An integrated health care information processing and retrieval system

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INTRODUCTION

In this paper we present the design and some initial experiences with a computerized medical records system (called the CSAR System) currently in use in several departments of the Milton S. Hershey Medical Center of The Pennsylvania State University. The purpose of this work has been to develop a high-speed efficient information system for the storage, retrieval and dissemination of the total patient medical record.

Initially, we were concerned primarily with the development of a system for epidemiological research. That is, a system which could be used to isolate population cross-sections from extensive patient data bases at very high speeds. For example, we wanted a system which could, in a few minutes or less, identify from a population of a hundred thousand or more those patients whose records indicated fulfillment of criteria such as: "... between ages 25 and 30 with three or more pregnancies, type AB blood and a family history of cancer...."

Coupled with the need for a research system, we sought a design which could deliver an improved medical record into the day-to-day process of health care delivery. That is, a more legible, complete, accurate, accessible and standardized medical record at equal or lower overall cost. The selected system design would need to be capable of maintaining a patient's total medical record, not just a recent portion of it. The system would need to be able to flexibly access and portray on command all and only that information deemed relevant by the system's user. The design would need to be very efficient and economical so as to be able to store at reasonable cost historical data over a period of several years.

Furthermore, we wanted a system design which would incorporate both the above in a modular scheme so as to permit simultaneous but independent software development on many aspects. This implied a design consisting of two parts: First, a data base independent system nucleus which

![Figure 1—Distributed network of medical information systems](image1)

![Figure 2—Basic system cycle](image2)
would provide centralized input/output, file management, information processing and information retrieval services for other parts of the system. Second, applications interface packages which would deal with data base and user de-

<table>
<thead>
<tr>
<th>TABLE I—List of Active Keys</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Key-Word</strong></td>
</tr>
<tr>
<td>PROBLEM</td>
</tr>
<tr>
<td>PAF</td>
</tr>
<tr>
<td>USCR</td>
</tr>
<tr>
<td>ANSCR</td>
</tr>
<tr>
<td>BLOOD TYPE</td>
</tr>
<tr>
<td>HPE</td>
</tr>
<tr>
<td>RIBELLA</td>
</tr>
<tr>
<td>2HGG</td>
</tr>
<tr>
<td>EDC</td>
</tr>
<tr>
<td>HCG</td>
</tr>
<tr>
<td>MEDICATION</td>
</tr>
<tr>
<td>NAME</td>
</tr>
<tr>
<td>RH</td>
</tr>
<tr>
<td>HCT</td>
</tr>
<tr>
<td>NEXT APPOINTMENT</td>
</tr>
<tr>
<td>ACTIVE PROBLEM</td>
</tr>
<tr>
<td>THERAPY</td>
</tr>
</tbody>
</table>

Another important design aspect is that of system expanda-

DISTRIBUTED NETWORK OF MEDICAL INFORMATION SYSTEMS

In order to fulfill the third specification mentioned above, that of expandability, a Distributed Network of Medical Information Systems is proposed. This is outlined in Figure 1. It will consist of many local medical information systems...
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$CSAR - SYSTEM FILES OPEN.
$CSAR - CSAR.D.1 (OBSYS/TRSYS)
$CSAR - SUB-POOLS WILL BE ACCUMULATED.

1 $NO LIST; /*DON'T LIST PATIENT NUMBERS AFTER SELECT STATEMENTS*/

2 SELECT: IF: RH = NEG; /*NEGATIVE RH FACTOR*/
$CSAR - SUB-POOLS SELECTED: 1
$CSAR - PATIENT NUMBERS SELECTED: 59

3 $AND;
$CSAR - SUB-POOLS WILL BE INTERSECTED.

4 SELECT: IF: BLOOD TYPE = 0;
$CSAR - SUB-POOLS SELECTED: 1
$CSAR - PATIENT NUMBERS SELECTED: 24

5 $AND;
$CSAR - SUB-POOLS WILL BE INTERSECTED.

6 SELECT: IF: PROBLEM = Y06.**; /*PREGNANCY ICD-7 CODE*/
$CSAR - SUB-POOLS SELECTED: 11
$CSAR - PATIENT NUMBERS SELECTED: 23

7 $AND;
$CSAR - SUB-POOLS WILL BE INTERSECTED.

