. The main reason for hardcopy review is that the MDIS Apple-based workstations are not optimized for display of MRI images, with its multitude of series and images. A Kodak/Imation 8700 dry printer within the MRI section provides dry film prints. A Kodak/Imation 8800 print controller allows both the Siemens and the GE MRI systems to print images to the 8700 printer. Currently, there is no backup dry printer for either of the MRI systems, even though the Siemens has an unused Kodak Ektascan 1120 laser printer in the mobile van. Technologists assigned operating duties at either of the MRI systems are responsible for retrieving and delivering film to be read.

Film accountability is a problem in the MRI section. ACH estimates it reprints between 5 and 10 percent of MRI exams. Since the site uses about 1,500 sheets of film a week at a cost of about $1.50 per sheet, the cost of film printing is about $117,000 annually. This cost should be eliminated with appropriate capability for soft-copy review.

There is a two-monitor GE Advantage Windows workstation in the section. Prior radiologists occasionally used this workstation for reformatting cardiac images and for assessing interventional MRA images. However, now the workstation is largely unused.

The reading areas within the MRI suite have two diagnostic-quality, four-monitor workstations (referred to as SCID 4As). These are used for viewing comparison CT and plain radiography images. All MRI images are displayed on alternators or light boxes within the same area. Reading is normally completed within 24 hours, although an occasional delay of 48 hours occurs.

The transcription backlog is significant. The Chief of Imaging believes that the transcription backlog for MRI is about 3 to 4 weeks. The current "fix" is to send CHCS e-mail messages to referring physicians when an important finding needs to be quickly communicated. We recommend that ACH consider implementing a voice-recognition dictation system that can be interfaced to CHCS. A recent contract with Dictaphone may bring about such functionality in a year or so; however, we can assist ACH now with exploring a voice-recognition dictation system developed by an Air Force radiologist. This system is in place at a few military hospitals and has the potential to drastically reduce or eliminate transcription backlogs.

Access to the MRI building is problematic, particularly for in-patients who need support. Although there is a covered walkway most of the way, it does not shield patients from the elements. Furthermore, there is no cover over a road crossing. However, once inside, the building provides a large and comfortable environment that allows for good patient workflow. A waiting area at the front has adequate seating. There are rest rooms, changing rooms, reading areas, and physician offices in the building. Wait times for patients are 15 to 20 minutes.

ACH refers very few patients to outside facilities for MRI studies. Only about four or five patients per month are referred out, typically because the patients are either claustrophobic or overweight (the current MRI table is rated at a maximum load of 300 pounds). On rare occasions, patients require anesthesia or sedation during the MRI exam, and

they can be handled adequately within the MRI section. An MRI-compatible monitoring system is available with both MRI systems but is used only with the GE MRI system. Because electrocardiogram (ECG) traces cannot be examined in the room, ACH is looking to replace its In Vivo Omni-Trak monitoring system with a more capable and better functioning system.

All MRI referrals are reviewed for appropriateness by radiology staff. The CHCS file and table, as it relates to MRI studies, has been edited to such an extent that referring physicians have a limited choice of exams (under coarse CPT codes, such as lower extremity as opposed to the more specific body part, such as ankle). Therefore, scheduling is done manually in the MRI section, although patient arrivals and departures are noted in CHCS. The result is that CHCS printouts do not show adequate detail to characterize the type of studies being conducted. We recommend that ACH revisit CHCS table and file editing. At the least, radiology staff needs to correct CHCS information at the time of patient arrival and departure.

Both MRI systems are currently under a maintenance contract with General Electric Medical Systems. The GE MRI system is in excellent condition and meets all the site's clinical needs for MRI services. Technologists report excellent system uptime. Review of AMEDDPAS information showed that the system had mainly minor problems during the past 12 months, most of them involving issues of compatibility of upgraded parts with existing parts. The Siemens system has had even better reliability with only 12 unscheduled visits during the past 5 years.

We recommend ACH consider the following short-term improvements:

- Complete configuring for DICOM Modality Worklist functionality for at least the GE MRI system. The GE MRI upgrade was purchased with Modality Worklist capability. The Siemens system probably cannot have this capability, but at eight or nine patients per day, this is not currently critical.
- Transition to softcopy review in MRI as soon as possible. To promote this transition, the TARA team has already approved and funded two GE PathSpeed NT workstations. These workstations offer more extensive display capabilities for CT and MRI studies and should meet the MRI physicians' needs better than the Apple-based Macintosh workstations. These PathSpeed workstations should be placed in the MRI section if that is where most of the MRI exams will be read.
- Assess the need for better coils for the GE MRI system. For example, the current spinal CTL coil is 6 years old and its image quality is marginal. Also, MRI staff members would like to see a high-resolution head coil.
- CHCS Table and File changes need to be made as soon as possible, so that exam types can be accurately tracked.

