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EVALUATION OF THE ORDER ENTRY SYSTEM BY END USERS —A STEP TO THE NEW HOSPITAL INFORMATION SYSTEM—

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ABSTRACT

Nagoya University Hospital has developed a new, comprehensive computerized hospital administration system since April 1992. In the present study, a user's evaluation questionnaire survey on the order entry system revealed that the improvements at the human interface level were appreciated by some respondents, but not all users felt the human interface provided, adequately meets their needs. Another presumed advantage of the micro-mainframe-link architecture is fast response, but in our study respondents considered the response time too long. Most users felt that transmission of orders was fast, accurate and clear, and that fast retrieval of the results of laboratory tests was good. Our system with this kind of architecture has thus proved satisfactory except for the slow response time. This study will be useful to reengineer our hospital information system in the next phase.

Key Words: Hospital information system, Order entry system, Micro-mainframe-link, Electronic medical records, PACS, CR

INTRODUCTION

The first hospital information system was adopted at the Nagoya University Hospital in 1986. However, the order entry system used by doctors for prescriptions, laboratory tests and the like required complex entries and operation, and resulted in slow response time. To overcome these weak points, a new comprehensive computerized hospital administration system[1,2] called CHART (Comprehensive Hospital Administration for the Twenty-First Century) was developed with the following objectives: (1) order entry system for both inpatient wards and outpatient clinics; (2) systematized management of all data bases, e.g., laboratory tests, hospital business, prescriptions; (3) multimedia system using optical disk filing; (4) physician-support system not only for diagnosis and treatment, but also for research and education; and (5) health insurance checking system. CHART was initiated in October 1991 for the inpatient wards, and in April 1992 for the outpatient clinics. In this paper, we present an evaluation of CHART by users. The opinions and evaluations obtained in the present study will be useful to reengineer our next hospital information system.

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SYSTEM CONFIGURATION

The CHART hospital information network is shown in Fig. 1. The system includes the order entry system, the system for each department, and the accounting system. These systems are linked to the CHART mainframe. Each department (i.e., hospital pharmacy, clinical laboratory, radiology, blood transfusion service, medical records, meal supply) has its own computer system. The physician's orders are for 1) prescriptions, 2) laboratory tests, 3) X-ray tests, 4) meals, 5) diagnoses, and 6) next clinic appointments. Orders for 1) prescriptions, 2) laboratory tests, 3) X-ray tests, and 4) meals are transmitted to the hospital pharmacy, the clinical laboratory, central block of radiology and meal supply department, respectively, and to the accounting system as well.

The mainframe is a Facom M770/8 with 96 MB memories. The 227 terminal computers (FMR-50TXs) are connected to the mainframe via Fujitsu's DSLINK (transmission speed: 10 Mbps). Inpatient wards have 80 terminals, and outpatient clinics have 147 terminals. An FMR-50TX is composed of a 32-bit CPU (386TM) with RAM (2 MB), hard disk (40 MB), CRT display, keyboard, and card reader. Computer operating systems used are an MSP for the mainframe and MSDOS for terminals.

Hospital beds numbered 922 and annual discharges were 7,155 with an average 1,909 outpatients per day in 1992.

MICRO-MAINFRAME-LINK

One of the outstanding CHART features is host-personal computer links (micro-mainframe-link) which assure rapid response time and user-friendly input, because most processing is done at the terminals so as to be customer-compliant; only finalized data are transmitted to the host computer.[3,4] The use of personal order sets is possible, which allows physicians to customize, by patient or patient type, a list of commonly ordered items.