8 SELECT: IF: EDC = 73/11/**; /*CONFINEMENT IN NOV 73, ANY DAY*/
$CSAR - SUB-POOLS SELECTED: 23
$CSAR - PATIENT NUMBERS SELECTED: 4

9 $SORT: EDC; /*ESTIMATED DATE OF CONFINEMENT*/
$CSAR - PATIENT NUMBERS SORTED.
$CSAR - PATIENT NUMBERS SELECTED: 4

10 DISPLAY: CENSUS:

<table>
<thead>
<tr>
<th>NAME</th>
<th>NRK</th>
<th>SEX/MARITAL</th>
<th>PHONE</th>
<th>ATTND</th>
<th>BT/RH</th>
<th>WGT</th>
<th>EDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>PATRICIA</td>
<td>0000</td>
<td>FEMALE, MARRIED</td>
<td>( )</td>
<td>50</td>
<td>0</td>
<td>NEG</td>
<td>134/73</td>
</tr>
<tr>
<td>JOANNE E</td>
<td>0000</td>
<td>FEMALE, MARRIED</td>
<td>(717) 367-</td>
<td>50</td>
<td>0</td>
<td>NEG</td>
<td>105/73</td>
</tr>
<tr>
<td>SUZANNE E</td>
<td>0000</td>
<td>FEMALE, MARRIED</td>
<td>(717) 533-</td>
<td>50</td>
<td>0</td>
<td>NEG</td>
<td>144/73</td>
</tr>
<tr>
<td>CAROL</td>
<td>0000</td>
<td>FEMALE, MARRIED</td>
<td>(717) 213-</td>
<td>50</td>
<td>0</td>
<td>NEG</td>
<td>150/73</td>
</tr>
</tbody>
</table>

Figure 4—SELECT statement examples
2 SELECT: IF: ATTENDING = 50; /*ATTENDING PHYSICIAN CODE*/
$CSAR - SUB-POOLS SELECTED: 1
$CSAR - PATIENT NUMBERS SELECTED: 128

3 $AND: /*"AND" NEXT PATIENT NUMBER LIST WITH CURRENT LIST*/
$CSAR - SUB-POOLS WILL BE INTERSECTED.

4 SELECT: IF: PROBLEM = Y06; /*PREGNANCY ICDA CODE*/
$CSAR - SUB-POOLS SELECTED: 11
$CSAR - PATIENT NUMBERS SELECTED: 125

5 $SET BASE; /*RETAIN THIS NUMBER*/
$CSAR - THE BASE IS: 1.250000E+02

6 $AND: /*"AND" NEXT PATIENT NUMBER LIST WITH CURRENT LIST*/
$CSAR - SUB-POOLS WILL BE INTERSECTED.

7 SELECT: IF: PAP = ******; /*ACCEPT ANY VALUE*/
$CSAR - SUB-POOLS SELECTED: 25
$CSAR - PATIENT NUMBERS SELECTED: 83

8 DISPLAY: PERCENTAGE; /*PERCENTAGE PREGNANT FOR 50 WITH PAP TESTS*/
$CSAR - CURRENT PATIENT NUMBER LIST IS 66.4% OF THE BASE.

9 $XOR; /*"EXCLUSIVE OR" NEXT PATIENT NUMBER LIST WITH CURRENT LIST*/
$CSAR - SUB-POOLS WILL BE EXCLUSIVE OR'ED.

10 SELECT: IF: PROBLEM = Y06; /*PREGNANCY*/
$CSAR - SUB-POOLS SELECTED: 11
$CSAR - PATIENT NUMBERS SELECTED: 274

11 $AND; /*INTERSECT PATIENT NUMBER POOLS*/
$CSAR - SUB-POOLS WILL BE INTERSECTED.

12 SELECT: IF: ATTENDING = 50; /*PHYSICIAN CODE*/
$CSAR - SUB-POOLS SELECTED: 1
$CSAR - PATIENT NUMBERS SELECTED: 42

13 DISPLAY: PERCENTAGE; /*PERCENTAGE PREGNANT FOR 50 WITHOUT PAP TESTS*/
$CSAR - CURRENT PATIENT NUMBER LIST IS 33.6% OF THE BASE.