The major upgrade and replacement recommendations are as follows:

- The Siemens system is due for an upgrade. An approved requirement exists for an upgrade at a cost of $700,000. We recommend that this requirement be changed in favor of a replacement 1.5-T system to be sited inside the main hospital. We will change the requirement to this effect. ACH will have to work with its facilities staff to estimate site preparation costs. The replacement system should be interfaced to MDIS.
- The GE MRI system was upgraded in 2000. In FY 2005, we recommend that this system be replaced with a new MRI system, with a short-bore, actively shielded magnet. At this time, ACH may wish to consider siting the replacement MRI system within the main hospital building also. Site planning for installing the replacement for the Siemens MRI system should take into consideration the possibility of a second MRI system in the vicinity.

Orthopedics

The orthopedic clinic has a Fischer 6700 general-purpose system. Hours of operation are 0730 to 1600, 5 days per week. The orthopedic clinic sees about 9,800 patients per year, which equates to a utilization factor of 1.2 or 2 systems. The clinic normally has one full-time technologist assigned. There is no significant backlog for patient appointments.

The Fischer 6700 was installed in 1992 and has an overhead suspension system with a Fisher RMS EXT 600 elevating table with floating top. The system also has a fixed wall Bucky that uses phototimer technology. Typical procedures performed include all general-purpose extremity exams but not chest and skull studies. The patient workload ranges from 30 to 80 exams. Uptime for this system is at 80 percent. No problems were indicated concerning the movement of patients using gurneys or wheelchairs within this room. Cassettes are processed digitally by a Fuji AC-2 CR reader.

Problems identified include lights that occasionally go out on the control panel, problems with the hydraulics on the table, and Buckys that sometimes cease to function. The clinical engineering department has been providing support to get these problems resolved. This unit has been heavily used for 9 years, and we recommend it be replaced as soon as possible.

The orthopedic clinic ideally should have two systems. Because of the limited floor space in this department, it is difficult to make space for a second radiographic room. In addition to the cost to purchase two orthopedic rooms, the aging CR reader will also require replacement soon. We feel that an appropriate compromise would be to replace the Fischer unit with a new DR system. These units will allow

the technologists to become far more efficient with their time. Exams can be performed, undergo QC, and sent to the PACS without leaving the room. We believe that this technology is mature enough and the utilization of 1.2 systems can be met with one DR system. We recommend that this Fischer 6700 be replaced with a DR system FY 2002. There is a 1A approved and funded requirement for a general-purpose radiographic system to replace the Fischer (ACN 3246-00-999). This ACN will be used to replace the general radiology system in room 3 in the radiology core. A new ACN (3189-02-999) has been generated for the DR system.

Gastrointestinal Clinic

The GI clinic has a Picker MTX fluoroscopy system. Hours of operation are 0730 to 1600, 5 days per week. CHCS workload indicates GI radiographic procedures equating to about 120 patients per year on one system. One of the nurses in the clinic indicated that there are seven or eight patients imaged in this room per week, and log files confirmed this was the case, making the annual workload about 350 studies per year. There is obviously a disparity between exams performed and what is indicated in CHCS. The clinic does not have a radiology technologist, and instead the physicians or nurses assigned to the department operate this machine.

The current system was originally installed in another hospital in 1987 and was moved in 1992. The system has an overhead suspension system with a Picker Vector 2 90/30 table with floating top. There was a digital upgrade to the system in 1997 that included a new imaging chain (with new image intensifier) and a new main control panel. There is no wall Bucky in this room, and all exams are limited to fluoroscopy procedures only with no straight radiographic exams required. Typical procedures performed include ECRPs, dilations, placement of rectal monometry, and colangiograms. Uptime for this system is at 90 percent. Because of the relatively minor use of this system and because there was a recent upgrade to the system, we recommend this system be replaced FY 2006 with a fluoroscopy system with an 80-kW generator and tilting table. An overhead suspension, wall Bucky, and other general radiology features will not be required.

Urology

The primary hours of operation for the urology department are from 0730 to 1600. The department is staffed with one laboratory technologist, two registered nurses, two licensed practical nurses, and three urology technologists/ licensed practical nurses. Urology workload has been going down during the past 5 years (from 1,778 studies in 1995 to 972 in 2000). About 1,000 imaging procedures (utilization factor of 0.4 or 1 system) were performed in urology and recorded in CHCS from February 2000 through January 2001. The procedures break down as follows: IVPs with tomography (38 percent), IVPs without tomography (14 percent), kidney, ureter, and bladder studies (KUBs) (14 percent), retrograde pyelograms with fluoroscopy (11 percent), voiding cystourethrograms-(VCUGs) (11 percent), retrograde urethrograms (9 percent), and C-arm exams (3 percent). The patient appointment backlog is less than 1 week.