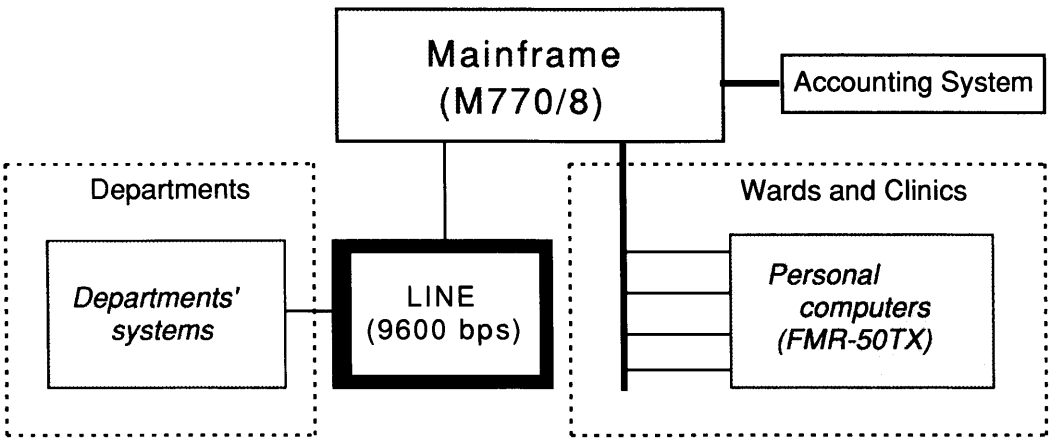

Fig. 1. The CHART hospital information network and micro-mainframe-link architecture.

USER'S ASSESSMENT OF HOSPITAL INFORMATION SYSTEM

Three months after introduction of the order entry system, the following inquiries were made of 487 physicians and 505 nurses; 241 physicians and 405 nurses answered. Questions covered three main areas: 1) assessment of each ordering system (① frequency of use; ② the manipulation of the terminal computer; ③ functional aspects; ④ response time; ⑤ later usage of the data), 2) general assessment (22 items shown in Fig. 3), and 3) opinions.

Of the 241 physician respondents, 215 regularly used the order entry system. As to usability of the system, 6% of these 215 respondents felt the system operated "well," while 32% of them felt it operated "poorly" (Fig. 2). As to functional aspects of the system, 5% of the 215 physicians considered the system "good," and 29% of them found it "poor." Regarding response time, only 3% of the respondents expressed a positive opinion, while 61% expressed a negative opinion, indicating that response time is slower than expected (Fig. 2). Thirty-six percent of the respondents indicated they would use the data for research or education later, while 26% answered they would not. Nurses answered they often used the meal order system (61% of respondents) and the laboratory test results retrieval system (68% of respondents).

In the general assessment of the system, high scores were obtained for the easy reference (accessibility) to test results (Fig. 3), as well as for storage, clarity and utilization of data. Lower scores were given for some system-downs of the CHART system and computer-related stress involved in manipulation of the terminal computers (Fig. 3).

The user assessment showed that the good points of the order entry system were 1) accessibility of laboratory test results, 2) data storage, and 3) clarity and accuracy of data. Some physicians recognized that the system saves processing time. The disadvantages of the order entry system mentioned were 1) troublesome manipulation of keyboards inducing computer-related stress, and 2) wasted time compared with written entries on paper charts, thereby causing 3) less time for doctors with patients (Fig. 3).

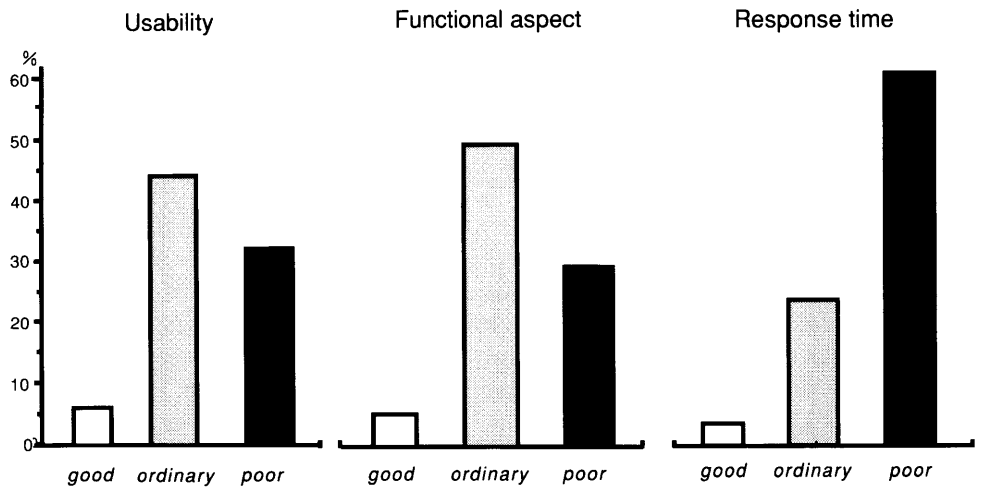

Fig. 2. Physicians' assessment of usability, functional aspects and response time of the order entry system. Sixty-one percent of respondents were displeased with response time.

