

AN ABSTRACT OF THE THESIS OF

Timothy Warren Evans for the degree of Master of Science  
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Title: DEVELOPMENT AND EVALUATION OF A COMPUTER AIDED PHARMACY  
PROFILE REVIEW SYSTEM IN A COMMUNITY HOSPITAL

Abstract approved: *Redacted for Privacy*

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Dr. Lee Strandberg

A 140 bed community hospital was the setting where the development and evaluation of a computer aided patient profile review system took place. This clinically oriented system involved the review of patient's drug regimen, diet, allergies, and laboratory tests for well documented contraindications or interactions. The pharmacist was involved in monitoring the potential problems that the computer system located, and would determine their validity and act accordingly by notifying other professional staff of the problems.

The goal of this study was to determine the effectiveness of the computer aided system in a community hospital. The study was designed to compare the impact the pharmacists had on changes in patient's orders before the computerized system was begun, with the changes initiated by the pharmacists afterwards. Statistical analysis of the data collected showed that there was a significant increase in the number of pharmacy

initiated order and scheduling changes after the computer aided system was initiated ( $\alpha = 0.05$ ).

Part of the drug regimen review included a Schedule II drug order renewal or discontinuation alert initiated by the system. This section of the program had the largest influence on the effectiveness of the system and for this specific area, the computer system was considered effective. There were 124 order changes that occurred in 31 days in this drug regimen review section.

The drug-drug, drug-laboratory test, drug-diet and drug allergy alerts totaled 70 different printouts in 31 days, an average of 2.26 per day. These potential problems had to be scrutinized by the pharmacist and proper action was taken if the problem seemed valid. Only seven of these alerts were eventually used to make order changes. Three additional alerts were drug-laboratory test interactions which were provided to the physician as points of information. These seven alerts were not a numerically large part of the total changes, however, in terms of patient monitoring each alert used was important.

By using this broad view of the patient's clinical picture, a more successful monitoring system can be developed. The larger the amount of data collected for each patient being monitored, the greater the potential for locating problems in patient care.

The system described in this paper was developed to monitor a patient's drug regimen, diet, laboratory tests and allergies for potential problems. It was shown that within a community hospital, (140 beds) this computer aided monitoring system did create a significant increase in the number of pharmacy initiated order changes

that occurred. It is hoped that this study may be of value to other community hospitals that may be considering such a system.

Development and Evaluation of a Computer Aided  
Pharmacy Profile Review System  
in a Community Hospital

by

Timothy Warren Evans

A THESIS

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Typed by Barbara Thornburg for Timothy Warren Evans

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I dedicate this work to my wife, Marcia. Her love, encouragement and help during the research and writing of this paper made it possible. I would like to express my sincere gratitude and thanks to Dr. Douglass Stennett who proved to be an excellent advisor and friend. His continual encouragement and guidance are deeply appreciated. In addition, I would like to thank the other members of my Graduate Committee, Dr. Paula Kanarek, Dr. Robert Sager, Dr. William Simonson, and Dr. Lee Strandberg for their helpful comments. Finally, I would like to express my gratitude to the Pharmacy Department, Administration and staff of the study hospital and the Computer Center of Oregon State University, whose financial assistance and cooperation contributed to the success of this study.

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DEVELOPMENT AND EVALUATION OF A COMPUTER AIDED  
PHARMACY PROFILE REVIEW SYSTEM  
IN A COMMUNITY HOSPITAL

INTRODUCTION

Purpose of the Study

This study was designed to determine the effectiveness of a computer aided pharmacy profile system, developed to review a patient's chart for potential problems in the community hospital. This review included the patient's drug regimen, diet, allergies, and laboratory tests, which were computer analyzed for well documented contraindications or interactions. The system provided daily reports to pharmacy staff which were used to aid in evaluating patient health care problems.

Background

The role of the hospital pharmacist has been changing tremendously in the past decade. Traditional patterns for the delivery of pharmaceutical services have given way to new concepts which have resulted in greater pharmacist involvement in the institutional patient's care. This clinical involvement requires pharmacists to be patient oriented as well as product oriented. (5)

These new concepts or role changes have occurred due to a broadening of the pharmacist's formal training and involvement with hospital staff as part of the health care team.

Schools of pharmacy have now also recognized the need for a clinical component in the undergraduate curriculum for the future practitioners and are establishing working relationships with hospitals as clinical facilities for the training of students. (5)

Clinical pharmacy is a significant component within the profession today. There still exists however, a great deal of variation among practitioners with respect to an understanding of clinical involvement. (4) Various authors have defined clinical pharmacy services to include the following: (15)

- (1) Drug History Determination
- (2) Drug Prescribing
- (3) Monitoring Drug Therapy
- (4) Drug Administration
- (5) Self-Medication, Discharge and Ambulatory Care Medication Patient Counseling
- (6) Providing Drug Information
- (7) Drug Utilization Review

The system developed in this study involves areas 2, 3, 4, 6 and 7 of the above list. It is involved with the vast amount of information that is available concerning the effects, proper use, and potential problems of medications for the hospitalized patient.

#### The Computer's Role

As in many business and professional areas, the computer has been put to use in the hospital pharmacy mainly for cataloguing of available products, billing, and other accounting purposes. (2,7,18,19) As the pharmacist has moved more into the clinical area of practice, the uses of the computer have also expanded. Computer programs written for more clinical applications include: adverse drug reaction reporting; drug-drug interaction detection and summarization; drug allergy detection; drug-laboratory test interaction detection and summarization; individualization of drug dosage regimens and drug interaction referencing. (1,4,8,10,12,14,17)

### Statement of the Problem

A review of the literature revealed two deficiencies related to computer use in various clinical pharmacy functions. The first deals with making complete use of available information when monitoring a patient's medical record.

The primary obstacle preventing pharmacists from promoting safe and rational drug prescribing in the hospital is that most pharmacists do not have ready access to the data bases of their patients.

The greater the degree of integration of drug information with the overall data base contained in the patient's medical record, the more successful clinical pharmacy computer applications will be. (15)

With the possible exception of one system developed and cited in the current literature, this integration has not been achieved. (10)

The second deficient area in the programs presently developed is the narrow spectrum of use. Nearly all the systems presented in the literature have been developed within large university teaching hospitals. This has virtually eliminated smaller community hospitals from being involved in the present stages of computer aided monitoring of patient care.

These two deficiencies in previous computer programs are addressed in this study. A broader view of the patient's clinical picture will be used when reviewing orders which will include the drug regimen, laboratory tests, allergies and diet. The effectiveness of this system in a community hospital will also be considered since it is in a unique setting when compared to the previously developed computer programs.

This paper addresses the stated deficiencies and evaluates the computer system's effectiveness in terms of order changes.

### Literature Review

#### Adverse Reaction Reporting Systems

Despite the length of time the computer has been in use in hospital pharmacy, there have been relatively few programs developed in the clinical area. Early clinical use of the computer included monitoring drug reactions to specific products and analyzing data on their incidence.

( 11 )      These data were used for research purposes and provided needed background and statistical information for publishing drug reactions.

The registry approach or the collection of sporadic reports of physician-diagnosed reactions was first attempted on a large scale in the U. S. A. in the 1950's. This method of drug surveillance proved inadequate by itself because of underreporting, the tendency to report only the reactions known to physicians, and the lack of denominator information to measure risk. To remedy these defects, the epidemiologic approach was tried in the 1960's--first with hospitalized patients. These hospital based drug reaction studies are now being most vigorously pursued by the Boston Collaborative Drug Surveillance Program. ( 11 )

This drug surveillance program was developed by the Clinical Pharmacology Unit, Lemuel Shattuck Hospital, Department of Medicine, Tufts University School of Medicine and the Harvard School of Public Health, Boston, in 1966. It was designed to permit the detection of unsuspected side effects and drug interactions, the quantitation of known effects, and the evaluation of the role of influencing factors. The program is now involved in at least eight different hospitals and in more than one country.

The Boston Collaborative Drug Surveillance Program also provides information about drug utilization such as: the overall magnitude of

drug use; the relative frequencies of various indications; the degree of utilization of individual drugs; and the variability of utilization patterns by hospital and geographic area. This type of information has been used to show the prevailing practices of drug therapy for educational and administrative purposes. (11)

Description of the Boston System: The starting drug orders for each patient involved in the study are recorded, as written by the attending physician, on the routine drug order sheet. The physician is then contacted and a statement is obtained concerning the indication for each drug. When a drug order is discontinued the attending physician is promptly interviewed regarding the reason for discontinuation, efficacy of therapy and side effects. At the time of patient discharge the physician is again interviewed to obtain information on all instances of specific adverse reactions to determine if these could be drug related. The discharge diagnosis is recorded and all data sheets are edited for completeness by specially trained personnel. The material is edited again by the computer for completeness, plausibility, and internal consistency. It is also subjected to analyses to evaluate both the suspected and unsuspected drug effects.

The potential for such discovery derives largely from the combination of the following characteristics of the system: uniform recording and routine collection of data on all drug exposures and their indications, all alleged side effects and other adverse events, efficacy ratings, patient characteristics, etc.; the large number of patients observed in different hospitals; the storage of data in a readily retrievable form; and the application of appropriate routine analyses designed to uncover unsuspected relationships. (11)

A similar system that involves the computer was developed by Kaiser Permanente of San Francisco. (8) Information was taken

from analyses of the drug dispensing and diagnosis data collected from the pharmacy in the hospital and six major outpatient clinics (medicine, pediatrics, dermatology, gynecology, surgery, and allergy), during the 6-month period from July to December, 1969. The study includes approximately 220,000 visits by 75,000 patients.

Description of the Kaiser System: The Kaiser Permanente Drug Reaction Monitoring System was planned to follow a population through its entire health care experience, both as inpatients and outpatients. Outpatient surveillance directs attention to a different group of drugs and patients than covered by inpatient monitoring. Furthermore, long term follow-up is possible in the relatively stable Kaiser Health Plan Population and drug reactions taking months or even years to develop may be detected.

Data are collected from two sources in the system, one of which is the pharmacy. This information is entered on-line directly to the patient's computer stored medical record. The other source is the clinic physician who completes a diagnosis card which will also be entered into the computer. These data are then used to detect and measure drug event associations. The monitoring analysis regarding a particular drug involves ascertaining who is receiving the drug, determining what new clinical events he experiences during a follow-up period and measuring the incidence rate for each event. Events are not limited to the routine monitoring analyses, but the computer system scrutinizes all events in the hope of discovering previously unsuspected reactions, (8)

The Boston Collaborative and Kaiser Permanente programs involve the

computer in clinical research, but do not deal directly with individual patient care. Since these studies were initiated, there has been development of computer programs which are used to monitor the therapy of the hospitalized patient and provide warnings to health professionals of potential therapy problems.

### Drug-Drug Interaction Systems

A development which followed clinical data collection was that of drug-drug interaction detection.

As practitioners began to look for such 'incompatibilities,' the number began to increase geometrically. Many more were reported than anyone could memorize. To keep up with all such reported occurrences, card files and indices became voluminous. In addition, we are now entering a time when good health care services are being asked for all citizens resulting in increased pressures to deliver more and better health care.