The department has three 9-year-old Liebel-Flarsheim Hydr-X CP80s systems with Hydrajust III tables (rooms 1, 2, and 5, respectively). All three systems provide radiographic and tomographic capabilities with rooms 1 and 2 also having fluoroscopic capability. Radiographs from the three systems are recorded on CR plates that are processed through a Fuji CR reader. The CR reader is networked to MDIS.

A fourth fixed imaging system is a new Medstone Uro-Pro-2000 (no MMCN) system in room 4 that has digital fluoroscopy capabilities. This system (which is Medstone's first production unit of this model) is connected to a dry film laser imager.

In room 3, a less than 1-year-old Ziehm Exposcop 7000 mobile C-arm digital fluoroscopy system is used with a Medstone urology table. The Exposcop 7000 apparently replaced an OEC-Diasonics 9000 C-arm. Our understanding is that Exposcop 7000, which was a loaner for the past 3 months, is now officially procured but not yet accepted by ACH, and this acquisition should negate the unfunded requirement.

These systems have no significant maintenance issues, except for the Liebel-Flarsheim fluoroscopy system in room 2, which has been experiencing internal circuit interruptions requiring the system to be cycled down and then restarting before a procedure can be resumed. Maintenance records indicate that the cumulative maintenance expense for this system is fast approaching the maintenance expense limit. An unfunded requirement exists for replacement of this system.

IVP procedures (with and without the use of tomography) are predominantly scheduled for the Liebel Flarsheim system in room 5. Most of the fluoroscopic procedures are performed on the new Medstone UroPro-2000 system in room 4. Room 1 is used as a backup. Based on the procedural statistics provided, fluoroscopy appears to have been used in a maximum of 350 procedures from February 2000 to January 2001.

Two fixed digital fluoroscopy systems (one of which should have linear tomography) and one mobile digital C-arm system should be sufficient to meet total imaging needs now and in the next 5 years for the urology department. This determination assumes that cases on average take 60 minutes to perform and 40 hours per week are available to conduct studies with an annual workload of 1,015 distinct imaging sessions.

For the diagnostic imaging systems in urology, we recommend that the system in room 2 be replaced in FY 2002 with an R/F/T system. The replacement should be

capable of pulsed fluoroscopy and should incorporate a high-frequency or constant potential generator capable of 30 to 60 kW, a tomographic attachment, a DICOM 3 interface, and a 90/15 table. The systems in rooms 1 and 5 should be removed and not replaced. If changes of workload significantly change or if other factors justify the replacement of these systems, then ACH should submit a MEDCASE package with adequate justification. The systems in rooms 3 and 4 should not be replaced during the next 5 years.

Cardiac Catheterization

The cardiac catheterization laboratories operate from 0800 to 1630 hours, Monday through Friday. Five cardiologists perform diagnostic and interventional procedures and are supported by one nurse. Utilization modeling indicates that one system can handle the current caseload and still maintain adequate reserve capacity. This determination assumes average procedure times of 90 minutes, a 40-hour per week equipment availability, and an annual workload of 620 studies (utilization factor of 0.6 systems). Staff stated that pediatric cases are not performed in either of these labs and very few cases involve biplane fluoroscopy.

From February 2000 through January 2001, 617 cardiac catheterization procedures were performed primarily using the 13-year-old Siemens Coroskop C/L biplane system in room 2-47-09. The Siemens has an XRE table. In 1995, this system was upgraded to have digital subtraction angiography. The Siemens biplane system is funded for replacement in FY 2001 and reportedly a purchase order was placed for a biplane system that enables both single-plane cardiac catheterization procedures and single-plane peripheral angiography procedures.

The 8-year-old, single-plane GE Advantx fluoroscopy imaging system in room 2 is used for about 60 procedures per year. This system had a digital imaging chain upgrade in 2000. The GE single-plane system receives limited use because the tube generator is underpowered to support adequate imaging resolution during stent placement procedures. As a result, this system is mostly used for pacemaker placement. We recommend this system be removed from service because its use is minimal, and it exceeds required capacity. By removing the system, ACH can also reduce contracted maintenance support from GE by $59,000 per year. This GE Advantx system should be removed from service only after the replacement system for the biplane system in room 2 is installed, accepted, and performing reliably through a normal workload period.

Picture Archiving and Communication System

ACH will ultimately need to transition to a full PACS to support digital radiology, and the Command group should be aware of how each modality fits into the digital environment. The radiology department will need to replace analog processing of plain film (normally 70 percent of the radiology workload) with digital processing by using CR readers.

