Computerized Data Acquisition and Data Management for the Open Heart Patient

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Abstract

(*J. Extra-Corpor. Technol.* 19[3] p. 287-289 Fall 1987) We have developed a complete system for acquiring data directly from electronic monitoring devices in the OR and ICU. In addition, this system maintains a database used for documentation of clinical management, report generation, and archival analysis of general patient information and clinical treatment.

This system is microcomputer based and file driven. Monitoring of patients occurs in the operating room, ICU, office, and at home via modem.

Since the system is file driven, it can be configured for any operation. It can be reconfigured at any time, including during an operation as clinical situations dictate.

Data is entered simultaneously from direct interface with monitoring devices and also manually. And as data is entered, new calculations are performed (i.e., SVR, LVSWI) to provide current clinical data so decisions in clinical management can be made.

Introduction

Three and a half years ago, we began to formulate and organize a database that we could use in our practice to help us gain better insight into the patient population we treat, their clinical course and the result of that treatment. This was done on a seven-page checklist covering general information, medications, risk factors, anesthesia and perfusion data, postop course (i.e., drugs, blood, C.T. loss), complications, and postop follow-up. Due to the general nature of our patients and aggressiveness of our practice, this became a formidable task.

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Patient Group

At the Valley Regional Heart Center in Harlingen, Texas, we performed some 1,050 open hearts during this same period. The examination of risk factors in these patients is quite eye-opening. It was found that the average age of our patients is over 70 years. A major reason for this is due to the fact that our area of South Texas is a haven for retired persons and winter visitors. Ninety percent (90%) have a positive family history of heart disease. Over 85% are hypertensive. Sixty (60%) of our patients are smokers at the time of operation, and another 10% have at least a 20-pack per-year smoking history prior to cessation. Sixty-five percent (65%) have had at least one myocardial infarction and thirty-five percent (35%) of that same group have had two or more documented infarctions. Forty percent (40%) are obese, (20% over the ideal weight for their height and build) and 25% are diabetic. In the diabetic population, 30% are insulin dependent. A major factor for the high diabetic population can be contributed to the large percentage of Mexican-Americans living in the Valley. Twenty percent (20%) have COPD, 15% have peripheral vascular occlusive disease, and 25% have hyperlipidemia.

The treatment of coronary artery disease in this group of patients is a clinical challenge, but a few more facts add to the task. One of every 3 (33%) of our patients is a female. Only 20% of our patients are operated upon on an elective basis. Eighty percent (80%) of our cases are urgent, or emergencies with unstable angina. In 1986, 320 open hearts were done in our hospital and 100 of them came to the operating room on the intra-aortic balloon and I.V. nitroglycerin. Also, during the same period, 150 patients have been operated on after streptokinase interventions.

With this knowledge of our patient population and aggressive intervention, we felt that better documentation of clinical management, analysis of clinical treatment, and retrospective study of that treatment would benefit both our patients and ourselves.

Materials and Methods

As mentioned previously, with the Open Heart Questionnaire, we had access to some data, but it was maintained and tabulated manually, and comparisons and correlations were difficult to obtain. So the first task was to create a database to keep this data, and then write a report generator that would allow us to analyze our data and compare it to the available published data. We were then able to put our patients in their proper sub-sets, compare mortality and morbidity figures to those published, and follow our patients better postoperatively. It was with these tasks that we saw the unlimited potential of the microcomputer as a data manager.

We realized that with a microcomputer we could not only store data to analyze retrospectively, but that we could record data—moment by moment—in the OR as it occurred. To accomplish this we needed to make an overall view of our needs and wants.

It was with this idea in mind that we developed our first anesthesia record that was microcomputer-driven for the OR. This record was designed to keep all the same general information as a usual anesthesia record keeps—such as monitoring lines, blood types, fluids and medications, but it added much more to the patient management. It recorded all hemodynamic parameters and medications at five-minute intervals throughout the operation. At any one time in the operation, any changes in hemodynamics could be directly seen and correlated with any intervention (i.e., fluids or drugs) that were used to bring that patient back to baseline. Also, once the hemodynamic parameters were entered, the computer was able to calculate such values as cardiac index (CI), systemic and pulmonary resistance (SVR, PVR), oxygen consumption, and left and right ventricular stroke work indices (LVSWI, RVSWI). These parameters are very necessary in those with poor ventricular function or other intra-operative problems. There was also an event parameter which consisted of 60 characters that were allotted for each five-minute interval throughout the case to make additional comments.