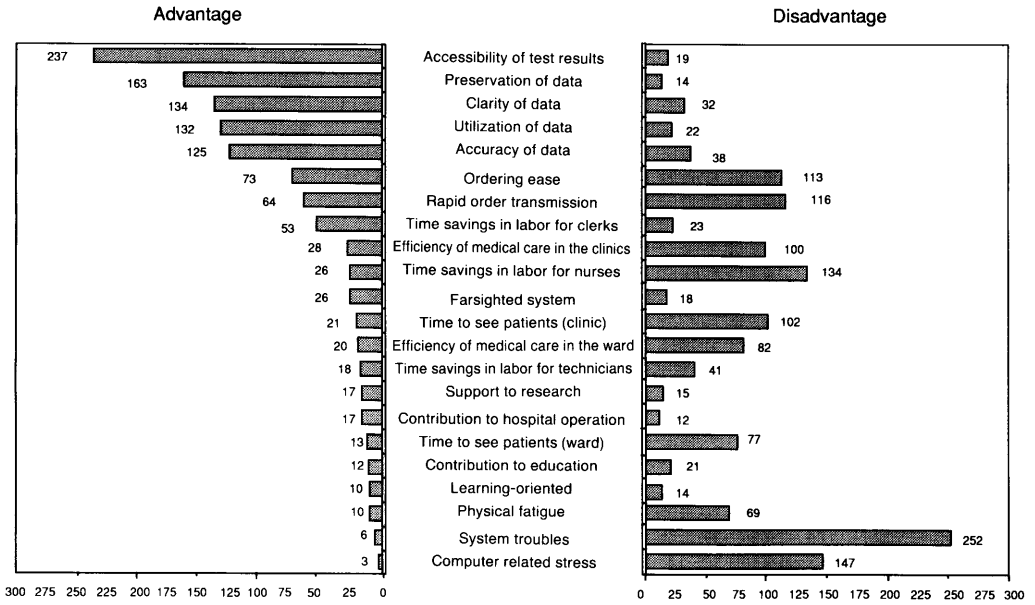

Fig. 3. General assessment of CHART system by physicians.

DISCUSSION

This investigation was performed three months after the new order entry system went into operation. Although users were not accustomed to operating the terminal computers at that time, they recognized the advantages of the hospital information system, transmission of accurate information, speed and clarity. All orders were switched from the paper slip (OCR sheets) system to terminal computer operations in three months. If we were to ask the same questions now, keyboard manipulation would probably pose less of a problem because everyone is more accustomed to the system. Although the slow response time of the terminal computers has been pointed out, before introduction of the system we assumed that the slowest response time would be at most 2 sec. However, the actual slowest response time was found to be 1 min at the peak hospital operation time, from 10 to 11 o'clock in the morning. This occurred when the terminal computer had to access files on prior prescriptions in the mainframe. For the time being, there is no effective way to solve the slow response time except by avoiding the concentration of patients in the morning by using an appointment system, or by introducing more sophisticated mainframe and terminal computers with greater processing ability. In our next system, we plan to introduce a three-layered architecture (mainframe-client-server computer system), in which most tasks will be performed by the client and server computer system, thereby assuring faster response time (Fig. 4).