These requirements for CR readers (two for radiology) can be met by relocating current CR assets. This would involve moving the Fuji AC-3 CS from the urology section and the Fuji AC-3 CS/ID from the TMC. A Kodak CR800 will soon be delivered to MACH. This single plate CR reader would better serve the workload requirements at the TMC. Finally, a smaller CR, e.g., the Fuji new Smart CR, should be procured and installed into the urology clinic. The rationale for moving the Fuji CR readers has to do with ensuring maximum utilization of these high-throughput devices. More information on placing the CR readers can be found in the CR section of this report.

All portable x-ray devices will share the use of the CR readers located in the radiology department. The existing fluoroscopy systems allow for spot imaging in a digital format, and their overheads can be done on the CR readers. The ultrasound scanners in the radiology department will use an analog to digital converter box such as those manufactured by Merge or DICOMMIT. Digital diagnostic imaging systems will need Digital Imaging and Communication in Medicine (DICOM) outputs to connect to PACS. CT and MRI systems are digital, and if the system in use does not provide for the necessary DICOM output, then a software upgrade will be needed to provide the necessary output to PACS. The gamma cameras will also require a review of current software to determine current DICOM functionality. Mammography is the only modality that will require the continued use of hard copy film printing, because digital mammography systems remain cost prohibitive.

For all radiology modalities, the minimum essential DICOM elements required will be DICOM Storage as a Storage Class User (SCU), Modality Worklist, and DICOM Print. Any new radiology modalities that are purchased and any further software upgrades should have these DICOM elements included. Another frequent area of concern regarding the installation of a PACS is the local area network (LAN). The minimum requirements for ACH will be for either an ATM (at least OC-12) or gigabit Ethernet backbone, with 100-Mbps capability to the desktop. Any outlying clinics that are spoke sites to MACH should have at least a T1 wide area network (WAN) connection between facilities or, if the location is close enough, a direct connection between facilities at 10- or 100-Mbps. ACH should work with the Tri-Service Information Management Project Office (TIMPO) on LAN upgrades. In addition, TIMPO should be advised of any future WAN requirements.

TECHNOLOGY ASSESSMENT AND RECOMMENDATIONS FOR CLINICAL LABORATORY EQUIPMENT

The clinical laboratory consists of the clinical and anatomic pathology services and a pathology support service. The anatomic pathology service includes surgical and autopsy pathology, cytopathology, and electron microscopy. The clinical pathology service includes chemistry, hematology, microbiology, blood transfusion, and a stat laboratory. The pathology support service includes quality assurance, quality improvement and risk management, decentralized laboratories, laboratory information systems, budget, and supply. Laboratory hours of operation are from 0730 to 1600 with emergency services available 24 hours per day, 7 days per week. laboratory authorized staffing on TDA01 includes 14 military pathologists (6 staff and 8 resident), 5 clinical laboratory officers, 78 enlisted soldiers, and 60 civilian personnel. laboratory also is a phase II training site for 15 to 20 students from the medical laboratory technician program.

Laboratory personnel have implemented many positive changes and incorporated numerous sound business practices. Examples include the use of the USAMEDCOM-administered contract for commercial reference laboratory testing; use of cost-per-test contracts, versus purchase, for capital equipment; and recycling of ethanol, formaldehyde, and xylene. The laboratory is also switching from glass to lighter and safer plastic collection tubes.

The laboratory uses CHCS as its primary automated information system and COPATH for anatomic pathology. The Defense Blood Standard System (DBSS) is also used in the blood transfusion service. Most of the clinical analyzers are interfaced with CHCS, and the workload is automatically captured. Managerial and supervisory staff should periodically validate workload by comparing manual reports with CHCS generated reports for the same period. This is essential to ensure accurate workload capture. Discrepancies should be brought to the attention of the laboratory's CHCS manager.

It is necessary to review workload reports for proper coding under the Current Procedural Terminology (CPT) system. The seven-digit CPT code includes the five-digit base code and a two-digit suffix modifier. The base code and suffix determine the procedure's corresponding weighted value. The current year's CPT code list, distributed by the USAMEDCOM Laboratory Program Manager, should be reviewed to learn about code additions, deletions, and changes. USAMEDCOM bulletins and the American Medical Association's CPT code book are also good sources of information.

