

UPDATE ON INFORMATION SYSTEMS AT THE JOHNS HOPKINS HOSPITAL

In 1983 I presented a brief survey of the use of information systems at the Johns Hopkins Hospital. In this update, I review what has transpired since then. Some old systems have grown in functionality, some effective systems have been retired, and some new facilities have been added.

When I reported on the use of clinical information systems at the Johns Hopkins Hospital (JHH) in 1983, I was full of optimism. My final sentence concluded, "Thus, one can expect even more exciting developments in the application of computers to medical care."¹ Soon after writing the article I left the School of Medicine (where I had been working full-time since 1976) and returned to APL. I had made whatever contribution I could to the emerging field of medical informatics; the time had come to leave the field to those with a commitment to and training in health care delivery.

Fortunately, the task I proposed for my first new APL assignment was accepted. I was allowed to write a book on clinical information systems,² in which I showed how computer technology had proved itself able to enhance the delivery of care and identified what could be done with the current technology. I saw that lowered computer equipment costs would lead to a more rapid exploitation of this relatively new technology.

Now, in reviewing the role of clinical information systems at JHH as they have evolved over the last six years, I am pleased to report that there has been progress. But I am not sure that the direction of the progress is consistent with my earlier predictions. Let me explain. Every hospital must address two classes of tasks. The first, the care of patients, is very labor-intensive, requiring considerable personal attention. We use technology to extend our abilities (e.g., the Programmable Implantable Medication System in the treatment of diabetic patients³), to collect data not otherwise available (e.g., an ingestible thermal monitoring system⁴), and to organize the data for better medical decision making (which is the principal goal of the clinical information system). The second task of the hospital is to manage its operations, including its hotel-like functions, its business office, large staff, specialized billing and reporting systems, and record-keeping activities. Like most large institutions, hospitals must rely on an automated information system to manage these operations.

Clearly, the hospital has two sets of information system needs. One has a clinical orientation, the other an administrative mission. Of course, the two overlap and share the same data but have basic differences. The clinical

system must emphasize timeliness and accuracy; the administrative system should be optimized for efficiency and cost. To illustrate this distinction, consider an administrative pharmacy system designed to capture charges and maintain an inventory. Its database can be updated once a day, it can be insensitive to computer downtime, and it can tolerate a large number of errors (which will affect only the charges). A clinical system, however, cannot accept this approach. Its database must be timely, always available, and completely accurate; sensitive clinical decisions depend on it.

A clinical pharmacy system has access to all the data required by the administrative pharmacy system. Appending the necessary billing and inventory modules is a fairly simple task. An administrative pharmacy system, on the other hand, cannot be enlarged to support the clinical functions; it was designed to carry out its mission efficiently, and its structure will not support the clinical responsibilities. Here, then, is the hospital-automation dilemma: clinical information systems, although expensive to build and operate, can support the primary mission of the hospital, whereas administrative systems are available commercially and operate efficiently, but cannot be extended to serve the clinical needs.

Given this choice of application type, the hospital's administration must weigh costs against needs and demands. Again, all hospitals of moderate or larger size must have some automated assistance. Moreover, in an era of nursing shortages, high labor costs, and restricted reimbursement plans, large institutions (such as JHH) must rely on automation to reduce paperwork and to speed the delivery of orders and the reporting of results. Such automation is the function of a modern hospital information system (HIS), and today no large hospital can be without one.

Thus, when examining how the information systems have evolved at JHH, we know that the hospital must operate an HIS or it must use a personnel system to print the employees' checks. A modern hospital needs terminals at the nursing station to provide access to laboratory results and to review radiology reports. The key issue for me, however, is the extent to which the hospital exploits computers in patient care. Naturally, the HIS en-

vironment can serve as the central focus for these clinical applications, but its existence is neither a necessary nor a sufficient condition for such use.

As I will explain, change has occurred, and progress has been made. If progress has been less comprehensive than my 1983 optimism anticipated, the cause can be traced to the lack of a unified and articulated demand for clinical information systems, characteristic of most institutions, not just JHH. For example, computerized axial tomography was quickly recognized as a major advancement in diagnostic radiology, and two of its developers were awarded the Nobel Prize in 1979. Unfortunately, clinical information systems have earned no such respect. Physicians do not perceive themselves to be the users of the information system; the tools of the commercial information system remain limited in scope and expensive to operate; and the demand is not great enough to cause hospital decision makers to select the more expensive clinical systems over the more available, cheaper administrative products. These conditions will change, but unlike the revolution in digital imaging, the transition to comprehensive clinical information systems seems to be evolutionary.

How have the JHH information systems evolved since 1983? In my earlier article,¹ I described the following information systems.

A central computer facility provided on-line services throughout the hospital and also supported its administrative functions. The clinically oriented functions were controlled by a patient identification system and an admission, discharge, and transfer (ADT) system. Both systems identified the patients in the nursing units and allowed access to their clinical data. Linked to the ADT system were a comprehensive pharmacy system, a clinical laboratory system that operated on separate computers in the clinical laboratory, and a radiology reporting system that relied on an innovative report-generation device. I also described in some detail both the pharmacy and radiology systems.

