LARGE SCALE IMPLEMENTATION OF COMPATIBLE HOSPITAL COMPUTER SYSTEMS WITHIN THE VETERANS ADMINISTRATION

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Abstract

The United States Veterans Administration provides a medical care delivery system comprising more than 170 hospitals, clinics and domiciliaries. Historically, these institutions have been relatively autonomous in their day-to-day operations and consequently efforts at computerization have been difficult to adequately coordinate. A recent undertaking of the VA has been to establish decentralized coordination of planning and implementation for hospital computer systems. This presents a unique opportunity to promote standard, portable and well-designed solutions to meet the widely variable needs of a large and diverse health care delivery organization. Although computer systems for each hospital will vary with the needs of the hospital, functional program packages can be delivered and maintained in a cost-effective and manpower-efficient manner. Additionally, because all systems will be based on a common data dictionary it will be possible to gracefully expand systems as needed and to study clinical care and delivery methodologies across many institutions.

Introduction

The Veterans Administration medical care system operates over 170 hospitals, domiciliaries and clinics. Whereas all of these facilities must conform to agency policies and regulations, each is autonomous in its day-to-day operations and sets its own priorities according to the needs of its own health care delivery system.

With such a diverse body, it comes as no surprise that the VA has endured a multitude of less than fully successful attempts to "computerize" operations across all of its many facilities. Generally these attempts have failed for one or more of three major reasons: 1) failure to respond to institution variability, 2) financial/procurement difficulties or 3) internal political struggles. Clearly, little can be done to suppress or circumvent the third stumbling block. However, recent progress at a decentralized approach directly deals with the first two problem areas and shows significant promise of success.

The Decentralized Approach: Phase I

For several years, a few VA facilities had been locally pursuing development of clinical applications based on ANS MUMPS and the File Manager. In February 1982, under the auspices of a Director's Executive Order, this resilient group of individuals received formal approval to propagate its results and methods to other VA medical centers. Since that time, over twenty medical centers have benefited from the products of this effort.

The initial 25 medical centers (see Table 1), known as Phase I sites, were selected because each had a computer system which was available and capable of running the CORE system (see Table 2). Each center assigned a system manager to supervise the system and to provide direction for growth and fulfillment of the institution's computer-based clinical needs. Each of these Phase I sites initially imported a standardized data dictionary, the File Manager and a set of VA developed applications. This CORE brought each center on-line

| New York, NY | Baltimore, MD |
| Brooklyn, NY | Memphis, TN |
| Bronx, NY | Pittsburgh, PA |
| Washington, DC | Lexington, KY |
| Oklahoma City, OK | San Francisco, CA |
| Palo Alto, CA | Bay Pines, FL |
| Loma Linda, CA | Martinez, CA |
| Albany, NY | Denver, CO |
| Tucson, AZ | Fresno, CA |
| Salt Lake City, UT | Reno, NV |
| Perry Point, MD | Brooklyn OC, NY |

TABLE 1: Phase I VA Medical Centers

Admissions-Discharge-Transfer & Clinic Scheduling:
Patient Identification
Admissions
Gains and Losses
Scheduling
Patient Tracking
Ward Census
File Room Operations

Out-Patient Pharmacy:
Patient Drug Profile
Drug Inventory
Formulary Manual
Prescription Filling

TABLE 2: Initial CORE Applications Package
with minimal difficulty, cost and manpower. As time progressed, the participating facilities offered suggestions for enhancements to the applications and as a result, all the Phase I centers benefited. In those situations where applications changes were relevant to single institutions, the underlying data dictionary and File Manager have remained constant. Thus, each institution remains able to accept and integrate new applications as they become available for field use.

Decentralized Approach: Phase II

Encouraged by its initial success, the decentralization effort anticipates inclusion of Phase II medical centers and upgrading of Phase I medical centers over the next year. This expansion requires the development, refinement and distribution of additional clinical applications and the acquisition of new, replacement and upgraded computer systems.

The Phase II hospitals (as yet no specific number of institutions has been determined, but it will probably be at least 40, perhaps upwards to 100) will each receive the CORE software (as in Table 2). The Phase I centers will be expanded to also cover those clinical areas listed in Table 3. As before, each Medical Center will be encouraged to tailor the applications to meet their local methods of operation and health care delivery. And, as before, the data dictionary and File Manager will remain constant across all institutions (note that the data dictionary provides a superset of data items which can be utilized as the individual center requires).

Clinical Laboratory:

Chemistry Lab Cumulative Reports
Critical Care (18 Tests)
Blood Gas Results
SMAC Results
CBC Results
Surgical Pathology Records
Cytology Records
Test Reports by Ward
Microbiology Sample Tracking
Laboratory Quality Control

Inpatient Pharmacy:

Patient Drug Profile
Drug Inventory
Unit Dose Ward Usage
Inpatient Prescriptions
Special Fluid Preparation Labeling

Radiology:

Film Tracking
Special Study Scheduling

In addition, other specialty areas such as Dietetics, Mental Health, Pulmonary Function Testing, Registries and Administrative packages are either under development or currently available.

The definition of suitable computer systems to support the Phase II centers and to upgrade the Phase I centers has presented the VA with an excellent opportunity to demonstrate the cost-effectiveness of its decentralized approach. It is clear that central procurement of all the computer systems can result in significant cost savings. Clearly, the first step in defining the computer system needs was to classify the VA Medical Centers according to their individual workloads and data loads. Because each center will eventually run the full CORE package of programs, the system sizing was matched to the full CORE system requirements. For each center the basic system requirements were defined by using available workload statistics as follows:

**Admission/Discharge/Transfer & Clinic Scheduling**

Using VA reports which report the patient load of each Medical Center, the total number of patients receiving care, the number of admissions and transfers and the number of clinic stops were extracted. In each formula, the subscript "p" refers to processor performance (in terms of MUMPS active partitions) and the subscript "d" refers to disk capacity.