Four numerical suffixes are used as CPT code modifiers: 00, 26, 32, and 90. The suffixes should be used as follows when establishing test files and workload collection forms:

- 00—used when the laboratory test is ordered and performed in-house, i.e., for beneficiaries registered in ACH's CHCS. For anatomic pathology tests, the base or 00-weighted codes include both the technical and professional components.
- 26—used for the professional component whenever a physician provides an interpretation and *separate written report* for selected laboratory services. Weighted values for the professional component are additive to the technical component and are defined for selected codes only.
- 32—used when the test is performed for a different facility. This code is appropriate when specimens are sent to the laboratory from a different laboratory or medical treatment facility.
- 90—used when laboratory specimens are sent to a referral laboratory for testing and reporting. *Note*: All procedures with a 90 suffix have a 0.3-weighted value.

A CHCS statistical detail report should be reviewed to ensure that the suffixes are correctly assigned to the CPT codes for tests performed. A review of reported workload showed several tests that were shipped-out receiving the improper weight. Files should be edited to ensure proper capture of the 90 suffix. Additionally, the files and tables are not established to allow capture of anatomic pathology workload in CHCS. Workload data is being provided to the Medical Expense and Performance Reporting System (MEPRS) office but the process could be improved. After periodic review, discrepancies, if any, should be brought to the attention of the laboratory's CHCS administrator for correction to the appropriate files. Additional questions or concerns should be directed to the USAMEDCOM Laboratory Program Manager.

Equipment workload information in this report was derived from an FY 2000 statistical detail report. Workload figures reflect only reportable tests and their corresponding weighted values. QC tests and repeat counts are not included but must be taken into consideration when making cost-per-test determinations and supply management decisions. Documentation of QC workload also is important for personnel requirements determination under Automated Staffing Assessment Module. Benchmark indicator data was derived from MEPRS centrally generated reports for FY 2000. Table 10 lists the laboratory equipment and their recommendations.

Department Layout

The current layout of the department is compartmentalized, but plans have been made to merge chemistry and hematology into a central testing area. We strongly recommend that this initiative continue. Planned changes will provide improved workflow and resource sharing and cross-training of technical employees. Consolidation will not nec-

essarily provide a reduction in the number of analytical platforms, but it will enhance the reference laboratory capabilities and possibly result in regional, system-wide savings.

Clinical Pathology Service

Clinical Chemistry

This section includes routine, immunochemistry, and special chemistry. Management staff includes an officer-in-charge (OIC), a civilian supervisor, and a non-commissioned-officer-in-charge (NCOIC). Seven personnel staff the day shift; the evening and night shifts have three personnel each. Approximate workload distribution is 53 percent day shift, 27 percent evening shift, and 20 percent night shift. Estimated annual workload for the section is 805,000 tests. A table of tests is not provided as there is little redundancy between testing platforms.

Major analytical equipment includes three Johnson & Johnson Vitros analyzers: two model 950s and one model 250. There are two Abbott AxSym instruments, two Chiron/Bayer model 855 blood gas analyzers, one Perkin Elmer atomic absorption spectrophotometer, one Beckman Array nephelometer, and one Biorad Variant. There is also one Johnson & Johnson ECI, an immunochemistry analyzer.

The Vitros analyzers are on a Tricare Region 11 cost-per-test contract and basic chemistries cost 18.5 cents per slide. Local area DOD laboratories support the contract. We recommend that the laboratory at Fairchild Air Force Base near Spokane be contacted about participation. Their added volume could possibly improve the discount rate and benefit the entire region.

The Abbott AxSym analyzers are used for therapeutic drug testing, endocrine and hormone assays, tumor markers, cardiac enzymes, fetal lung maturity, and medical alcohol analysis. Legal blood alcohol testing is referred out. The systems are government owned and should remain in service.

The Chiron/Bayer 855 blood gas analyzers are owned by the government. They should remain in service.

The Perkin Elmer graphite furnace atomic absorption spectrophotometer (model 4100ZL) is used only for blood lead testing. The instrument is owned and maintained by the facility. It was installed in 1993 and has reached its life expectancy. Annual workload is only about 500 tests. During the past few years, the workload has substantially declined. Effective 1 October 2001, we recommend that blood lead screening be discontinued at ACH and sent to an Army Medical Center. The instrument should be turned in to property management for disposition. In FY 2001, ACH received $2,500 from the USAMEDCOM for blood lead screening. The estimated supply cost for testing is $3 per sample, amounting to an annual requirement of only $1,500 based on 500 samples per year. USAMEDCOM funding for blood lead screening will be discontinued at the end of FY 2001.

The Beckman Array nephelometer is also owned by the government. It should remain in service.

The BioRad Variant is used for gylcosylated hemoglobin analysis, but conversion to hemoglobin A_{1C} testing is being considered. The change is recommended on concurrence from endocrinology. Annual workload is about 9,000 tests.

The Johnson & Johnson ECI, which is leased, is used for ferritin analyses only. We recommend that the test be performed on the Abbott AxSym and that the ECI be returned to the contractor.