The only piece of equipment that can memorize all the information in a systematic fashion and give back the required data instantaneously, is the computer. (12)

The programs written to deal with drug-drug interactions vary widely in the type of information provided. One of the earlier and smaller systems was developed by Werner Lowenthal, Associate Professor in the Department of Pharmacy, in conjunction with the Department of Biometry, Virginia Commonwealth University, Richmond, Virginia.

Description of the Lowenthal System: This system operates when a pharmacist enters a drug to determine if it has any incompatibilities listed in memory. The computer simply searches its memory and prints a listing of potential drug interactions: (Figure 1)

ASPIRIN	ANTICOAGULANT	+ANTICOAGULANT
ASPIRIN	PARA-AMINOSALICYLIC	PAS TOXICITY
ASPIRIN	PHENOBARBITAL	-ANALGESIC-Q
ASPIRIN	METHOTREXATE	PANCYTOPENIA

(12)

The information is entered into memory by IBM (Holerith) cards, and consists of the name of the drug, the drug with which it interacts and a short statement pertaining to the interaction or incompatibility.

The trade names and nonproprietary drug names are also stored in memory which enable retrieval of information on incompatibilities of drug classes. This system was written in FORTRAN IV programming language and was used on an IBM 1130 computer. (12)

A much more extensive drug-drug interaction monitoring system, MEDIPHOR, has been developed at the 612 bed Stanford University Medical Center by David Tatro and Associates in the Division of Clinical Pharmacology.

An on-line computer based program has been developed at Stanford University Medical Center to prospectively monitor drug usage and alert pharmacists, nurses and physicians as to the severity and immediacy of potentially interacting drug combinations. (17)

Description of the MEDIPHOR System: As a new drug is entered into the patient's computer profile, the computer searches for possible interactions between the newly entered drug and the previously prescribed medications. The following information is included for each drug interaction detected:

- (1) Pharmacological effect of the interaction, e. g., pharmacological effect of drug "A" decreased.
- (2) Mechanism involved in the interaction, e. g., inhibition of neuronal uptake of the drug.
- (3) Clinical symptoms which may be expected with concomitant administration of the interacting drug combination.
- (4) Clinical significance of the interaction, e. g., clinical significance demonstrated in humans. Effects are dose dependent.
- (5) Clinical management suggestions, e. g., avoid drug "A" may need higher dose of drug "B".

6. References documenting the interaction. Primary references are always cited.
7. Comments useful to the physician in interpreting the interaction information, e. g., blood levels of drug "A" increase to the toxic range in approximately 10% of the patients concurrently receiving drug "B".
8. Alert classification, provided as statements on the immediacy and severity of the interaction. (Figures 2-6)

The MEDIPHOR system has the capacity to serve as a retrieval source for drug interaction information. A list of two or more drugs can be entered and the computer will respond by giving reports on interacting drug combinations. In addition, bibliographies can be produced by entering key words or author's names into the computer. This data base is regularly updated and therefore stays as a current source for drug interaction information.

The MEDIPHOR system has been marketed commercially by B-D Spear Medical Systems. The required hardware and software are available for approximately \$100,000. (14)

#### Drug-Drug and Drug-Laboratory Test Interaction Systems

Another step in the use of computers for clinical monitoring of patients, is the inclusion of laboratory tests with drug-drug interactions.

The Clinical Pathology Department of the Clinical Center, National Institutes of Health, has developed a referenced listing of drug-laboratory test interactions.

While most physicians are aware of the major physiological or pharmacological effects of therapeutic drugs on laboratory tests, many do not know the minor effects of even some of the most widely used drugs. Few patient care physicians are aware of the possible influence of drugs administered to patients on the analytical procedures used to measure constituents of body

Figure 2.

# MEDIPHOR

The MEDIPHOR Data Base is a computerized drug/drug interaction data base that was developed by Stanley N. Cohen, M.D., Ph.D. and associates at the Stanford University School of Medicine. Dr. Cohen is the Chairman, Division of Clinical Pharmacology of Stanford University.

MEDIPHOR is designed for "real time" application as a reference tool to aid the physician and pharmacist in health care delivery. As with any information that is used as an aid in making therapeutic decisions, accuracy and validity are paramount. The MEDIPHOR data base contains *only* information which is convincingly documented in the primary literature. Throughout the compilation of the data base, special emphasis was placed on evaluation of both clinical relevance and the design of all supporting experimental studies.

Documented information provided by MEDIPHOR includes:

- (a) Pharmacological effects of the interaction.
- (b) Mechanism of the interaction.
- (c) Clinical findings that might result from administration of the combination.
- (d) Clinical significance of the interaction.
- (e) Coded designation of the immediacy and severity of the potential consequences.
- (f) Duration.
- (g) Clinical management suggestions.
- (h) Primary literature references for documentation.

MEDIPHOR is available as an integrated part of the Spear Pharmacy System 830, where it automatically screens every medication order entry for potential drug/drug interaction. The data base may also be purchased for inclusion in other computer systems or accessed on a subscription basis from a computer service company.

The samples enclosed in this folder show the results of a typical request for an interactive check between specified drugs. Refer to the legend below for an explanation of the MEDIPHOR Alert Classifications.

## MEDIPHOR ALERT CLASSIFICATIONS

### Immediacy Code

-  If the consequences of this interaction occur, they may be evident soon after the administration of this drug combination and
-  If the consequences of this interaction occur, they may be evident after several doses of the drug combination are administered and
-  If the consequences of this interaction occur they may not be evident until this drug combination has been administered for a variable period of time, but they
-  (same as immediacy code "3" except "but they" replaced with "but they may be ignored if one of the drugs is administered PRN")
-  This designation is used for potential interactions that are not well documented or not thought to be clinically relevant.

### Severity Code

-  may be potentially life threatening or cause permanent damage.
-  may lead directly to deterioration of the patient's clinical condition.
-  may potentially lead to symptoms of toxicity or loss of therapeutic efficacy of one or both of the drugs listed in this report.
-  Undetermined.

*Note- The immediacy and severity codes may be combined in any order to relate the appropriate alert condition!*

Figure 3.

## COMPLETE INTERACTION REPORT

6/10/76  
 B-D SPEAR MEDICAL SYSTEMS  
 123 SECOND AVENUE  
 WALTHAM, MASS. 02154  
 TELEPHONE (617) 890-4300

IMMEDIACY: (7) SEVERITY: (1)

DRUG COUMADIN  
 WITH PERCODAN

DRUG: WARFARIN  
 CLASS: COUMARIN ANTICOAGULANTS

DRUG: PHENACETIN  
 CLASS: ACETAMINOPHEN DERIVATIVES

PHARMACOLOGICAL EFFECTS: PHARMACOLOGICAL EFFECTS OF COUMADIN INCREASED.

MECHANISMS: UNKNOWN.

CLINICAL FINDINGS: REDUCED PROTHROMBIN LEVELS. POSSIBLE BLEEDING.

CLINICAL SIGNIFICANCE: PROBABLY SIGNIFICANT BUT NEEDS MORE STUDY.  
 EFFECTS ARE DOSE-DEPENDENT.

CLINICAL MANAGEMENT SUGGESTIONS: MAY NEED LOWER DOSE OF COUMADIN DURING  
 CONCURRENT ADMINISTRATION OF PERCODAN.

## REFERENCES:

ANTLITZ, A.M., ET AL.: CURR THER RES, 10: 501 (1968)  
 ANLITZ, A.M. & ANALT, L.F.: CURR THER RES, 11: 360 (1969)  
 UDALL, J.A.: GP, 40: 117 (1969)

## COMMENTS:

ANTLITZ SHOWED THIS INTERACTION WAS SEEN IN SOME  
 PATIENTS AFTER ACETAMINOPHEN WAS GIVEN DAILY FOR TWO TO FOUR WEEKS  
 DURING CONCURRENT ADMINISTRATION OF VARIOUS ORAL ANTICOAGULANTS,  
 ALTHOUGH NO EFFECTS WERE SEEN AFTER SHORT TERM ACETAMINOPHEN  
 THERAPY. UDALL DID NOT OBSERVE THE INTERACTION, BUT HIS DATA  
 WERE INSUFFICIENT TO DISPROVE ANTLITZ'S RESULTS.

S  
 A  
 N  
 T  
 L  
 I  
 T  
 Z  
 I  
 M

Figure 4.

## COMPLETE INTERACTION REPORT

6/10/76  
 B-D SPEAR MEDICAL SYSTEMS  
 123 SECOND AVENUE  
 WALTHAM, MASS. 02154  
 TELEPHONE (617) 890-4800

IMMEDIACY: (3) SEVERITY: (1)

DRUG COUMADIN  
 WITH PERCODAN

DRUG: WARFARIN  
 CLASS: COUMARIN ANTICOAGULANTS

DRUG: ASPIRIN  
 CLASS: SALICYLATES

PHARMACOLOGICAL EFFECTS: PHARMACOLOGICAL EFFECTS OF COUMADIN INCREASED.

MECHANISMS: CONTROVERSIAL POSSIBLY ADDITIVE PHARMACOLOGICAL ACTIVITY.  
 IMPAIRMENT OF PLATELET FUNCTION.

CLINICAL FINDINGS: POSSIBLE BLEEDING.

CLINICAL SIGNIFICANCE: PROBABLY SIGNIFICANT BUT NEEDS MORE STUDY.  
 EFFECTS ARE DOSE-DEPENDENT.

CLINICAL MANAGEMENT SUGGESTIONS: MAY NEED LOWER DOSE OF COUMADIN DURING  
 CONCURRENT ADMINISTRATION OF PERCODAN.

## REFERENCES:

WATSON, R.M. & PIERSON, R.N., JR.: CIRCULATION, 24: 613 (1961)  
 MEYER, D.D. & HOWARD, E.: PROC SOC EXP BIOL MED, 53: 234 (1943)  
 O'REILLY, R.A., ET AL.: ANN NY ACAD SCI, 179: 173 (1971)

## COMMENTS:

SALICYLATES IN HIGH DOSES APPEAR TO HAVE A HYPOFIBRINOGENEMIC  
 EFFECT SIMILAR TO THAT SEEN WITH COUMARIN ANTICOAGULANTS.  
 CLINICALLY SIGNIFICANT ADDITIVE EFFECTS HAVE BEEN OBSERVED  
 IN SOME PATIENTS. IMPAIRMENT OF PLATELET FUNCTION BY  
 SALICYLATES (EXCEPT SODIUM SALICYLATE) MAY ALSO ENHANCE THE  
 POSSIBILITY OF BLEEDING TENDENCY IN ANTICOAGULATED PATIENTS.