**FORMULA:**

\[ A_p = (#-of-outpatients-receiving-care) \times 2 + \frac{(#-of-Admissions + #-of-Transfers + #-of-Clinic-Stops)}{2} \]

A 2.0 weighting factor was applied to # of outpatients-receiving-care due to the CPU activity required.

The formula for determining the disk storage indicator (to define storage capacity) was:

\[ A_d = (#-of-outpatients-receiving-care) \times 15 + \frac{(#-of-Admissions) \times 2 + (#-of-Transfers) \times 2 + #-of-Clinic-Stops}{2} \]

Weighting factors of 15.0 and 2.0 were applied to the # of outpatients-receiving-care and # of Admissions plus # of Transfers, respectively, due to the increased disk storage required for those sub-functions.

**Inpatient and Outpatient Pharmacy**

Total number of outpatient prescriptions filled. Plus: for inpatient totals, total number of "Sterile Products" (i.e., Admixtures, Piggybacks and Hyperalimentation). Plus: Total Inpatient Prescriptions. Then: Total Inpatient Unit Doses.

**FORMULA:**

Where: $IP_{Rx} =$ # of Inpatient Prescriptions, $OP_{Rx} =$ # of outpatient prescriptions,

\[ P = P_d = IP_{Rx} + OP_{Rx} + IV_{Additives} + IV_{Piggyback} + IV_{Hyperalimentation} + Inpatient Unit Doses \]

**Clinical Laboratory**

Unweighted total number of tests performed

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**TABLE 3: Enhancements to Initial CORE Package**
FORMULA:

\[ L_p = L_d = \text{Unweighted Total # of tests} \]

Radiology:

Total films used.

FORMULA:

\[ R_p = R_d = \text{Total films used} \]

For convenience, the numbers generated by the above equations were scaled as follows: Within each function, the largest workload was defined as 10.0. Then each of the remaining were scaled proportionately by dividing that workload by the largest and multiplying by 10.

Having scaled numbers for each function at each medical center, two categories of weighted workloads were generated for the functions — CPU capacity and disk storage. The weighting factors were as follows: (these factors are based on estimates by the developers of the respective applications)

CPU:
- \( A \) (ADT & Sched) = \( x \) 1
- \( L \) (Lab) = \( x \) 6
- \( P \) (Pharm) = \( x \) 3
- \( R \) (Rad) = \( x \) 1

DISK:
- \( A \) (ADT & Sched) = \( x \) 10
- \( L \) (Lab) = \( x \) 15
- \( P \) (Pharm) = \( x \) 10
- \( R \) (Rad) = \( x \) 1

These weighted totals were then applied to the sizing requirements.

System sizing requirements were generated to yield a specified level of performance for the execution of VA software (in terms of response time and assuming the anticipated number of active users at peak load). We found good agreement between the rankings produced by this measure and those determined independently from extensive personal knowledge of operations at the individual facilities currently using the applications. As a result, we feel that this measure does provide a practical means to establish system requirements for the full range of VA facilities.

After this sizing method was applied to each medical center, the results were noted to be distributed over 11 general size groups and therefore appropriate system capacity was defined for each group (see Table 4). This sizing determination was principally concerned with processor capacity. Distributed systems were recommended because they provide a necessary fall-back mechanism in the event of hardware failure. Thus, if one processor should malfunction, the remaining processor(s) will either support a subset of the total operation or provide full operation at somewhat reduced response levels. The remainder of the system specification defines the disk capacity needed and a baseline number of CRT's and printers (see Table 4). Each of the Phase I hospitals will be upgraded according to this table. All Phase II centers will receive a "first half" of the appropriate system. Phase I centers will also receive a "front-end" computer (e.g., a 11/23 with Winchester disk) to interface to laboratory instruments. Additionally, CRT's and various printers will be procured to meet the individual institutional needs.

Conclusions

The past two years have witnessed a successful decentralized development, distribution and maintenance of clinical computer applications by the Veterans Administration. Each of twenty-five medical centers now utilizes packages for support of the admissions-discharge-transfer, clinic scheduling and the out-patient pharmacy. Over the next year these centers will be upgraded to provide computer-based support for the clinical laboratory, in-patient pharmacy, radiology film tracking and ward reporting. In addition, several more medical centers will begin operations to support ADT, clinic scheduling and out-patient pharmacy (with expectations for expansion to full support in subsequent years).

With the advent of these computer-based clinical support systems, the Veterans Administration can take a leadership role in the promotion of standardized, portable and well-designed solutions to data management in the hospital environment. The central focus of these systems is a standardized, widely accepted data dictionary and the File Manager. Within this framework each institution can adjust applications to suit its unique institutional needs. Combined with centralized procurement based on institution workload, each center will benefit from a "solution" which fits their profile and still promotes sharing of data and software. Thus, the decentralized approach offers a solution which both 1) meets the individual institution goals and 2) is cost-effective.

References


5. "Data Dictionaries - Field Developed Hospital Information Systems" Medical Information Resources Management Office, Veterans Administration, Department of Medicine and Surgery, November 1982.


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<th>Class</th>
<th>Configuration</th>
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**TABLE 4:** Proposed Computer System Configurations