Hematology/Clinical Microscopy

Hematology/clinical microscopy is staffed with a civilian supervisor, an NCOIC, and military and civilian testing personnel. A medical technologist coordinates teaching and training functions. Stat testing is available 24 hours per day, 7 days per week, with one person covering each (day, evening, or night) shift. Eight personnel perform routine priority testing on the day shift (0730 to 1700). Workload distribution is similar to chemistry with 52 percent during the day shift, 30 percent during the evening shift, and 18 percent during the night shift. Testing consists of hematology, coagulation, urinalysis, body fluid analysis, and flow cytometry.

Major instrumentation includes two Coulter Gen S hematology analyzers, two Yellow Iris urine analyzers, two Diagnostica Stago STA Compact coagulation instruments, one Becton-Dickinson FACSCalibur flow cytometer, and a Helena Cliniscan. The Coulter and STA instruments are on cost-per-test contracts. These instruments are in excellent condition, and our recommendation is to continue with the present arrangement but including as many regional customers as possible.

The Iris 500 instruments (manufactured by International Remote Imaging) are urine analyzers. One instrument is in hematology and the other in the stat laboratory. The STA Compact coagulation instruments are similarly used. These instruments are in excellent condition, and we recommend continuing with the cost-per-test contracts.

Hemoglobin electrophoresis is performed on the Helena Cliniscan. It was placed in service in 1999 as replacement for an instrument that was not year 2000 (Y2K) compliant. We recommend the Cliniscan continue in its current use.

There are no other equipment recommendations for this section. We recommend the cross-training initiative be continued. Cross-training can help to eliminate lost response time during critical situations and will ensure maximum cost-efficient operation of equipment will occur staff shortages or leave. This will become even more important with the consolidation of hematology and chemistry sections.

(Continued on page 38)

Table 8. Laboratory Equipment Recommendations, ACH

Equipment	Manufacturer	Model	Contract Type	Equipment Recommendation
		Clinical Chemistry		
Chemistry analyzer	Johnson & Johnson	Vitros 950	Cost per test	Continue with cost per test contract
Chemistry analyzer	Johnson & Johnson	Vitros 950	Cost per test	Continue with cost per test contract
Chemistry analyzer	Johnson & Johnson	Vitros 250	Cost per test	Continue with cost per test contract
Immunoassay analyzer	Abbott	AxSym	Owned	No change
Immunoassay analyzer	Abbott	AxSym	Owned	No Change
Blood gas analyzer	Chiron/Bayer	855	Leased	No change
Blood gas analyzer	Chiron/Bayer	855	Leased	No change
Osmometer	Advanced Instruments	3D3	Leased	No change
Osmometer	Advanced Instruments	3D3	Leased	No change
Chemistry analyzer	Abbott	TDx/FLx	Leased	No change
Atomic absorption spectrophotometer	Perkin Elmer	4100ZL	Owned	Turn in to property management effective 1 March 2001
Nephelometer	Beckman	Array	Owned	No change
		Hematology/Clinical Chemistry		
Hemoglobin analyzer	Biorad	Variant	Cost per test	Change to hemoglobin A_{1C} testing on concurrence from endocrinology
Immunochemistry analyzer	Johnson & Johnson	ECI	Leased	Return to contractor
Hematology analyzer	Coulter	Gen S	Cost per test	Continue with cost per test contract
Hematology analyzer	Coulter	Gen S	Cost per test	Continue with cost per test contract
Urine analyzer	International Remote Imaging	Yellow Iris 500	Cost per test	Continue with cost per test contract
Urine analyzer	International Remote Imaging	Yellow Iris 500	Cost per test	Continue with cost per test contract

(Continued on next page)

Table 8 (continued). Equipment Recommendations, ACH

Equipment	Manufacturer	Model	Contract Type	Equipment Recommendation
Hematology/Clinical Chemistry (continued)				
Coagulation instrument	Diagnostica Stago	STA Compact	Cost per test	Continue with cost per test contract
Coagulation instrument	Diagnostica Stago	STA Compact	Cost per test	Continue with cost per test contract
Flow cytometer	Becton-Dickinson	FACSCali-bur	Owned	No Change
Electrophoresis system	Helena	Cliniscan	Owned	No Change
Bacteriology				
Bacteria analyzer	Biomerieux	Vitek	Cost per test	Continue with cost per test contract
Blood culture analyzer	Difco	Bacti-Alert	Owned	Replace in FY 2002 (CEEP)
Anatomic Pathology				
Electron microscope			Owned	Refer workload to Armed Forces Institute of Pathology
Immunology/Serology				
Immunoassay system	Grifols-Quest	Triturus	Reagent rental	Concur with plan to evaluate Tigris Aptima
Cytology				
Pap smear analyzer	Cytyc ThinPrep	TP-2000	Owned	Continue current use
Blood Transfusion Service				
Immunoassay analyzer	Abbott	Commander	Owned	Possible changes to be recommended by new Army Blood Program Officer