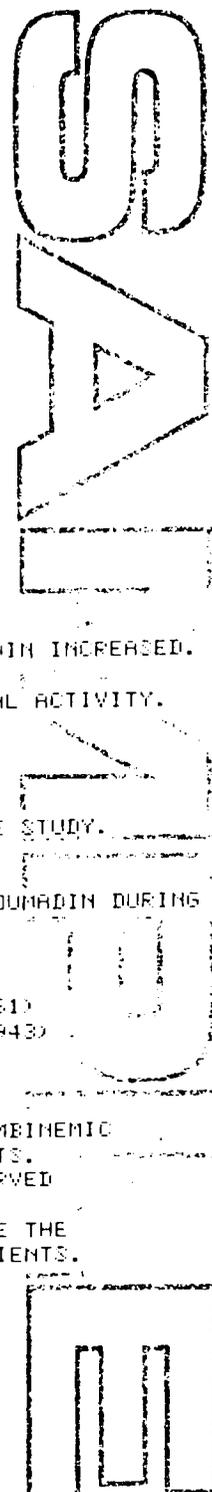


Figure 5.

## COMPLETE INTERACTION REPORT

6/10/76  
 B-D SPEAR MEDICAL SYSTEMS  
 123 SECOND AVENUE  
 WALTHAM, MASS. 02154  
 TELEPHONE (617) 890-4800

IMMEDIACY: (3) SEVERITY: (1)

DRUG COUMADIN  
 WITH BUTAZOLIDIN

DRUG: WARFARIN  
 CLASS: COUMARIN ANTICOAGULANTS

DRUG: PHENYLEBUTAZONE  
 CLASS: PHENYLEBUTAZONES

PHARMACOLOGICAL EFFECTS: PHARMACOLOGICAL EFFECTS OF COUMADIN INCREASED.

MECHANISMS: DISPLACEMENT FROM PLASMA PROTEIN BINDING SITE.

CLINICAL FINDINGS: REDUCED PROTHROMBIN LEVELS. POSSIBLE BLEEDING.

CLINICAL SIGNIFICANCE: CLINICAL SIGNIFICANCE DEMONSTRATED IN HUMANS.

CLINICAL MANAGEMENT SUGGESTIONS: MAY NEED LOWER DOSE OF COUMADIN DURING  
 CONCURRENT ADMINISTRATION OF BUTAZOLIDIN.

## REFERENCES:

- EISEN, M. J.: JAMA, 189: 64 (1964)  
 FOX, S. L.: JAMA, 188: 320 (1964)  
 O'REILLY, R. A. & ASSELER, P. M.: PROC SOC EXP BIOL MED, 128: 1080  
 (1968)

## COMMENTS:

CONVINCING CASE REPORTS AND EXPERIMENTAL DATA SUGGEST THAT  
 THIS INTERACTION OCCURS TO SOME DEGREE IN MOST PATIENTS  
 RECEIVING THIS COMBINATION OF DRUGS.

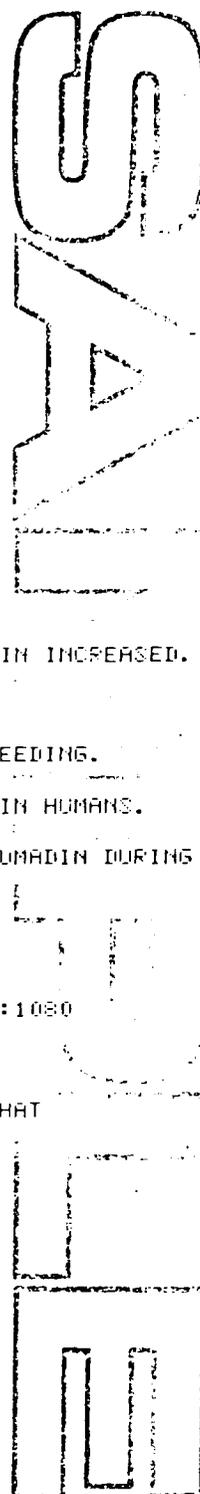


Figure 6.

## COMPLETE INTERACTION REPORT

6/10/76  
 B-D SPEAR MEDICAL SYSTEMS  
 123 SECOND AVENUE  
 WALTHAM, MASS. 02154  
 TELEPHONE (617) 890-4800

IMMEDIACY: (7) SEVERITY: (3)

DRUG BUTAZOLIDIN  
 WITH PERCODAN

DRUG: PHENYLEBUTAZONE  
 CLASS: PHENYLEBUTAZONES

DRUG: ASPIRIN  
 CLASS: SALICYLATES

PHARMACOLOGICAL EFFECTS: COMBINATION PRODUCES EFFECT NOT EXPECTED FROM EITHER TAKEN ALONE.

MECHANISMS: CONTROVERSIAL PROBABLY INTERFERENCE WITH ACTION OF SALICYLATE ON RENAL TUBULE.

CLINICAL FINDINGS: POSSIBLY HYPERURICEMIA.

CLINICAL SIGNIFICANCE: PROBABLY SIGNIFICANT BUT NEEDS MORE STUDY. EFFECTS ARE DOSE-DEPENDENT.

CLINICAL MANAGEMENT SUGGESTIONS: MONITOR SERUM URIC ACID. AVOID PERCODAN OR AVOID BUTAZOLIDIN

REFERENCES:  
 DYER, J.H., ET AL.: AMER J MED SCI, 251: 1(1966)

COMMENTS:  
 IN SOME OF THE PATIENTS FOLLOWED IN THIS CLINICAL STUDY, PHENYLEBUTAZONE REVERSED THE URICOSURIC EFFECT OF HIGH-DOSE ACETYLSALICYLIC ACID. WHEN HIGH DOSES OF ASPIRIN WERE ADMINISTERED CONCURRENTLY WITH PHENYLEBUTAZONE (400MGSDAY) FOR 3 DAYS, URIC ACID EXCRETION FELL BELOW PREDRUG LEVELS IN A FEW PATIENTS AND SERUM URIC ACID ROSE 1 TO 1.5 MG% ABOVE PREDRUG LEVEL. THE STUDY DID NOT INVESTIGATE LONG-TERM ADMINISTRATION OF THESE DRUGS, SO IT IS NOT KNOWN WHETHER THE OBSERVED EFFECT WOULD PERSIST OR INCREASE WITH CHRONIC THERAPY. HOWEVER, WE SUGGEST CHECKING URIC ACID LEVELS IN PATIENTS RECEIVING THIS DRUG COMBINATION.

SAFETY

fluids in the clinical laboratory. In the present publication we include many common and less common effects of drugs on laboratory tests that have been reported in the literature..... We should emphasize that we believe that the present list should be used as a guide for the interpretation of results. It should not be thought of as providing the correct explanation for any abnormal data in any given situation. The disease for which a drug was administered should always be considered initially as a source of abnormal results. (20)

This listing of laboratory test interactions (acronym CLAUDE) has approximately 9,000 entries. Modifying influences on the laboratory test results have been included. Examples are: influences of certain foods; the menstrual cycle and menopause in women; and the effects of activity and change of posture in subjects from whom blood is obtained. These factors are often overlooked in the interpretation of laboratory data, yet can alter the results of several tests to such an extent that erroneous conclusions may be drawn about the state of health of the individual. (20)

The information in this listing has been organized and indexed in the following headings:

- Generic/Proprietary name directory of drugs;
- Abbreviation and short form directory;
- Alphabetic listing of effects by generic names of drugs;
- Alphabetic listing of effects by laboratory test;
- Reference file.

CLAUDE can be easily interfaced with any compatible computer system and serves as a readily available source of drug-laboratory test interaction information.

An example of a computer system using both drug-drug and drug-laboratory test interactions is the program in use at Mercy Hospital Pittsburgh (604 beds), developed by Vincent Bouchard and J. E. Bell.

Most clinical practitioners agree that one of their most

important responsibilities is to monitor patients for drug-induced modifications of laboratory test values and for drug interactions. (4)

This computer program was developed to help in these areas.

This system was written in the COBOL programming language and consists of four different programs, each of which perform a specific function.

- (1) The Update Program is used to read the data into the system and arrange them in a randomly accessible file on disk. The random characteristic of the file allows searches without the necessity of reviewing the entire file. A record is created for each drug and each test. Data can be added to the file at anytime using the Update Program.
- (2) The Search Program accepts the patient profile, compares it to the interactions in the file created by the Update Program and prints out a list of "hits".
- (3) The List Program functions to provide the user with a summary of all interactions for a given drug or test.
- (4) The Revise Program is used to change or delete the remarks and/or reference for any interaction previously entered in the file. The Revise Program will change only references and remarks or delete entire entries. Any attempt to change drug or test names would destroy the system's indexing and retrieval routines. (4)

The pharmacist collects the data used for the system by reviewing the patient's chart at the nursing station. He records the drug and laboratory test information, using a Code-A-Phone recording device. This information is later played back by a member of the pharmacy staff, who retrieves a prepunched Holerith card labeled with the appropriate drug or laboratory test. These cards are organized with a patient identification card and sent as batch data to be run on the computer. The output responds with the drugs and laboratory tests entered, a list of drug-drug interactions, and a list of drug-laboratory test interactions. The type and/or result of the interaction is also listed and referenced.(1)

( see Figure 7 )

The output is used as a screening tool to identify a potential interaction. The patient's chart is then reviewed by a pharmacist to see if the information is correct and pertinent. Appropriate action is then taken, if needed, to alert the physician.

An evaluation was made of this system which involved processing 225 drug-laboratory test profiles on 173 different patients. No statistical analysis was presented, but 31 communications were sent to physicians. Of these 31, 19 were of a nature that the pharmacist expected the physician to implement his suggestion. Fourteen of these 19 were actually accepted and responded to by the physician. ( 4 )

Like the MEDIPHOR system, this system is available commercially from The Professional's Data Services Center, Inc. However, this company does not sell the computer hardware necessary to operate this system. The company only sells the program and updating service which must be interfaced with a computer. The initial cost of the program and installation is \$400, with a monthly charge of \$200 to update the system. (1)

#### An Integrated System

A medication monitoring system was recently cited in the literature which combined more than drug-drug and drug-laboratory test interactions. This system was developed in the 550 bed LDS Hospital in Salt Lake City, in conjunction with the University of Utah. (10)

By considering more of the patient's data, better and more complete drug monitoring can occur. This system monitors not only drug-drug interactions, but also drug-allergies, drug-laboratory interactions, drug-disease interactions, digitalis therapy, and anticoagulant therapy. (10)

Figure 7.