Users complained that the system had too many problems even in the early introductory stages from October 1991 to March 1992. Four of the five times our system was down were due to program bugs in the order entry system. The other was due to a shortage of RAM memory in the mainframe. Downs due to program bugs occurred when a new computer program was installed for minor changes. After April 1992, large system-downs decreased. When such occurred, however, in order to maintain hospital business, we used the so-called OCR (optical

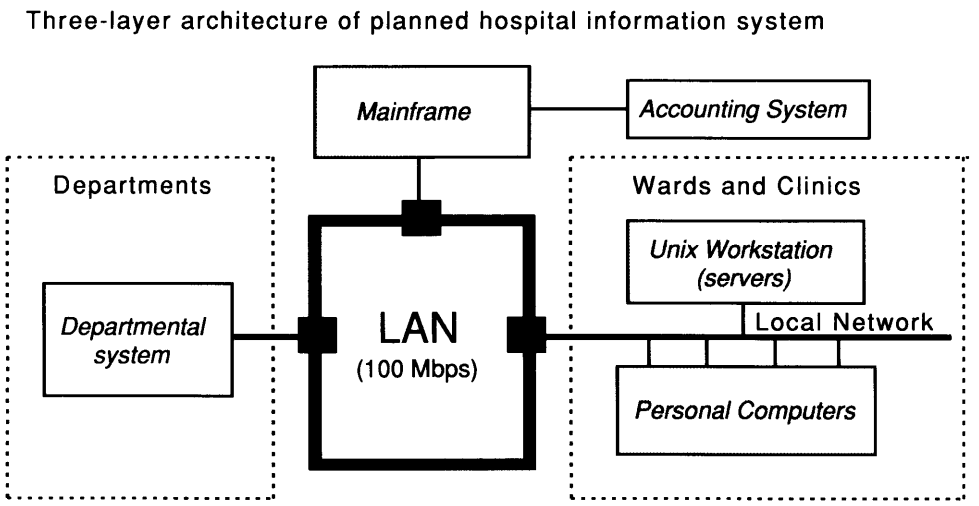

Fig. 4. The planned hospital information system. System hardware will have a three-layer architecture (mainframe, client, and server system).

character reader) sheets, which had been used when the first computer system came on line in 1986.

The responses to the present survey of physicians and nurses revealed that the hospital information system is for the most part useful. However, the hospital's primary "customer" is the patient; information systems need to be customer-oriented.[5] After CHART was introduced, most patients noticed less waiting time at the hospital pharmacy and found it easier to see doctors and have clinical tests done. In the next stage, a patient survey should be conducted.

One of the main objectives of our hospital information system has been to achieve a multimedia system using optical disk filing. We reported elsewhere the development of our optical disk-based imaging system of clinical charts.[2,6,7] PACS (picture archiving and communication system) also uses the optical disk filing system, and a test run between the central block of radiology and the radiologist laboratory started in 1989.[10] Computed radiography (CR), a method to digitize X-ray images, magnetic resonance, computed tomography, ultrasonography, and nuclear medicine, and to permit the electronic storage of pictures, is the essential technology used in PACS. At present, 50% of X-ray pictures and 100% of the computed tomograms are digitized and stored in our optical disk filing system. But digitized X-ray data so far have only been transmitted between the central block of radiology and the radiology laboratory. Basic experiments on image compression,[8] observer performance reading CT images,[9] and so on are also being conducted to create a hospital intelligent information system.[10,11] PACS will actually serve as a third hospital information system to link the central block of radiology, the radiology department and orthopedic surgery, using a large-infrastructure network.

We believe that the ultimate purpose of the hospital information system is to keep electronic medical records covering all patient-related system operations, including all medical information currently in written records.[12] In our system only 24% of the clinical charts has been digitized, and the rest, most in the form of descriptive and handwritten documents of physicians and nurses, has remained undigitized.[13] Although the development of a system to digitize the handwritten data is important, the essence of the current problem is that much of the data is only "unstructured narrative." Words are not structured into information readily useful for clinical

decision-making. To convert this information into structured, codable input, physicians would have to undergo some kind of behavior modification. This will be the next problem to be solved.

CONCLUSION

Our survey on the order entry system using micro-mainframe-link architecture showed that transmission of orders from physicians to each department was fast, accurate, and clear. Improvement at the human interface level was acknowledged by some respondents, but there have been complaints of slow response time between micro-mainframe links. A new hospital information system with a three-layer architecture would achieve more rapid response time when we re-engineer our present comprehensive electronic medical record system.

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