Figure 5—SELECT statement examples
connected centrally into regional control systems which could themselves, in turn, be connected into state-wide or larger networks. Each local facility will maintain its local database which may be interrogated locally. In addition to this, however, each local facility can route requests to the central facility for access to information not stored locally. In turn, the central facility will poll simultaneously the proper set local facilities with the forwarded request. Replies will be collected and returned to the requesting station. The central control point need not be much more than a minicomputer with a suitable amount of telecommunications equipment and disk buffers for queueing of information. Alternatively, the central control point could be a major shared computer facility providing centralized facilities for many small medical centers.

The great advantages of a design such as this are its simplicity, flexibility, and modularity. Control systems are easily designed. Flexibility and modularity is achieved across the network in that each local system can differ totally from each other system so long as it communicates its requests and replies according to a standard network protocol. This will permit a wide variety of local development to take place simultaneously.

Furthermore, if the central control points are regional shared resources, this design will permit smaller installations to access and benefit from computational and program library facilities which would otherwise be unavailable. The development of a distributed medical information network will enable individual institutions to specialize in designated areas of program development, library maintenance, and so
JANE
PHONE: (717) 944-...
BIRTH: 12/10/...
PATIENT NUMBER: 00...
FEMALE, MARRIED

ATTENDING: 50004  BLOOD TYPE: A NEG
USUAL WEIGHT: 126  EDC: DDDD/73
NEXT APPOINTMENT: ___/___/___ AT ___ WITH ___

CONDITION OF PATIENT AT THIS OBSERVATION:

CAPABLE OF NORMAL ACTIVITY:
1. ASYMPTOMATIC
2. SYMPTOMATIC

UNABLE TO WORK:
3. CAPABLE OF SELF-CARE
4. NOT CAPABLE OF SELF-CARE

SEVERLY DISABLED:
5. NOT TERMINAL
6. TERMINAL

DEAD:
7. AUTOPSIED
8. NOT AUTOPSIED

DIAGNOSTIC PROCEDURES PERFORMED, THIS OBSERVATION:
1. EXFOLIATIVE CYTOLOGY  4. X-RAY
2. HEMATOLOGY  5. AUTOPSY
3. HISTOLOGY  6. OTHER

SCHEDULED FOLLOW-UP VISIT: ___/___/___

NEW MEDICATIONS:  CODE  DESCRIPTION

DISCONTINUED MEDICATIONS:  CODE  DESCRIPTION

NEW THERAPIES:  ICD CODE  DESCRIPTION

DISCONTINUED THERAPIES:  ICD CODE  DESCRIPTION

Figure 6-2
forth. The benefits of these efforts could be shared by all.
Thus a medical facility in a small rural hospital could have
access to the same tools at the same cost as a large metro­
politan hospital. In general, this cost should be lower than
it now is due to the elimination of duplication.

PROTOTYPE IMPLEMENTATION

At present, a prototype of a local medical information
system is being tested. The prototype is written in PL/I
and is being run on The Pennsylvania State University’s
IBM 370/165 research computation facility at University
Park, Pennsylvania. The user population, at the Milton S.
Hershey Medical Center in Hershey, Pennsylvania (108 miles
distant), interact with the system via a Remote Job Entry
system and a state-wide remote batch network. It is antici­
pated that work will commence shortly to transfer those
portions of the system which are completed onto a small
computer located in Hershey. Research and development,
however, will still be carried out at University Park.

The basic system cycle is given in Figure 2. Figure 3 is an
overview of the computer structure of the medical record.
For purposes of explanation, user requests are divided into
two classes: the “SELECT” statement and the “DISPLAY”
statement. Others, however, are available but not considered
here.