## COMPUTER PRINTOUT

DRUG INFORMATION SERVICES  
OF  
NAME

PROFILE FOR - JD 7N-39  
REQUESTOR - PHARMACY-MS

<u>DRUG/TEST REQUEST</u>	<u>SYNONYM</u>	<u>DRUG/LAB.</u>
GUANETHIDINE		DRUG 01580
IMIPRAMINE		DRUG 01705
DIETHYLSTILBESTR		DRUG 01155
HYDROCHLOROTHIAZ		DRUG 01655
QUINIDINE		DRUG 02935
PROTEIN BOUND I		LAB. 08085
SER URIC ACID		LAB. 08190
THROMBOCYTES		LAB. 08225
SER SODIUM		LAB. 08185
SER POTASSIUM		LAB. 08180
SER CHLORIDE		LAB. 08150
CO2 CONTENT SER		LAB. 08025

<u>DRUG / DRUG TESTED FOR POSSIBLE INTERACTIONS</u>	<u>REMARKS</u>	<u>REFERENCE</u>
GUANETHIDINE      IMIPRAMINE	G ANT I I ANT G	DI 2=176
GUANETHIDINE      HYDROCHLOROTHIAZ	H ENH G ADD EFF	DI 2=176

<u>PROFILE CONTINUED - LABORATORY TESTS</u>	<u>REMARKS</u>	<u>REFERENCE</u>
PROTEIN BOUND I      DIETHYLSTILBESTR	ELEVATED	AJHP 25=506
SER URIC ACID      HYDROCHLOROTHIAZ	ELEVATED	AJHP 25=511
THROMBOCYTES      HYDROCHLOROTHIAZ	DECREASED	AJHP 25=516
THROMBOCYTES      QUINIDINE	DECREASED	SEOD 5=197
SER SODIUM      HYDROCHLOROTHIAZ	DECREASED	SEOD 5=224
SER POTASSIUM      HYDROCHLOROTHIAZ	DECREASED ORAL	SEOD 5=224
SER CHLORIDE      HYDROCHLOROTHIAZ	DECREASED	AJHP 25=503

Description of the HELP System: This system (acronym HELP) contains 149 different drug-monitoring sectors or interaction searches. They are categorized as follows: 52 drug-drug interactions; 44 drug-allergy interactions; 30 drug-laboratory test interactions; 9 drug-disease problems; 6 drug-dose problems; 4 drug-diet problems; 2 drug-route problems; 1 drug-interval problem; and one alternate drug suggestion.

The HELP system involves data entered from many sources in the hospital. These may include laboratory studies and their results, sex and age, blood pressure, temperature, drug history (self administered by the patient), as well as other types of information. The pharmacy is responsible for entering drug allergies and drugs taken by the patient. The computer will work through these 149 drug monitoring sectors as each new drug is entered, to determine if any apply to the patient. If an interaction or contraindication is detected, it is printed via line printer to the pharmacist for his information and follow up. If no contraindication is found the computer requests the scheduling of the next drug order.

The drug interaction or monitoring sectors are a more involved evaluation than any previous system discussed in this paper. The drug-laboratory test interactions, as an example, are concerned with more than drug-laboratory test interactions. The HELP system also evaluates the patient's laboratory test results, and if there is some variation from normal for which the drug may be responsible, the alert is printed. If the laboratory test result is within normal limits the alert will not be printed. This eliminates the time taken by the pharmacist to determine whether or not the laboratory value may indeed

be affected by the drug. This system does not have as many interactions or contraindications to examine as other systems previously discussed, but it does involve a more indepth evaluation of the searches it does run.

Although the design and development of computer applications for clinical hospital pharmacy services can be done in a piecemeal approach, pharmacy departments should strive to obtain integration of pharmacy computer applications with the total hospital information system. (15)

The HELP system has the potential to achieve this integration for a more comprehensive clinical use of the computer in hospital pharmacy practice.

Clinical pharmacy services are becoming more widely established and are being considered necessary in order to optimize patient care. Computers can be used to help render many of the main components of a clinical pharmacy service program. The results of a successful program will be improved patient care. Clinical pharmacists will be freed by the computer from mass routine repetitive clinical functions. This will allow the clinical pharmacist to spend more of his time pursuing clinical drug problem areas requiring his drug expertise and knowledge. (15)

## METHODS

Description of the Study

The setting for this study was a 140 bed community hospital. The hospital is an acute care institution, with an average census of 100 to 120 patients (71-86% occupancy). New medication orders number approximately 250 per day, as do laboratory tests. Generally, from 25 to 40 patients will have some type of drug allergy recorded, and 15 to 30 patients may have a restricted calorie or sodium diet.

The study consisted of a comparison of significant problems, identified by the pharmacist, concerning medication orders collected before the computer aided system was initiated, with those collected afterward. The data were obtained from computer printouts and tape recorded telephone conversations between pharmacists and physicians or nursing staff.

Approximately one-half of the hospitalized patients' records during the study were put on the computerized system. The intensive care unit (12 beds) and three medical wards (16 beds each) comprised most of the patients who were monitored using the computer aided system. The entire hospital was used to obtain the baseline data on pharmacy input into medication order changes. (Refer to Collection of Baseline Data)

The System

The implementation of the system was done using an on-line

teletype communication with the Control Data Corporation 3300 computer, using the OS-3 operating system at Oregon State University. The program was written using Oregon State University's version of the programming language BASIC. (3) Daily updating of patient information was fed directly to the computer from the pharmacy using the on-line system. A printout of information was obtained and analyzed by pharmacy staff for potential problems.

The program itself enabled the computer to keep a daily profile on each patient being monitored. Pharmacy staff entered new data daily, including new drug orders, discontinuations, discharges, laboratory tests, diets and allergies. A check for continuation of schedule II automatic stop orders was included as part of the review of the patient's drug regimen.

The output from the computer included:

- (1) a printout by nursing station of the patient and names of the drugs that need to be renewed by the physician;
- (2) lists of patients whose drug order renewal has not been confirmed;
- (3) listing of drug-interactions (coded);
- (4) listings of drug-laboratory test interactions (coded);
- (5) listings of drug-dietary interactions (coded).

Patient name and identification number were also provided with the above items (1-5). Each patient's profile stored in the computer's memory could be printed out on request to verify medications, laboratory tests, allergies and diet.

Upon receiving the printed information via teletype, the pharmacist

analyzed possible problems and took appropriate action. In some cases the circumstances dictated that nothing need be done. In other cases a consultation with other professionals must be made, and any resulting scheduling or order changes were documented as part of the study.

A written communique was developed (pharmacist-physician worksheet) to aid the transfer of information to physicians which was not conveyed over the telephone. (Appendix A)

There were many variables which could potentially influence the results of this study.

- (1) If the type of information available to the pharmacy staff was not consistent in both study groups, there may have been an inordinantly high number of changes in the second group.
- (2) Fluctuations in the hospital census could result in erroneous conclusions.
- (3) If the method of collecting baseline information (i. e., the number of schedule or order changes initiated by the pharmacist independent of the computer system) by telephone monitoring was inconsistent between study periods, results may not be valid.
- (4) If the periods of study were different lengths, a comparison may not be valid.
- (5) If the method of collection and screening data was not consistent, resulting information may not be valid.
- (6) Personality conflicts or acceptance of pharmacy information by hospital staff may influence the data.
- (7) Changes in the type of patients monitored during the two

study periods may lead to invalid results.

Attempts were made to keep these variables constant by:

- (1) providing the same information to the pharmacy staff before the initiation of the system, as was used when the computerized system was in operation (e. g., dietary lists, laboratory test lists, allergy information, diagnosis, and the patient profile);
- (2) incorporating the hospital census into the statistical analysis so differences play no part in the evaluation;
- (3) monitoring the same telephone similarly for both study periods;
- (4) making both periods of study thirty-one days in length;
- (5) having the same person collect and record all of the data;
- (6) by comparing a control period with a computer study period to eliminate the influence of personality conflicts on the data;
- (7) including general medicine, intensive care, and coronary care patients in the control and study groups.

#### Evaluation

Evaluation of the data which were obtained before and after the automated system was completed as follows:

- (1) the computer aided patient profile review system was considered effective if a statistically significant increase ( $\alpha=.05$ ) in the number of pharmacy-physician, and/or pharmacy-nurse consultations, which result in scheduling or order changes, occurred;
- (2) if there was no change, or a statistically significant decrease in the number of consultations, ( $\alpha=.05$ ) the system was considered ineffective.

### Proposal To The Hospital Administration

To develop this computer aided pharmacy profile review system, the financial backing and cooperation from the hospital administration was required. A proposal was prepared that explained the system's objectives, methods, costs, evaluation and potential benefit to the hospital. In the proposal costs of two different alternatives for obtaining the needed equipment were outlined.

This proposal was presented to the administrator and controller on March 12, 1976, and the first alternative for equipment was approved. This proposal appears in Appendix B.

### Collection of Baseline Data

The type of information needed for this study before the computerized system was initiated is termed the baseline or control data. It was collected in order to determine the level of the pharmacist's input into the patient's medication orders prior to initiation of the computer program. These data were used later to compare the effect the computer aided system had on the patient's orders.

Before these data could be gathered, all of the information that would be provided to the pharmacist while using the computer had to be initially provided to the pharmacy staff. This information included the patient's diagnosis, allergy identification, daily laboratory test listings, daily dietary listings, and the patient's medication profile. The only information the pharmacy had access to prior to the study was the patient's medication profile. The other information had to be channeled into the pharmacy on a regular basis from the different areas

of the hospital.

The patient's admitting diagnosis was recorded during the interview by the admitting clerk, a copy of which was sent to the pharmacy. This form also provided some useful facts for other areas of pharmacy service such as home address and previous admissions.

The identification of the patient's allergies was recorded by the nurse during his or her initial interview with the patient. as part of the admission procedure developed by nursing administration. A special bright colored form was developed to record allergy information and was included with the chart and nursing notes used when admitting a new patient. This form was not easily overlooked, and was small enough to be quickly and easily completed. (Appendix C) The patient's name, room number, nursing station and any known allergies were recorded and the form sent to the pharmacy. Good cooperation was received from the nursing staff in completing these forms, which was encouraging after many failures of lists and daily updating by pharmacy staff.

The daily laboratory tests ordered by the physicians were available but not readily accessible to the pharmacist on the patient's chart. The pharmacy would receive a No Carbon Required copy of the original orders, but would not always get the section which included the laboratory tests ordered by the physician. This was especially true if the physician had written orders in the same section of the chart for many departments in the hospital. It was determined that the laboratory was preparing a daily work list which included all the tests to be run that day. A copy of the daily list was made and sent to the pharmacy thereby eliminating the compilation of this information by the pharmacy staff.

The dietary department collected the information for patients' diet orders by using an NCR multiple part form which was updated during the day by the nursing station. A copy would be picked up before each mealtime to determine the number and type of special diets which needed to be prepared. The special diets, which included sodium and sugar restrictions, were of interest to the pharmacist. The evening ward secretary was requested to send the old dietary sheet to the pharmacists for their information. After many reminders were posted, this became part of the routine and again good cooperation was received from the ward secretaries.

The pharmacy medication profile was updated as new medication orders were obtained. Orders were NCR copies of the physicians' original orders, which eliminated potential judgemental and recopying errors by nursing staff. This was a well developed and functioning part of the pharmacy system and it was not necessary to change this activity.

#### Methods for Recording Data

In order to determine the amount of input into medication order changes, a recording system had to be initiated. Since the primary method of communication from the pharmacy to other health professionals was via telephone, this was deemed the logical place to monitor the communications. The first attempt to compile data involved some discipline on the part of pharmacy staff to complete a form summarizing the type of information communicated when only a physician was contacted.

This method was changed because the forms were not being completed on a regular basis due to the inconvenience of stopping during a busy part of the day to record the proper information. In addition,

communication with physicians and nurses was having an effect on the medication orders. Scheduling the proper times to administer the medication such as: with meals, to avoid meals, and to avoid other medications, was determined to be an important part of the pharmacist's input into the medication order for the patient. It was unrealistic to expect the pharmacy staff to record data consistently due to the volume of telephone contacts made each day from pharmacist to nurse and physician.