Results

With these parameters so readily visible and available, we have been able to be on top of the clinical changes as they have occurred in our patients. One very clear example is the clinical problem of a protamine reaction after cardiopulmonary bypass (CPB). We have been able to clearly document changes in CO, PVR, and PAP pressures before other catastrophic changes have occurred, and intervene and stop the anaphylatic process before complete cardiovascular collapse. This anesthesia record has provided us with a great deal of insight into the hemodynamic changes as they occur in the entire operation—from induction to transfer of the patient. And it has also afforded us the opportunity to know how patients have responded to the various stresses and interventions that can occur during the open heart procedure.

This record was more accurate, was easier to maintain than the standard record, and provided the anesthesiologist with more time for attention to the patient. However, it was still a manual record. Our next goal was to automate it. At that point we looked at the short and long term goals of our open heart program and at our computer system as a part of that program.

Discussion

Our caseload was growing and so was our desire to maintain our patients more closely. Technology had progressed to the point that we knew that computers had the capability to talk to the devices that were used to monitor and maintain our patients. Not only could they talk to them, but in turn they could acquire the same data that we looked at on the screens of these devices and place that data in a program such as a perfusion, or anesthesia record. This communication, or interface, could occur—not only for the anesthesiologist, but for the perfusionist and the devices he uses during cardiopulmonary bypass. Also, this same interface could occur in the Intensive Care Unit (ICU) and in the Progressive Care Unit (PCU), until a patient left the hospital.

Communication technology within the computer field has also progressed a great deal. There are now Local Area Networks (LANs) available that allow computers to share and transfer data. In our practice, this means that we can monitor our patients in the ICU from the office, the OR and even at home.

Our data collection and management system has accomplished this goal. Our system uses the Compaq 286 Microcomputer for data collection in the operating rooms and in the ICU. An Intel 286-310 is used in our office as the main file server. All of the computers are linked to the main file server by a network which allows them to talk and share information.

The software we use is custom designed. It is file driven and thus configured for any application. In the development of the software, our priorities were for it to be flexible, user friendly and very expandable. These priorities had to be accomplished, so as technology progressed the program had to allow for new devices and updated changes without changing the basic structure of the program. It also had to be easy enough so that a "perfusionist" could use it. As far as flexibility is concerned, the program can be reconfigured during an operation to add devices, medications, or change monitoring parameters. Even the polling (sampling) rate of the computer to the devices can be changed as clinical situations dictate.

We now have several devices that we have interfaced with the computer from which to acquire our data. These devices include the heart monitor, anesthesia machine, noninvasive blood pressure cuff and a mass spectrometer. At this time, the Bio-Medicus pump is having output jacks installed so we can record RPMs and pump flow on the perfusion record. All of these devices are polled every 10-15 seconds and values are recorded every five minutes in the OR.

Several of the same devices are interfaced in the ICU; however, the polling cycles are usually longer but can be changed if clinical situations dictate. An added feature to the program—especially in the ICU, is the "Help" screens. These screens facilitate the use of the various parts of the program by "helping" the user in a query for a random field. For example, if a patient needs the drug Dopamine, the user would push the "D" key for drugs, show off a menu on the screen, select Dop for Dopamine. The computer would then ask how many micrograms per kilogram of the drug that you wish to administer. Once you select that number, it will indicate the normal concentration that we use and then calculate the number of milliliters that are needed. This is only one of many user friendly features of our software.

Finally, there is a security system for entry into the program that allows either limited or global access to the files on the computer. Each patient's file consists of four parts: 1) general patient file, 2) anesthesia file, 3) perfusion file, and 4) ICU file. The general patient file contains the important information that most of our statistical data is generated from. This information is automatically shared from the other three files to the general file as it is formulated. Thus, the anesthesiologist needs to see only the anesthesia file, and the nurse needs only the ICU file.

There are still some new developments to come in our program. We hope to stop the small amount of manual entry left by the use of voice recognition. Many new developments and successes have occurred in this area recently and we hope to take advantage of it. This would allow the computer to enter data in the proper fields as we speak to the computer about random clinical data as it occurs. Another idea we hope to add is a library. This would allow us to store information about medicines, clinical phenomena, and techniques that we do not see often—but when they occur, a vast amount of clinical knowledge and intervention is needed to prevent a potentially serious event.

In summary, we have developed this system for data acquisition and management to do our necessary and medical-legal recordkeeping for us. It can certainly record more data, be more accurate, and even help provide current clinical data so correct decisions in clinical management can be made. But most of all, it allows us to pay more attention to the most important person involved: the *patient.*