With the “SELECT” statement, the user specifies criteria
for a population cross-section search. For example:

SELECT: IF: RH=NEG AND PROBLEM=Y06.0;

This request seeks the identity of all those patients with a
negative RH factor who are pregnant (ICDA [1] Code). The
result of this request is a list of patient identification numbers
(hospital numbers) of those patients who fulfill the stated
criteria. An example is given of such a request in Figure 4.
The relational operators “>”, “<” and “=” may
also be used as can be seen in Figures 4 and 5. Asterisks are
used to indicate that any recorded value for the selected
field position will be acceptable. Table I gives a summary of
those keys which are currently active for selection.
Pools of patient identification numbers are normally
ordered by ascending value (default sort). This can be
changed by the “SORT” statement as is shown in Figure 4.
This is particularly useful when preparing patient charts for
clinic visits. By selecting those patients who are scheduled
for a given day, it is then possible to sort them by hour and
by physician thereby greatly reducing clerical effort.

Having settled upon a list of patient identification numbers
and having ordered them as desired, actual displays of data
from patient records can be requested with the “DISPLAY”
statement. Figures 6 and 7 give several examples of patient
data displays. At present, there are three applications pack-
<table>
<thead>
<tr>
<th>CURRENT PROBLEM LIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>05/11/73 RH INCOMPATIBILITY</td>
</tr>
<tr>
<td>05/11/73 HX OF HIGH BIRTHWEIGHT INFANT</td>
</tr>
<tr>
<td>08/13/73 GESTATIONAL DIABETES</td>
</tr>
<tr>
<td>08/11/73 HX FETAL DEATH IN UTERO</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LAB TESTS NEEDED:</th>
</tr>
</thead>
<tbody>
<tr>
<td>RETURN VISIT ____ AT: ____ WITH: ____</td>
</tr>
</tbody>
</table>

Figure 7—Obstetrics outpatient system example
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Page 2

PROGRESS NOTES

05/11/73.1 WELL. 2HR. BLOOD SUGAR = 122
05/25/73.1 WELL.
06/08/73.1 WFL\.
06/15/73.1 HAS PREGNANCY GRANULOMA OF GUMS. RH TITER
06/15/73.2 TODAY. WILL START ORAL CONTRACEPTION 3 WKS PP.
06/22/73.1 WELL.
06/29/73.1 WELL.
07/13/73.1 HISTORY OF 9-10# INFANTS. CX CLOSED, SOFT.
07/20/73.1 PELVIC MOVING ANTERIORLY, ICM, SOFT, 10% EFF.
07/27/73.1 HX OF MENSTRUAL INTERVALS UP TO 40 DAYS
07/27/73.2 COMING OFF PILLS. CX LONG, POST. CLCSED. PT
07/27/73.3 & HUSBAND ACCEPT PROBLEM WELL.
08/03/73.1 CX-LONG, ICM. NOT RIPE. NOT RIPE ENOUGH TO
08/03/73.2 INDUCE. INFANT 10# + NOW.
08/11/73.1 PT INFORMED OF PROBABLY DEMISE. TO COME IN
08/11/73.2 MONDAY. IF FHT AUDIBLE WILL INDUCE. IF NOT,
08/11/73.3 WAIT CX RIPENING PROBABLY. CX 2 CM DIL, 60% EFF
08/11/73.4 MEMBRANES STRIPPED.
08/11/73.1 DELIVERED 5130GM MALE, APGAR 0,0.

Figure 7-2

Systems in operation: (1) an Obstetrics Outpatient Clinic System; (2) an Obstetrics Labor and Delivery Information System and; (3) a Regional Tumor Registry System. Examples of pre-printed work-sheets and displays for these are given in Figures 6 and 7. Other systems, including a General Outpatient Clinic System which will be similar to the Obstetrics version, are in preparation.

SYSTEM DESIGN

Details of the system file structure and design are given in References 2 and 3. The overall design of the system consists of two parts. The first of these is a system nucleus which is largely data independent except for certain driver tables.
JANE