The change in method of data collection had to involve a minimum amount of time expended by the pharmacy staff. It also had to be as complete as possible. The decision was made to use a cassette tape recorder to record telephone conversations which could be played back at a later time for collection of needed data. Using the tape recorder met both of the criteria for a new method of collection. First, it only required the pharmacy staff to turn the cassette tapes over when they ran out, or to replace them with a blank. Compliance in this task was much greater than the written form, since it only took a few moments once or twice each eight hour shift. Compliance improved to almost one hundred percent when a buzzer was installed to signal the end of a tape. The second criterion was also met because the tape contained the majority of phone conversations and included complete information unbiased by the recorder.

The telephone conversations were recorded by wiring the recorder into two telephones located in the pharmacy. A switch was installed that would turn the tape recorder on only when the receiver was off the hook. This eliminated the excess use of tape and provided a record

of only the telephone conversations. The secondary telephone provided little relevant information and was not included in the data.

The recorded tapes were then played back and pertinent data noted for future reference. Any confirmation of recorded data was accomplished using the patient's chart or the nursing MAR (medication administration record). Information gathered included any pharmacy-initiated change in the scheduled time which a drug was to be given, for pharmacological or therapeutic reasons, or a change in the drug order concerning dosage, route, dosage form, interaction; or contra-indication.

A considerable amount of other data not relevant to this study was also collected from these conversations which may be of value in future studies or departmental policies.

#### Description of the Computer Program

The computer program developed for this pharmacy profile review system was written in BASIC (acronym for Beginner's Allpurpose Symbolic Instruction Code), a technical, high level programming language. The computer used was the Control Data Corporation 3300, at Oregon State University. (3) Since the hospital was located 135 miles from the computer, the option of using Holerith punch cards and running them in a "batch" was impractical. The on-line communication ability of the operating system, OS-3, allowed conversational time sharing over telephone lines with a remote teletype in the pharmacy.

Being able to communicate with the computer on-line had specific benefits when using this program. An immediate response to the input

data allowed rapid recognition of potentially serious drug interactions or allergy contraindications. Another benefit of being on-line was the computer's ability to provide a listing of any patient's profile if a question arose about potential problems that were printed.

New information on patients was collected on a daily basis and entered into the computer. This was accomplished by separating it into three different files, DIS, DC, and UPDATE. The DIS file included the names and identification numbers for those patients being discharged. The DC file included the names of the patients, their identification numbers, and the code numbers indicating the drugs or diet restrictions to be discontinued from the patient's orders. The UPDATE file included the patient's name, identification number, and the code for any new order for a drug, diet restriction, laboratory test, or allergy, on a new or old patient.

These files were entered on paper tape before the pharmacy logged onto the computer. This was done to save computer time since the paper tape (ticker tape) could be read into the computer faster and with more accuracy than if typed in manually.

Other files already in storage were:

- (1) MASTER, which contained all the previous patient information;
- (2) NARCLIST, which contained all the information on the scheduled drugs for renewal;
- (3) NARCALPH, which provided the generic narcotic name in English for the narcotic renewals;
- (4) DATA, which provided the information for the drug-drug, drug-laboratory, drug-diet and drug-allergy screen;

- (5) MONITOR, which worked in conjunction with DATA to guide the search for interactions;
- (6) NURSTA, which listed the nursing stations in English for narcotic renewal printouts;
- (7) BAHP, the actual program to organize and manipulate all these files. (Appendices D,E,F,G,H,I and J)

Data for drugs, special diets, laboratory tests, and allergies were all coded numerically for easy manipulation within the computer. The patient's name and nursing station were the only nonnumerical entries into the system. The codes used were the same numbers used for billing purposes with some modification, so a completely new numbering system did not have to be developed. (Appendix K)

#### Use of the Program BAHP

After the DIS, DC and UPDATE files are entered into the computer, the BAHP program is called and is requested to run. The computer responds by asking the pharmacist to answer questions about the desired program output. The first question requires the pharmacist to enter the Julian date, which is used when determining when the controlled drug orders expire. Next, the computer requests the pharmacist to indicate the number of narcotic checklist renewal forms needed for the nursing stations. Once this information is supplied, the computer reads the MASTER and UPDATE files into its working area. The DIS and DC files read in and discharges and discontinuations are then completed. Appropriate error messages are printed if any of the data are entered incorrectly. A Schedule II drug checklist is then printed for the appropriate nursing stations. (Figure 8) The checklist includes patient

name, identification number, generic name of drug that should be renewed, and the Julian Date. The computer lists any patients who have a Schedule II drug which is neither renewed nor discontinued after its stop date, with a message indicating the error. (Figure 8)

At this point the computer initiates a systematic search of the new information in UPDATE and compares it to previous entries for the same patient stored in MASTER. If a Schedule II drug is located in the UPDATE file, the computer requests on which nursing station the patient is located and records this in the NARCLIST file for future reference when the order expires. Each new entry of a drug, laboratory test, allergy, or dietary restriction is selected individually, and by using the MONITOR file, is compared to all the values which have potential interactions listed (DATA file). If a drug has potential interactions, all of its noted interacting drugs are compared to the patient's previous profile and new entries for that day. If an interaction is detected, a listing of the type of interaction (e. g., DRUG-DRUG or DRUG-LABORATORY INTERACTION) (Figure 8) , patient's name, identification number, and the numerical code for the drugs or laboratory tests is printed. If an allergy-drug or diet-drug contraindication is detected a short explanation of the problem is printed again with the coded drug or diet listed and patient name and number. (Figure 8)

At a number of places in the program a question is asked of the pharmacist if there is a patient profile that he desires to have printed. If there is, he enters the patient's name and identification number. The computer will immediately respond by printing the profile

## Figure 8.

## DRUG-LAB TEST INTERACTION

SIMONSON.W 9085 43004 9680

MUSTOE.T 11980 3AS HAD SECOBARBITAL CAP ORDERED ON JULIAN  
 DATE 115 AND IT HAS NOT BEEN CONTINUED OR D/C'D TO THE  
 COMPUTER'S KNOWLEDGE. PLEASE GET ME A RESUME OR D/C  
 THANKS!

DAILY SCHEDULE II MEDICATION RENEWAL LIST  
 NURSING STATION: 2AS DATE:123

NARCOTICS  
 (3 DAY STOP ORDERS)

PATIENT	MED REC	SCHED II MED	DATE ORDERED
SAGER.R	5924	MORPHINE	120
WEST.L	25704	PERCOLAN	120

SEDATIVE-HYPNOTICS  
 (7 DAY STOP ORDERS)

PATIENT	MED REC	SCHED II MED	DATE ORDERED
HOBBS.E	27222	PENTOBARBITAL CAP	116
PROSA.A	12492	SECOBARBITAL CAP	116

PLEASE STAMP PHYSICIAN ORDER SHEET FOR CONTINUE OR  
 D/C ORDERS

IF ANY OF THE ABOVE SCHEDULE II MEDICATIONS HAVE ALREADY  
 BEEN REORDERED OR D/C'D, PLEASE LET THE PHARMACY KNOW.

STRANDBERG.L 6852 HAS A RESTRICTED CALORIE OR DIABETIC  
 DIET AND IS TAKING -5085 WHICH IS HIGH IN SODIUM OR SUGAR

## DRUG-DRUG INTERACTION

STRANDBERG.L 6852 6270.72 0.6200

STENNETT.D 5935 HAS A RESTRICTED CALORIE OR DIABETIC  
 DIET AND IS TAKING -8390 WHICH IS HIGH IN SODIUM OR SUGAR

KANAREK.P 6926 PATIENT HAS ALLERGY TO VALIUM AND IS ON  
 7280.34

in its memory or by saying that the profile is not available.

After all the data in the UPDATE file has been searched and compared to the MASTER file for potential problems, this new data as well as the old is written into the new MASTER file to be used for the following day's run. The final information printed by the computer is the number of patients that it has in storage in its MASTER file. The program then terminates. The pharmacist logs off the computer and deals with the information provided by the computer aided profile review.

The time involved for a pharmacy technician or pharmacist to prepare the DIS, DC and UPDATE files is approximately 30-40 minutes. Once logged into the computer it takes the pharmacist between five and ten minutes to finish a program run, depending upon the amount of output received.

#### Development and Initiation of the System

As with most complex computer programs, this was started by developing a flow chart or diagram of the logical steps needed to work with the data provided. These steps were then coded into the programming language.

When preparing the computer program, certain criteria were desirable to have included. Among these were:

- (1) a drug-drug interaction search that included only well documented clinically significant drug interactions;
- (2) a drug-laboratory test interaction search that included only well documented laboratory test interactions;
- (3) a drug-allergy search that included most of the commonly

- reported drug allergies;
- (4) a drug-dietary interaction search which included two specific restrictions in diet where drugs could have an important effect;
  - (5) a monitoring system for the Schedule II drugs to insure their proper renewal or discontinuation by the physician according to guidelines determined by the Patient Care Committee;
  - (6) storage and retrieval of patient profiles for the entire hospital;
  - (7) alphabetic listing of patients in the MASTER file for easier retrieval by the computer;
  - (8) generic drug names, diets, laboratory tests and allergies printed in English when an interaction was detected;
  - (9) easily understood error messages developed for the pharmacy staff while using the program;
  - (10) good documentation within the computer program to help in understanding its functions if revisions were to be made;
  - (11) an easily updated data base for adding or deleting information in the interaction searches;
  - (12) an easy method for inputing the new information collected daily;
  - (13) and, most importantly, an efficient and easily run program.

After the program was written, it was determined that its size would be a limiting factor. There is a smaller amount of storage area within the programming language BASIC for the program, its files and working area, than with other languages. However, since BASIC was the only language with which the author was intimately familiar, it was the only alternative available. Since the size of the program that was originally

written was too large, some compromises were made. Consequently, the criteria previously mentioned were not all included and some were incorporated in part. Criteria 1-5 were included in their entirety; criteria 6, 8, 9, and 11-13 were included in part only; and criteria 7 and 10 were eliminated. This put the program length under 500 lines, which provided sufficient room to run and have adequate storage. After these modifications were completed, the program was ready to be used on a daily basis. The inevitable "bugs" were to surface as the program was put to use, and they were dealt with as they became known.

#### Staff Communications

Communications were sent to ward secretaries, physicians and nursing staff describing the system as it affected them.

The ward secretaries were informed on a personal basis about the content of the printouts they would be receiving daily. These forms contained the Schedule II medication renewal lists for the patients on their wards. By using this information, they recorded in the patient's chart a notification to the physician of medications which needed to be renewed or discontinued. The physician's response, or lack of it, was used as information in this study.

Physicians were notified by pharmacists of the potential problems that were discovered by the computer aided monitoring system. A communication form (Appendix A) was developed to aid in contacting physicians when they could not be reached by phone, or if the information was not of an immediate nature. This was done to save pharmacists' time and to better coordinate the type and amount of information that was distributed. This form was submitted to and approved by the Patient

Care Committee of the hospital. It was then sent as a memo, with an explanation, to the physicians specializing in internal medicine.