(Continued from page 36)

Microbiology

This section includes bacteriology, serology, immunology, mycobacteriology, mycology, parasitology, and virology. Management staff includes an OIC, a civilian supervisor, and an NCOIC. There are 20 employees, and the workload is about 160,000 tests per year with 99 percent of the workload performed on the day and evening shifts. The day shift performs almost 75 percent of the work. In vitro devices and products that use molecular diagnostics are becoming much more readily available. Consequently, costs are moving downward, and we recommend that greater utilization of this new technology be explored. Maintaining a regional reference center status depends on it. In addition, the microbiology staff are commended for their work in bioterrorism preparedness and response. Much progress has been made in gaining Centers for Disease Control and Prevention (CDC) level B status, and we recommend continued partnering with the state public health laboratory in Seattle.

Bacteriology

Most procedures in bacteriology are performed manually. Major instrumentation is limited to the Biomerieux Vitek and the Difco Bacti-Alert. The Vitek, which is used for automated bacterial identification and antibiotic susceptibility testing, is on a cost-per-test contract, and no change is recommended. The Bacti-Alert is used for blood culture

analysis. The system is government owned and has reached life expectancy. A replacement item should be programmed.

Virology

Workload is recorded under the virology accession area for a workload of about 6,200 tests annually. There are no recommendations for this section.

Immunology/Serology

This area includes diagnostic immunology and infectious disease serology. Annual workload is about 65,000 reportable tests. A Grifols-Quest Triturus immunoassay system serves as the section's primary instrument. It was acquired through a reagent rental agreement and allows the section to expand its offerings and capture regional workload with substantial savings. The section also plans to evaluate the new Tigris Aptima and bring automation to amplification testing, initially for GC and Chlamydia then other assays later. The Tigris will eliminate manual sample processing.

Mycobacteriology/Mycology/Parasitology

Workload is recorded under the respective accession areas, and the combined workload for all three areas is about 16,000 reportable tests. There are no equipment recommendations.

Anatomic Pathology Service

The anatomic pathology service consists of surgical, autopsy pathology, and cytopathology. There are authorizations for six staff pathologists and eight resident pathologists. There is also a pathology residency training program. Staff also include six civilian histotechnologists (four full-time and two part-time) and five full-time cytotechnologists (two military and three civilian). Anatomic pathology uses the COPATH information system that is interfaced with CHCS. We recommend that a voice recognition system be considered. Sites using voice recognition systems have been able to dramatically reduce the number of transcription and clerical personnel while improving report turnaround times. Electron microscopy is also performed in laboratory and cases number about 20 per year. The annual service contract is more than $8,000. We recommend that consideration be given to turning in the electron microscope and referring the workload to Armed Forces Institute of Pathology. Costs would be nominal, if any.

Significant differences from the CAP Workload Recording Method exist in the reporting of CPT codes for anatomic pathology (cytopathology and histology) workload. Data capture for the pathologist professional component is critical to the system and for many of the surgical pathology codes the level of complexity and diagnosis of each case controls the proper CPT coding of the workload. Steps should be taken to ensure that the data counting mechanisms are sufficient to capture the proper CPT codes.

Even though the COPATH system is interfaced with CHCS, the CHCS files have not been populated. Consequently, the anatomic pathology workload is not automatically captured by CHCS, and statistical detail reports cannot be generated. Furthermore, if the CHCS files were populated, COPATH allows entry of only one CPT code per case. This would necessitate manual capture and entry of additive workload for complete reporting. The surgical pathology workload is predominantly from level IV cases, and many of them have special stains. Rather than rely on CHCS, the service uses a COPATH generated report. The data is then manually entered into MEPRS.

Histology

The histology section is open weekdays from 0500 until 1700 hours. Surgical cases number about 12,000 per year, and there are 25 to 30 frozen sections per month. Autopsies number about 70 per year. Histology is well equipped with tissue processors, embedding centers, routine stainers, and an automated coverslipper. Special stains and immunohistochemical stains are performed manually. We recommend that automated stainers be evaluated for possible procurement.

Cytology

The cytology section is open Monday through Friday, 0730 to 1630. Workload consists of about 19,000 Pap smears and 1,200 non-GYN cases per year. The section is neat, organized, and well equipped. The Bethesda System used for GYN cytology and Pap smears has an in-house turnaround time of an impressive 2 to 3 days. In addition to the usual cytology laboratory equipment, the section has acquired a Cytyc ThinPrep model 2000 (TP-2000) liquid-based slide processor. It can be used for either GYN or non-GYN cases. Soon, contingent on USAMEDCOM funding, a second TP-2000 will be placed and conventional Pap smears converted to liquid-based analyses. There are no additional equipment recommendations for this area.