PHONE: (717) 944-

BIRTH: 12/10/47

PATIENT NUMBER: 00

FEMALE, MARRIED

ATTENDING: 50004 BLOOD TYPE: A NEG

USUAL WEIGHT: 126 EDC: 07/1/73

NEXT APPOINTMENT: ___/___/___ AT ___ WITH ___

MEDICATIONS

<table>
<thead>
<tr>
<th>DATE</th>
<th>GENERIC NAME AND DOSAGE</th>
<th>CODE</th>
<th>DIRECTIONS</th>
<th>DUR</th>
<th>RT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>05/11/73</td>
<td>FERROUS SULFATE 300MG</td>
<td>26201</td>
<td>1TID</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>08/14/73</td>
<td>ORTHONOVUM 1/50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PO <strong>/</strong>/**</td>
</tr>
<tr>
<td>08/14/73</td>
<td>COLACE 100MG</td>
<td>65206</td>
<td>1TID</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>08/11/73</td>
<td>RHOGAM</td>
<td>82107</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CURRENT PROBLEM LIST

<table>
<thead>
<tr>
<th>DATE</th>
<th>PROBLEM</th>
<th>CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>05/11/73</td>
<td>RH INCOMPATIBILITY</td>
<td>634.50</td>
</tr>
<tr>
<td>05/11/73</td>
<td>HX OF HIGH BIRTHWEIGHT INFANT</td>
<td>778.4H</td>
</tr>
<tr>
<td>08/13/73</td>
<td>GESTATIONAL DIABETES</td>
<td>250.AA</td>
</tr>
<tr>
<td>08/11/73</td>
<td>HX FETAL DEATH IN UTERO</td>
<td>779.0H</td>
</tr>
</tbody>
</table>

INACTIVE PROBLEM LIST

<table>
<thead>
<tr>
<th>DATE</th>
<th>PROBLEM</th>
<th>CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>05/11/73</td>
<td>PREGNANCY</td>
<td>Y06.00</td>
</tr>
<tr>
<td>07/13/73</td>
<td>LARGE BAY FOR DATES</td>
<td>777.41</td>
</tr>
<tr>
<td>08/10/73</td>
<td>FETAL DEATH IN UTERO</td>
<td>779.9B</td>
</tr>
<tr>
<td>08/11/73</td>
<td>SHOULDER DYSTOCCIA</td>
<td>656.8B</td>
</tr>
<tr>
<td>08/11/73</td>
<td>4' PERINEAL LACERATION</td>
<td>658.3A</td>
</tr>
</tbody>
</table>

THERAPY LIST

<table>
<thead>
<tr>
<th>DATE</th>
<th>THERAPY</th>
<th>CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>08/11/73</td>
<td>SPONTANEOUS DELIVERY</td>
<td>650.00</td>
</tr>
<tr>
<td>08/11/73</td>
<td>REPAIR 4' LACERATION</td>
<td>078.3C</td>
</tr>
</tbody>
</table>

The second part consists of data dependent applications packages.

The system nucleus monitors and provides basic input/output services. It reads the system command language and, based upon entries in driver tables, constructs various population cross section keys ("SELECT" statement keys), patient data description keys ("DISPLAY" statement keys) and output report generation format tables. Nucleus routines retrieve patient numbers (for "SELECT" statement keys) and record addresses (for "DISPLAY" statement keys). The basic file structure is that of a blocked key file. The nucleus performs the logical operations (AND, OR, XOR) upon pools of retrieved patient numbers. In the case of record addresses (from "DISPLAY" statements), it retrieves the records and passes them to the proper applications package along with report format description tables.
During updates the nucleus monitors the optimal placement of patient records on bulk storage files. It automatically repositions patient records in order to maintain the complete record set for each patient on a single direct access disk cylinder thereby greatly reducing device arm movement. Other functions of the nucleus include sorting, timing and statistics collection. A built-in PL/I sub-set interpretive compiler permits dynamically entered user functions to interact with retrieved data.

Typically, applications interface packages are concerned with output print formats and updates. Routines vary in size and complexity depending upon the nature of the application. Data entered into a patient record as a result of any application package is available to any other package.

The system maintains four main files. These are: (1) a control file; (2) a key file consisting of pages or blocks of ordered keys; (3) a pool file containing sets (sub-pools) of patient numbers and (4) a bulk-file containing actual data records. Key-to-bulk file record address ("DISPLAY" requests) and key-to-patient number sub-pool ("SELECT" requests) are performed in the block structured key file. This works as follows:

At system initiation the control file is loaded. It lists the high and low key values for each block in the key file. Within each block keys are ordered from low to high. Associated with each key is a 32-bit number which is either: (1) a relative record address in the bulk-file or (2) the relative record address of a sub-pool of patient numbers in the pool file. A positive value indicates the first case and a negative value the second.