(Appendix L) These physicians were selected since it was felt they would be dealing with the form more than other physicians. This also eliminated the scrutinization and potential objection by physicians who would not be concerned with the form.

The nursing staff was also informed of both types communications from the pharmacy, and was able to help incorporate them into the everyday activities on the nursing unit.

#### Trial Period

The system was given a trial before the second study period was begun, to determine the amount of time required to assimilate the data and run the program. It also showed how much computer time would be needed to complete the study. It was found that more computer time would be needed than had been allotted in the grant from the Department of Computer Science at Oregon State University (Appendix M), and a grant for additional time was obtained which would allow completion of the study. Since the running of the computer program did not become an integral part of the operation of the pharmacy department, this trial period also determined the amount of free time that was eliminated from the investigator's schedule!

An additional form was developed for each nursing station involved in the study to insure that all new data for a given day was incorporated into the system. (Appendix N)

A method was also developed to monitor new drugs or allergies that were recorded on the patient's medication profile maintained in

in the pharmacy. By checking off the name of each drug which was entered daily for a particular patient, it was easy to tell which new drugs had been added to the profile since the previous day. Any drugs which were discontinued were highlighted and the check mark was then circled when the discontinuation was entered into the computer. A system of using carbon paper to collect the new drugs and discontinuations proved to be impractical due to the amount of manipulation of paper and the design of the medication profile.

Once this system of recording was developed, the study with the computerized system was begun. At the same time that the computer data was being collected for input into the change of patient's orders, the baseline or control telephone data was also being collected in the same manner as previously described.

#### Development of Supporting Literature File

To support the information that was being provided to the physicians, appropriate literature was collected. The citations of the interactions were taken from various sources which included:

American Drug Index, Wilson, Charles O. and Tony E. Jones, J.B. Lippincott Co. Philadelphia, Penn. 1976.

American Hospital Formulary Service, American Society of Hospital Pharmacists. 4630 Montgomery Ave. Washington, D.C.

Clinical Literature (articles from current literature)

(obtained primarily from Oregon State University Drug Information Service)

Current Medical Diagnosis and Treatment, Krupp, Marcus and Milton Chatton.

Lange Medical Publications. Los Altos, Calif. 16th Ed. 1976.

- Current Pediatric Diagnosis and Treatment, Kempe, C. Henry, Henry Silver and Donough O'Brien. Lange Med. Pub. Los Altos, Calif. 1977.
- Drug Consultation Guide, Washington State Pharmaceutical Association, Maudlin, Robert, and Lloyd Young. 1975.
- Drug Induced Diseases, Meyler, L. and H.M. Peck. Exerpta Medica, Amsterdam, The Netherlands. Volume 4. 1972.
- Drug Interactions, Hansten, Philip D. Lea and Febiger. Philadelphia, Penn. 2nd Edition. 1973.
- Extra Pharmacopeia, The, Blacow, N., Editor. The Pharmaceutical Press. London, Great Britain. 26th Edition. 1972.
- Facts and Comparisons, Kastrup, E.K., Editor. Facts and Comparisons, Inc. St. Louis, Montana. 1972.
- Intravenous Incompatibilities, Don and Monte Cohon, University of Wisconsin Hospitals. 1974.
- Manual of Medical Therapeutics, Rosenfeld, M., Editor. Little, Brown and Company. Boston, Mass. 20th Edition. 1973.
- PharmIndex, Skyline Publishing Company. Portland, Oregon. 1974.
- Physician's Desk Reference, Huff, B.B., Medical Economics Company. Oradell, N.J. 30th Edition. 1976.
- Remington's Pharmaceutical Sciences, Osol, A., Editor. Mack Publishing Company. Easton, Penn. 14th Edition. 1970.
- Sodium Content in Medicinals, San Francisco Heart Association. 1973.
- The Medical Letter Handbook of Antimicrobial Therapy, The Medical Letter Inc. New Rochelle, N.Y. January 1974.

The Pharmacological Basis of Therapeutics, Goodman, Louis and Alfred Gilman. The MacMillan Co. New York, N.Y. 1970.

The texts listed were all available in the hospital pharmacy; however, the current clinical literature had to be obtained from an outside source (in most cases). The Drug Information Service at Oregon State University was called upon for copies of specific articles from journals that were not available at the hospital. When completed, there were over 55 articles concerning drug-drug and drug-laboratory test interactions. These articles, with the various texts outlined previously, provided the needed information for the interactions in the data base. These interactions were all classified as clinically significant according to Drug Interactions by Phillip Hansten (page 38). This source was used to determine which of the thousands of interactions reported in the literature should be included in this system.

The journal articles were numbered consecutively and filed accordingly. A cross index according to the drug or laboratory test was designed to permit rapid retrieval of these articles for review. This documentation was necessary to provide specific articles to physicians if requested.

#### Collection of Computer Data

The method of collecting the baseline or control data has been described previously. For the second part of the study the computer output information was collected, as well as the baseline telephone data. Collection was accomplished by saving the printouts from each computer run. Copies of the narcotic renewal or physician consultation forms were

made before the forms were sent to the individual nursing stations.

The information was put in various categories for daily analysis which included:

- (1) a control group consisting of the number of changes in physician orders initiated by the pharmacy before the computer system;
- (2) a control group consisting of the number of changes in physician orders initiated by the pharmacy concurrent with but independent of the computer system;
- (3) a control group consisting of the number of dosage scheduling changes initiated by the pharmacy before the computer system;
- (4) a group consisting of the number of dosage scheduling changes initiated by the pharmacy concurrent with but independent of the computer system;
- (5) sample data consisting of the number of drug-drug interactions printed out;
- (6) sample data consisting of the number of drug-drug interactions that were acted upon;
- (7) sample data consisting of the number of drug-laboratory test interactions printed out;
- (8) sample data consisting of the number of drug-laboratory test interactions acted upon;
- (9) sample data consisting of the number of drug-dietary interactions printed out;
- (10) sample data consisting of the number of drug-dietary interactions acted upon;

- (11) sample data consisting of the number of drug-allergy interactions printed out;
- (12) sample data consisting of the number of drug-allergy interactions acted upon;
- (13) totals of these categories;
- (14) daily averages of these categories;
- (15) standard deviations of these categories.

The data are summarized for analysis in Tables I and II.

## RESULTS

Summary of the Data

The data for the two study periods appear in Tables I and II. In the census column appear the actual hospital census for each of the days included in the study. The baseline or telephone data include the number of physician order changes initiated by the pharmacy (# of PHYS CHNG) and the number of drug scheduling changes initiated by the pharmacy (# OF SCHED CHNG) for each day of the study. This baseline information appears in both tables for the two study periods.

The other column headings are described as follows: the number of drug-drug interactions printed (# OF DRUG PRNT); the number of drug-drug interactions printed that led to order changes (# OF DRUG USED); the number of drug-laboratory test interactions printed (# OF LAB PRNT); the number of drug-laboratory test interactions printed that were sent as notifications to the physicians (# OF LAB USED); the number of drug-dietary interactions printed (# OF DIET PRNT); the number of drug-dietary interactions printed that led to order changes (# OF DIET USED); the number of drug-allergy interactions printed (# OF ALRG PRNT); the number of drug-allergy interactions printed that were acted upon (# OF ALRG USED); the number of Schedule II drug order changes (# OF SCHED 2 RNW); and the total number of changes recorded, not including drug-laboratory test interaction notifications (# OF TOTAL CHNGS).

Included are totals of each column, in addition to the data for each day, the average per day and the standard deviations for each column.

Tabulation of Data

TABLE I  
FIRST STUDY PERIOD  
BASELINE OR CONTROL DATA

TELEPHONE  
BASELINE

DATE: February 19, 1976-March 20, 1976

DATE	CENSUS	# OF PHYS CHNG	# OF SCHD CHNG	# OF DRUG PRNT	# OF DRUG USED	# OF LAB PRNT	# OF LAB USED	# OF DIET PRNT	# OF DIET USED	# OF ALRG PRNT	# OF ALRG USED	# OF SCHD 2RNW	# OF TOTAL CHNG
2-19	129	3	1	0	0	0	0	0	0	0	0	0	4
2-20	117	2	0	0	0	0	0	0	0	0	0	0	2
2-21	104	1	0	0	0	0	0	0	0	0	0	0	1
2-22	111	2	0	0	0	0	0	0	0	0	0	0	2
2-23	114	6	0	0	0	0	0	0	0	0	0	0	6
2-24	112	2	0	0	0	0	0	0	0	0	0	0	2
2-25	105	3	1	0	0	0	0	0	0	0	0	0	4
2-26	98	1	3	0	0	0	0	0	0	0	0	0	4
2-27	91	0	2	0	0	0	0	0	0	0	0	0	2
2-28	94	1	1	0	0	0	0	0	0	0	0	0	2
2-29	95	3	1	0	0	0	0	0	0	0	0	0	4
3-1	104	2	2	0	0	0	0	0	0	0	0	0	4
3-2	107	5	2	0	0	0	0	0	1	0	0	0	8
3-3	103	3	0	0	0	0	0	0	0	0	0	0	3
3-4	119	3	4	0	0	0	0	0	0	0	0	0	7
3-5	127	0	0	0	0	0	0	0	0	0	0	0	0
3-6	115	1	3	0	0	0	0	0	0	0	0	0	4
3-7	117	1	3	0	0	0	0	0	0	0	0	0	4
3-8	130	4	2	0	0	0	0	0	0	0	0	0	6
3-9	127	3	5	0	0	0	0	0	0	0	0	0	8
3-10	126	2	1	0	0	0	0	0	0	0	0	0	3
3-11	129	0	1	0	0	0	0	0	0	0	0	0	1
3-12	118	2	0	0	0	0	0	0	0	0	0	0	2
3-13	103	2	0	0	0	0	0	0	0	0	0	0	2
3-14	107	2	0	0	0	0	0	0	0	0	0	0	2
3-15	123	2	5	0	0	0	0	0	0	0	0	0	7
3-16	120	1	1	0	0	0	0	0	0	0	0	0	2
3-17	134	2	0	0	0	0	0	0	0	0	0	0	2
3-18	139	2	1	0	0	0	0	0	0	0	0	0	3
3-19	122	0	2	0	0	0	0	0	0	0	0	0	2
3-20	121	1	1	0	0	0	0	0	0	0	0	0	2
TOTAL	3561	62	42	0	0	0	0	0	1	0	0	0	105
AVE./DAY	114.87	2	1.35	0	0	0	0	0	0.03	0	0	0	3.39
STD. DEV.	12.46	1.39	1.47	0	0	0	0	0	0.18	0	0	0	2.09