The Oncology Clinical Information System (OCIS) operated on two dedicated computers in the Oncology Center and was specifically designed to support medical decision making. Also available were abstracts of the patient record, displays of patient data, and a daily care plan for computer-generated, protocol-directed therapy.

The Core Record System was an extension of the early Minirecord System, which APL was instrumental in developing. Designed for outpatient clinics, the Core System was installed in the emergency room, the orthopedics clinic, and a walk-in clinic. It provided access to a summary (core) medical record and integrated patient scheduling, charge capture, and test ordering.

In addition, the Department of Pediatric Medicine had a computer system to support its Comprehensive Child Care Program. That system also offered some clinical assistance. The Department of Anesthesiology and Critical Care used a very small computer to facilitate the scheduling of operating rooms and the evaluation of resource utilization. A CLINFO system was available for the analysis of clinical trial data, and—as expected in such

a large institution—many other computers dedicated to specialized applications were in use.

Today, two main efforts best characterize the use of information systems at JHH: the consolidation of the central computing facilities and the continuing expansion of OCIS in the Oncology Center.

In 1983 JHH was committed to the installation of a patient care system that would integrate the various functions residing on the central computers. Because many of the operational programs had been custom-designed and relied on special optimizing techniques, the conversion from one system to the other proved to be difficult and took longer than planned. The new system was renamed the Hopkins Patient System (HOPS), and several changes were made. Most of the custom-crafted software was replaced by standard products, and HOPS now provides ADT, patient billing, inpatient pharmacy support, and many report and inquiry functions.

The hospital also installed a network to link the many computers that supported its operations. After APL's successful participation in the implementation of a network at the University of California Hospital in San Francisco (cited in Ref. 1), Steven Tolchin of APL was given a temporary appointment to JHH to help create a similar network. The project was successful, and today JHH has one of the most advanced hospital networks;⁵ it links all of the computers previously identified plus some others. Several critical and innovative applications also were built to support integrated patient identification, outpatient scheduling, reporting of clinical results, and an automated clinical résumé discharge report.⁶

The Oncology Center's system, OCIS, also experienced considerable growth. The number of functions it supported expanded, user reliance on the system increased, and its physical facilities were enlarged. The system now runs on five networked computers, supports over 200 terminals, and is an essential tool in the delivery of care in the Oncology Center. Widely recognized as one of the most comprehensive information systems in a tertiary care setting, OCIS has been licensed for use by other institutions. It has been operational in Sydney, Australia, for several years, and a prototype system at the Ohio State University is being expanded to support that institution's new cancer center. (For a description and evaluation of OCIS, see Ref. 7.)

The pharmacy system described in Ref. 1 was replaced by one less expensive to operate. (Because the features of the older system were considered essential for the care of cancer patients, OCIS was expanded to incorporate that system's pharmacy functions.) The radiology reporting system was a commercialized version of a locally developed prototype. It failed to sell, and only a few data recording terminals (now 15 years old) remain in use; all other radiology reports are dictated for later transcription. The Core Record System was retired when the central system provided comparable functions for all outpatient units. For the units that used the Core System, this represented a reduction in clinical support, even though the network provided on-line access to some clinical data not previously available. Systems for both the

Department of Pediatric Medicine and the Department of Anesthesiology and Critical Care now reside on larger, more powerful computers. The pediatrics computer supports essentially the same services. The role of the anesthesiology system has continued to grow; it provides advanced support for operating room scheduling and the analysis of resource utilization. Finally, there are many tools that provide the data-management functions of CLINFO.

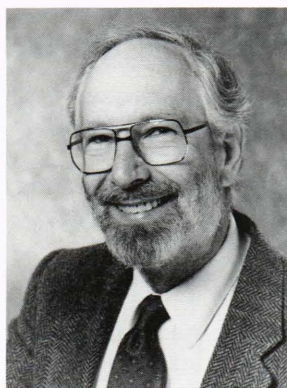
To summarize my evaluation of the state of information systems at JHH six years after the earlier survey, I conclude with the following observations. In the Oncology Center, with its commitment to the clinical use of computing, the role of the computer has expanded. The rate of growth is not as rapid as all would like, but considering the limited funding, the functional expansion of and dedication to OCIS has been remarkable. In the centralized hospital system, great technological advances have been made, and JHH clearly is one of the leaders in the field. The hospital's direction and priority setting have suffered from changing strategies, however, and questions remain as to how the applications will be able to take advantage of this infrastructure. I would expect time and an increased awareness of trends in medical systems to create greater demand for the clinically oriented tools.

Progress is not monotonic. Some good ideas fail; some demonstrated principles are ignored. My vision of how computers will contribute to medicine remains steadfast. Clearly, as this update demonstrates, changes at JHH have occurred. Although six years ago I would have predicted greater hospitalwide automated support for clinical tasks, I am pleased to observe that many conditions are better now than they were then.

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