For retrieval, incoming keys are compared against the block high and low keys. If the incoming key lies outside the ranges of all, then nothing is retrieved. On the other hand, if the key lies within the range of some block, it is loaded (if not already resident). The block is searched in a binary manner. A list is developed consisting of the numbers (called registry numbers) associated with accepted keys. These are passed on to other parts of the nucleus.

The advantage of this type of retrieval technique is its speed and simplicity. Maximum time of search for an explicit key is, with a resident control file, independent of the size of the key file as bulk file. At worst case, the system must load a new page. Non-explicit searches vary in time depending upon the number of keys selected.

Experience indicates that, after an initial period of time, the rate at which new keys enter the system becomes linear and rises at a rate far less than corresponding increases in the size of the bulk file. This is also true of the pool file. The key file, at this writing, is 5 percent of the bulk file and rises at a rate far less than corresponding increases in the size of the bulk file. The key file as bulk file. At worst case, the system must load a new page. Non-explicit searches vary in time depending upon the number of keys selected.

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Experience indicates that, after an initial period of time, the rate at which new keys enter the system becomes linear and rises at a rate far less than corresponding increases in the size of the bulk file. This is also true of the pool file. The key file, at this writing, is 5 percent of the bulk file and pool file in size.

It is anticipated that the internal organization of blocks in key file will be restructured in the near future to that of m-way trees. This will reduce the amount of storage required. Further, it should decrease the number of page swaps.

**PERFORMANCE**

Presently, after 10 months of operation, there are about 500 patient records resident on the system. With the intro-
<table>
<thead>
<tr>
<th>DATE</th>
<th>TIME</th>
<th>WK</th>
<th>BP</th>
<th>ED</th>
<th>WT</th>
<th>AL</th>
<th>FH</th>
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<th>PF</th>
<th>ST</th>
<th>SZ</th>
<th>EXM</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/12/73</td>
<td></td>
<td></td>
<td>14</td>
<td>130/80</td>
<td>00</td>
<td>127</td>
<td>**</td>
<td>LMS</td>
<td>**</td>
<td>**</td>
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<td>** VGS</td>
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<td></td>
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<td>00</td>
<td>131</td>
<td>00</td>
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<td>**</td>
<td>**</td>
<td>** HCG</td>
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<td>120/75</td>
<td>00</td>
<td>133</td>
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<td>RLQ</td>
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<td>**</td>
<td>**</td>
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<td>VT</td>
<td>FL</td>
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WK = WEEK OF GESTATION;  
ED = EDema;  
WT = MATERNAL WEIGHT;  
AL = ALBUMin;  
FH = POSITION OF FETAL HEART;  
FD = HEIGHT OF FUNDUS(CH);  
PF = PRESENTATION OF FETUS;  
ST = STATION;  
SZ = FETAL SIZE(X100 GMS);  
EXM = EXAMINER;

$CSAR - END OF SUMMARY FOR: JANE

Figure 7-6

duction of the recently completed Regional Tumor Registry Information System package, this is expected to reach 5,000 in the next 12 months. At present, the cost per patient per month is about $0.12 using an IBM 3330 Disk Storage device (this includes cost of the pack and drive plus shared costs of the controller and channel). The cost per patient record printout varies with respect to the size of the record, but is generally on the order of $0.05 to $0.15 for a moderately large record. Retrieval ("SELECT" statements) times vary upon the amount of patient numbers retrieved and are not significantly influenced by file size (this is characteristic of block structured techniques). In general, between 500 and 750 patient numbers per second can be retrieved.

CONCLUSION

We believe that the present system design can be exploited to handle the entire patient medical record economically. Having completed work on the basic system nucleus, several
applications packages are under development. One such project is in the area of billing and finance. By including an additional flag in the field for each chargeable item or service, the system can be used to produce an integrated patient account statement. Another project is in the area of developing an automatic constructor which will enable an implementor to define new applications by means of a high-level system definition language. Based on such a definition, appropriate applications routines and driver tables will be generated.

REFERENCES