TABLE II  
SECOND STUDY PERIOD  
BASELINE AND CONCURRENT COMPUTER DATA

TELEPHONE  
BASELINE

DATE: July 20, 1976-August 5, 1976  
August 7, 1976-August 20, 1976

DATE	OENSUS	# OF PHYS CHNG	# OF SCHD CHNG	# OF DRUG FRNT	# OF DRUG USED	# OF LAB FRNT	# OF LAB USED	# OF DIET FRNT	# OF DIET USED	# OF ALRG FRNT	# OF ALRG USED	# OF SCHD 2RNW	# OF TOTAL CHNGS
7-20	125	1	3	8	0	0	0	4	1	1	1	0	6
7-21	126	2	2	7	1	0	0	0	0	0	0	0	5
7-22	124	0	0	0	0	0	0	0	0	0	0	0	0
7-23	106	3	3	3	0	0	0	0	0	0	0	0	6
7-24	95	0	0	7	0	0	0	1	0	0	0	0	0
7-25	110	2	0	0	0	0	0	0	0	0	0	0	2
7-26	112	0	2	7	0	0	0	0	0	0	0	0	2
7-27	113	6	2	0	0	0	0	0	0	0	0	0	8
7-28	110	0	1	0	0	0	0	0	0	0	0	12	13
7-29	115	0	1	0	0	0	0	0	0	0	0	6	7
7-30	106	3	0	4	0	0	0	1	0	0	0	0	3
7-31	92	1	2	0	0	0	0	0	0	0	0	0	3
8-1	89	1	2	0	0	0	0	0	0	0	0	13	16
8-2	93	1	0	0	0	0	0	1	0	0	0	10	11
8-3	98	0	0	0	0	0	0	0	0	0	0	0	0
8-4	87	2	1	0	0	0	0	0	0	0	0	0	3
*8-5	87	0	0	0	0	0	0	0	0	0	0	0	0
8-7	86	0	2	2	0	0	0	0	0	0	0	0	2
8-8	96	0	2	0	0	0	0	0	0	0	0	0	2
8-9	98	1	1	0	0	0	0	0	0	0	0	10	12
8-10	100	1	0	6	0	0	0	1	1	0	0	12	14
8-11	90	3	0	2	0	0	0	0	0	0	0	12	15
8-12	97	2	0	2	0	1	1	0	0	0	0	4	6
8-13	99	0	0	2	0	2	2	2	2	0	0	4	6
8-14	96	2	0	1	0	0	0	0	0	0	0	0	2
8-15	94	0	0	0	0	0	0	0	0	0	0	2	2
8-16	98	1	0	1	0	0	0	0	0	0	0	0	1
8-17	99	1	1	0	0	0	0	0	0	0	0	0	2
8-18	108	1	0	0	0	0	0	0	0	0	0	3	4
8-19	112	2	2	0	0	0	0	0	0	0	0	21	25
8-20	105	2	1	2	0	0	0	2	1	0	0	15	19
TOTAL	3166	38	28	54	1	3	3	12	5	1	1	124	197
AVE./DAY	102.13	1.23	0.90	1.74	0.03	0.10	0.10	0.39	0.16	0.03	0.03	4.0	6.35
STD. DEV.	11.20	1.33	1.01	2.58	0.18	0.40	0.40	0.88	0.45	0.18	0.18	5.92	6.32

## DISCUSSION

Review of Data

Some general observations of the Tabulation of Data include the following:

- (1) the hospital census was higher for the initial period of the study, than for the second period;
- (2) for the first period there was only one problem identified by a pharmacist in the areas that the computer would monitor in the second period;
- (3) the number of Schedule II drug order changes was by far the largest of any order change recorded in the second period;
- (4) the number of physician order changes and scheduling changes from the baseline data was larger per day during the first period (3.35) than the second (2.13);
- (5) there were more interactions printed by the computer than were actually used, due to determining the clinical significance of the problem by the pharmacist;
- (6) the study periods were both 31 days in length, however, the second study period was not consecutive days since one day's data was not collected due to a malfunction of the tape recording system (August 6, 1976) and
- (7) the laboratory test interactions were not included as changes made since they were supplied as points of information only.

These observations are of importance when making conclusions about the effectiveness of the study.

### Statistical Analysis

The evaluation of the data that was obtained before and after the automated system was initiated as follows:

- (1) the computer aided patient profile review system will be considered effective if a statistically significant increase ( $\alpha = 0.05$ ) in the number of pharmacy-physician and/or pharmacy-nurse consultations which result in scheduling or order changes;
- (2) if there is no change, or a statistically significant decrease in the number of consultations ( $\alpha = 0.05$ ), then the system will be considered ineffective.

The statistical analysis for the data presented was completed by using the Statistical Interactive Programming Systems version 4.1, (acronym SIPS), computer program, available through the Computer Center, Oregon State University. ( 9)

The data presented previously was categorized as follows: The total number of scheduling and physician's orders changed for each day of the two periods of study (CHNGS); the census for each of the days in the two test periods (CENSUS); and study periods (BFRAFT).

Using the SIPS computer program, linear regression analysis was applied to the data to determine the significance of computer aided profile review. The number of total changes, CHNGS, was considered the dependent variable, while CENSUS and BFRAFT were the independent variables.

The BFRAFT variable was entered as an indicator variable to distinguish between the two periods of the study. The CENSUS variable was the first to be applied to the regression analysis. By entering it first, any effect that the fluctuating hospital census may have had on the outcome of the data, will be eliminated when the BFRAFT variable is added. Addition of the BFRAFT variable, with the effects of the census held constant, appears in Figure 9. A normal plot of the dependent variable (CHNGS) indicated that it was not normally distributed. Therefore, a transformation was performed to make a more normally distributed relationship so that linear regression can be used. The dependent variable was transformed to the square root of CHNGS plus one. This dependent variable (SQRTCHNG) was then applied to the analysis in the same manner as before leaving the other variables the same. The addition of the BFRAFT variable, with the effects of the census held constant appears in Figure 10. The normal plot of this relationship showed a straight line passing through the origin which indicated the transformation was normally distributed. This data was then used to find the significance of the regression.

A "student's t" or "t" test was applied to determine if there was a significant difference in the number of order changes between the two periods of study. The significance of the BFRAFT coefficient at the  $\alpha=0.05$  level is determined by testing the null hypothesis  $H_0: \beta_{\text{BFRAFT}}=0$  with the alternative hypothesis  $H_a: \beta_{\text{BFRAFT}} \neq 0$ . The calculated "t" value, 2.374, was larger than the critical "t" value of 2.001 for  $\alpha=0.05$  and 59 degrees of freedom. The null hypothesis  $H_0: \beta_{\text{BFRAFT}}=0$  which implies that the BFRAFT variable has no relation to the number of order changes (CHNGS), can therefore, be rejected in favor of the alternative

$H_a: \beta_{\text{BFRAFT}} \neq 0$ , at the  $\alpha=0.05$  level. The alternative hypothesis which was accepted implies that there is a significant difference in the number of order changes at the  $\alpha=0.05$  level. Since the coefficient for the BFRAFT variable is positive (+0.156), the significant change observed is an increase in the number of order changes.

Figure 9.

```

CHNGS = 4.9871E+00
:ADD,1,F
CHNGS = .8.6213E+00          -3.4417E-02 CENSUS
ENTERING F VALUE:          .5249
DEGREES OF FREEDOM:      1 , 60
:AVTABLE

```

ANALYSIS OF VARIANCE TABLE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
TOTAL	61	1.49420968E 03	2.44952406E 01
REGRESSION	1	1.29579363E 01	1.29578363E 01
RESIDUAL	60	1.48125184E 03	2.46975307E 01

R SQUARED = .00867203

```

:RCOEFS,T
VAR          S.E. OF REGR. COEF.          T
CONSTANT     5.19278452E 00              1.66024489E 00
CENSUS       4.75050840E-02              -7.24481697E-01
:ADD,4,F

```

```

CHNGS = 2.3530E-01          +2.7157E-02 CENSUS
        +3.4105E+00 BFRAFT
ENTERING F VALUE:          6.1011
DEGREES OF FREEDOM:      1 , 59
:AVTABLE

```

ANALYSIS OF VARIANCE TABLE

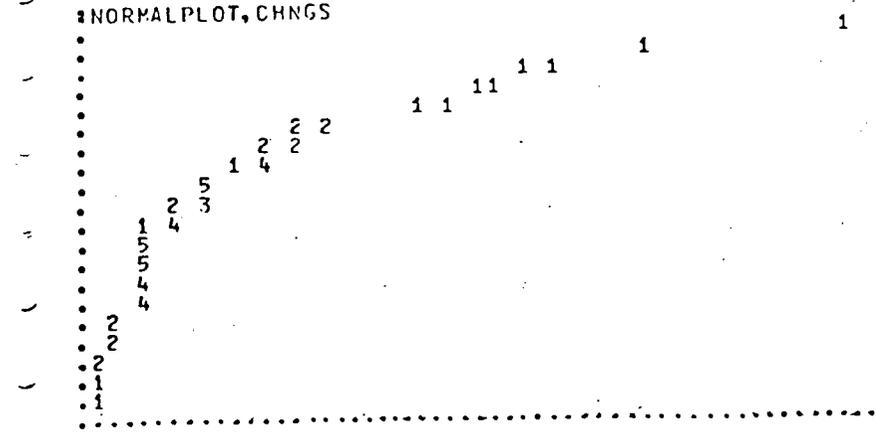
SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
TOTAL	61	1.49420968E 03	2.44952406E 01
REGRESSION	2	1.51776445E 02	7.58882223E 01
RESIDUAL	59	1.34243323E 03	2.27531056E 01

R SQUARED = .10157640

```

:RCOEFS,T
VAR          S.E. OF REGR. COEF.          T
CONSTANT     6.03148115E 00              3.90113157E-02
CENSUS       5.19741952E-02              5.22507924E-01
BFRAFT       1.38076783E 00              2.47003724E 00

```





Evaluation

The results of the statistical analysis showed that there was a statistically significant increase ( $\alpha=0.05$ ) in the number of pharmacy-physician and/or pharmacy-nurse consultations, which resulted in scheduling or order changes. This leads to the conclusion that the Computer Aided Profile Review System developed in a community hospital is considered effective.

## SUMMARY AND CONCLUSIONS

A 140 bed community hospital was the setting where the development and evaluation of a computer aided patient profile review system took place. This clinically oriented system involved the review of patient's drug regimen, diet, allergies, and laboratory tests for well documented contraindications of interactions. The pharmacist was involved in monitoring the potential problems that the computer system located, and would determine their validity and act accordingly by notifying other professional staff of the problems.

The goal of this study was to determine the effectiveness of the computer aided system in a community hospital. The study was designed to compare the impact the pharmacists had on changes in patient's orders before the computerized system was begun, with the changes initiated by the pharmacists afterwards. Statistical analysis of the data collected showed that there was a significant increase in the number of pharmacy initiated order and scheduling changes after the computer aided system was initiated ( $\alpha=0.05$ ).

Data in tables I and II show the comparison between the two study periods. The values in table II show the increase in order changes due to the computerized system. The Schedule II renewal or discontinuation alerts initiated by the computer system had the largest influence on the effectiveness of the system. For this specific area of drug regimen review, the computerized system was very effective.

The drug-drug, drug-laboratory test, drug-diet and drug-allergy alerts totaled 70 different printouts in 31 days, an average of 2.26. These potential problems had to be scrutinized by the pharmacist and proper action was taken if the problem seemed valid. Only seven of these alerts were eventually used to make order changes. Three additional alerts were drug-laboratory test interactions which were provided to the physician as points of information. These alerts were not a numerically large part of the total changes, however, in terms of patient monitoring each alert used was important.