General Equipment

The department has developed a 5-year equipment replacement plan that identifies all equipment past or reaching its end of life expectancy. We recommend that, in addition to looking at life expectancy, the department annually assess for operational capability as part of the CEEP replacement program. The CEEP 2000 program included requests for

general-use items only. There were no requests for diagnostic equipment.

Blood Transfusion Service and Blood Donor Center

Blood operations include a transfusion service and the Armed Services Blood Bank Center (ASBBC). The ASBBC is a separate MEPRS "F" account (as opposed to an Ancillary "D" account). Both areas use the Defense Blood Standard System for information management. Transfusion services are open 24 hours per day, 7 days per week, and are managed by a civilian supervisor and an NCOIC. The ASBBC is generally open 0730 to 1630, Monday through Friday, and is managed by an OIC and an NCOIC. Blood collections number about 550 units per month, but efforts are underway to increase collections to 800 units per month. The only major instrument in the ASBBC is the Abbott Commander, used for infectious disease testing of donated units. Samples for mandated nucleic acid testing are referred to Fort Hood. An automated system has been ordered for ABO testing and antibody screens. There is no testing equipment in the transfusion service, but there is interest in obtaining gel technology. There are several distinct quality advantages to gel technology, and we recommend placing it on the CEEP list. The blood outdate rate is 1.8 percent, well below the MEDCOM standard of no more than 5 percent. The cross-match to transfusion ratio is 2.06 with the standard being 2.0. This indicates good use of the type and screen and allows for improved inventory management.

Benchmark Indicators

As part of the TARA report, laboratory benchmark indicators are collected and reported out to the facility. The indicators are derived from CHCS workload and MEPRS reports. TARA team members do not validate the data but rather accept it as reflected in the reports. Attention to detail is important if accuracy of data is to be ensured. Managerial personnel should periodically validate CHCS workload data and Uniform Chart of Accounts for Personnel System input. MEPRS data from FY 2000 were used for the calculations. Laboratory benchmark indicators and comparative data follow.

Laboratory Benchmark Indicators for ACH

Workload

Ancillary Services (D Codes)	
Ancillary CPT Weighted Procedures	1,069,847
Ancillary CPT Reportable Tests	1,102,338

Personnel

	Assigned	Available
FTEs (all)	129.8	112.6
Technical FTE	123.1	107.1
FTE (% Available)	86.8	
CPT weighted/FTE	8,245	9,503
CPT weighted/tech FTE	8,692	9,991
CPT reportable/FTE	8,496	9,791
CPT reportable/tech FTE	8,956	10,294
% Direct Exp (Personnel)	80.3	

Expenses

Direct	Personnel	Finance	Support	Ancillary	Total
$7,354,854	$5,902,879	$1,451,975	$1,507,450	$83,349	$8,945,653

Cost per weighted procedure—$8.36

Cost per reportable test—$8.12

SAMPLE FOR DEMONSTRATION PURPOSES

Inpatient Services

Item	Value	Item	Value
CPT Weighted Workload	248,564	Dispositions	5,753
CPT Reportable Tests	317,512	Case Mix	1.6075
CPT Weight/Reportable	0.78	Inpatient Work Units	9,247.9
Laboratory Expense	$2,159,398	CPT Weight/Disposition	43.21
Cost/Weighted Procedure	$8.69	CPT Report/Disposition	55.19
Cost/Reportable Test	$6.80	CPT Weight/IWU	26.88
Lab Cost/Disposition	$375.35	CPT Report/IWU	34.33
Lab Cost/IWU	$233.50		

Outpatient Services

Item	Value	Item	Value
CPT Weighted Workload	768,527	Outpatient Visits	511,969
CPT Reportable Tests	412,078	Avg Amb Weight	0.0310
CPT Weight/Reportable	1.86500347	Amb Work Units	15,893
Laboratory Expense	$3,798,398	CPT Weight/Visit	1.50
Cost/Weighted Procedure	$4.94	CPT Report/Visit	0.80
Cost/Reportable Test	$9.22	CPT Weight/AWU	48.36
Lab Cost/Visit	$7.42	CPT Report/AWU	25.93
Lab Cost/AWU	$239.01		

Recapitulation

	Expense	Workload	% Expense	% Workload
Inpatient Services	$2,159,398	248,564	36.24%	24.44%
Outpatient Services	$3,798,398	768,527	63.76%	75.56%
Totals	$5,957,796	1,017,091	100.00%	100.00%