An increase in the length of time for the study periods and number of patients involved may show a more significant number of the order changes or notifications concerning drug-drug, drug-laboratory test, drug-diet and drug-allergy interactions.

By using this broad view of the patient's clinical picture, a more successful monitoring system can be developed. The larger the amount of data collected for each patient being monitored the greater the potential for locating problems in patient care.

The system described in this paper was developed to monitor a patient's drug regimen, diet, laboratory tests and allergies for potential problems. It was shown that within a community hospital, this computer aided monitoring system did create a significant increase in the number of order changes that occurred. It is hoped that this study may be of value to other community hospitals that may be considering such a system.

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## APPENDICES

APPENDIX A  
BAY AREA HOSPITAL

PHYSICIAN-PHARMACIST  
WORK SHEET

PHARMACIST

PHYSICIAN

PHARMACIST	PHYSICIAN

APPENDIX B

PROPOSAL FOR AN INTEGRATED  
COMPUTER AIDED PATIENT PROFILE  
REVIEW SYSTEM

TIM EVANS, R. PH. PHARMACY RESIDENT  
PHARMACY SERVICES  
BAY AREA HOSPITAL

## OBJECTIVES:

My objective is to initiate a system in the pharmacy to integrate our medication profiles, diet list, diagnosis, allergies, and laboratory tests, for the patients in the hospital. This will enable us to collect information on potential drug-drug interactions, drug-allergy reactions, contraindicated drugs with a certain diagnosis, influence of drugs on restricted diets, influence of drugs on specific laboratory tests, and to increase the control of drugs within the hospital.

I have gathered the information needed to accomplish this, and it is readily available to us at this time. However, it is not within our manpower capability to search manually through this information to detect these problems. This type of ongoing information must be gathered on a daily basis and evaluated daily, to make it meaningful. This problem can be solved by the application of a specific computerized system for storage and retrieval of this data.

With this daily profile review, any problems that are detected will be acted upon by either initiating a change in the pharmacy, or consulting with a physician or nurse to make a change. The result may improve patient care by addition of a badly needed integrated monitoring system.

## METHODS:

The method suggested to implement this system would be an on-line teletype with a paper type data set. This would be tied into the OS-3 computer at Oregon State University. Using this on-line system, daily updating of information could be fed in from the pharmacy, and with no delay, a printout of potential problems would be received.

With this teletype-paper tape data set, information could be gathered all day and entered at one time in the evening when telephone rates are cheaper.

Using a patient's medical record number as identification, the code numbers for drugs, diet, lab tests, allergies, and diagnosis, would be entered, searched for problems and printed out. This would be updated daily until the patient is discharged.

I am familiar with the computer at Oregon State University and feel that the program I write can be tailored to our specific needs quite easily. In addition, there would be no programming cost, an otherwise extremely expensive part of a computerized system.

## COST:

At this time rental of equipment seems the most logical step while the system is being evaluated.

Rental from Northwest General Telephone of needed equipment would involve the following costs:

	Monthly Rate	Installation
33 ASR Teletype with Data Set, Friction Freed	\$60.00	\$75.00
1 Cut Off Key (to adapt to present phone)	1.50	6.50
<hr/>		
Total cost of rental for three month evaluation:		\$266.00

Other costs:

Cost of phone call for transmission	\$1.00/day or less (estimated)
Cost of computer time on OS-3	-0- (Grant from O.S.U. Computer Center)
Cost of program	-0-

TOTAL COST FOR SYSTEM:

( Over a three month evaluation period )

\$356.00 or less

\$3.95/day (approx.)

Date of installation is within 30 days of order.

## EQUIPMENT ALTERNATIVE:

This system is available through Western Union. It consists of the same equipment as through the General Telephone Company (i.e., Model 33 ASR Teletype with Data Set tape printer), however, it will include a direct TWXT line to other teletype systems in the state, giving us an information source not now available in the area. The most notable asset is that the University of Oregon Health Sciences Center would be on-line and they have a direct line to MEDLINE, the national medical library service. This alone would be of great benefit for medical information, if put to regular use. In addition, the teletype would be available to communicate with the computer at O.S.U. as with the other system. This would also be available within 10 to 14 days of order which would increase the evaluation period, as compared to the 30 day delivery from GTE.

## COST:

	Monthly Rate	Installation
Model 33 ASR Teletype and TWXT line	\$95.00	\$100.00
Data Set	8.00	
Cost of phone call for transmission (estimated)	30.00	
<hr/>		
Total cost of rental for three month evaluation:		<u>\$499.00</u>
		<u>\$5.54/day</u> (approx.)

I feel that this system with its greater capability for information retrieval through the TWXT line, as well as the on-line connection with Oregon State University would be a much more valuable set-up for the pharmacy. In addition, the delivery time makes it more desirable.

## EVALUATION:

I will be evaluating the effect of this system as part of a Master of Science thesis. I am currently compiling data on the pharmacy monitoring system as it now exists and the type and amount of information we are presently providing to the hospital staff. In addition, data on patient medication changes, initiated by the pharmacy, resulting in consultations with physicians or nurses is also being collected.

This study would be continued when the new system is initiated, and a comparison would then be made of data collected before and after its incorporation. This evaluation would be continued until my Residency is completed on June 30, 1976, approximately  $2\frac{1}{2}$  months.

Once set up, this system should be able to be maintained by the pharmacy staff with a minimal amount of inservice. It could then be kept as an integral part of the pharmacy function if it is proven to be worthwhile. An increase in cost may arise if the computer time supplied by the School of Pharmacy is cut off after I have finished my Residency at Bay Area Hospital. This cost could be better estimated once the amount of computer time used is determined.

I feel that this computer aided profile review system will serve a very valuable function in the area of patient care, which would greatly outweigh the minimal cost that is incurred. This system and the changes it brings about would be very consistent with Bay Area Hospital's goal of the best possible patient care.

APPENDIX C

PHARMACY:

1. The Pharmacy recently initiated a new procedure regarding notification to them regarding a patient's allergies. On admission of a patient the person noting the orders should complete the following form:

PHARMACY DEPT. ALLERGY  
NOTIFICATION FORM

PATIENT \_\_\_\_\_

FLOOR \_\_\_\_\_

ROOM \_\_\_\_\_

ALLERGIES \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

FOR NEW ADMITS, PLEASE FILL  
OUT AND PLACE IN COURIER  
BOX TO BE RETURNED TO PHARM-  
ACY.      THANK-YOU

If the patient has no allergies, write NONE. If the patient has allergies, identify on the form, e.g. Codiene, Penicillin.

Additional forms can be obtained from Pharmacy.





## APPENDIX F

FIN, \*NARCALPH

## LIST

(001): ANILERIDINE.TAB, ANILERIDINE.INJ, CODEINE.INJ, CODEINE.TAB,  
(002): HYDROMORPHONE.TUREX, HYDROMORPHONE.TAB, MEPERGAN.FORTIS, MEPERGAN.I  
NJ,  
(003): MEPERIDINE.INJ, MEPERIDINE.TAB, MORPHINE, OXYMORPHONE, PANTOPON,  
(004): PERCODAN, METHAQUALONE, PENTOBARBITAL.CAP, PENTOBARBITAL.INJ,  
(005): SECORARBITAL.CAP, SECORARBITAL.INJ, TUNAL.CAP

3

## APPENDIX G

\*\*\*\*\*

MARCH 18, 1977 12:13:46 PM TRM 100-3454 51.33

EDIT

FIN, DATA

LIST

(001):7610,5635,.64,0,9800,0.50,.62,.84,9773,0,7790,5703.80,5735.80,  
 ( )  
 (002):0,.64,7610,6825.70,.68,7511,0,.82,.62,6160,0,6160,.82,.84,5240,  
 (003):6320,6741,7287,6585,6590,6595,6575.66,.86,7381.62,0,6140,.82,  
 (004):.84,5240,6320,6741,7287.76,6585,6590,6595,6575.66,.86,7381.62,  
 (005):0,.88,6325.76,0,5226,.58,0,5439.78,.58,.66,0,5540,7640,6075,0,  
 (006):5530,7640,6075,0,5601,7640,6075,0,.62,9800,.68,6140,6595,6575,  
 (007):6270,72,0,5703.80,7790,0,7670.80,  
 (008):7530,7540,0,43001,.50,.60,0,.84,9800,6160,6140,.84,.50,.70,0,  
 (009):43002,9640,7526,7475.42,0,6317,9855,0,5490.72,7650,7640,5530,0.,  
 7  
 2,5530,  
 (010):0,5240,6160,6140,0,7625,.58,0,6320,6160,6140,0,.56,7640,7650,  
 (011):0,43003,.70,  
 (012):6384,6389,5450.78,.78,6345.76,9760,5636,9640,.68,0,43004,9680,  
 (013):9606,9734,9757,9760,0,.58,5226,5439.78,7625.76,7640,7650,.74,0,  
 ( )  
 (014):6741,6160,9773,6140,5611,0,9773,9800,6741,0,8073.42,6075,0,5915,  
 (015):.68,0,7640,5540,5530,5601,9125,5525,.56,.58,5490.72,.72,0,7650,  
 ( )  
 (016):5490.72,.72,.56,.58,0,7287,6160,6140,0,6325.76,.88,7315,0,43005,  
 (017):9680,9606,9734,9757,9760,0,7439,9680,9606,9734,9760,9757,.72,726  
 4,  
 (018):5650,0,7725,7530,7540,0,6585,6160,6140,0,5611,6741,0,8290,5545,  
 (019):5510,0,9760,9634,9734,9731,9733,9757,0,5545,8290,0,6655.50,.68,  
 ( )  
 (020):0,5636,7610,0,5740.80,.86,0,.76,7315,0,.68,.64,.62,5915,5995,  
 (021):.50,6010,9510,5102,5110,5115.10,0,5995,.68,0,.86,6160,6140,7795,  
 (022):0,7511,.64,0,7510,.64,0,5420,7640,6075,0,6075,8073,0,.78,.66,  
 (023):6420,0,.74,.58,0,8855,6317,0,7381.62,6160,0,43010,9680,6345.76,  
 (024):9760,.74,5755,5760,5722,0,43011,6389,6384,6455.36,6604.16,9760,  
 ( )  
 (025):.86,.70,.68,6689.5,6790.88,0,5735.80,7790,0,6420,5450.78,.78,0,  
 (026):0.50,.68,0,9125,7640,6075,0,6590,6160,6140,0,6595,.62,6160,6140,  
 (027):0,6595,.62,6160,6140,0,6575.66,.62,6160,6140,0,7795,.86,0,6270.7  
 6,  
 (028):.62,0,8780.62,9800,6140,6160,0,6010,.68,0,5557,6075,0,9634,9760,  
 0  
 ,  
 (029):9757,9760,0,9734,9760,0,6295,6075,0

J

\*OFF

COST \$0.36

CPU TIME SEC. 2.7

STBLKS 5

WC TIME MIN. 4.1

## APPENDIX H

EDIT

FIN, \*MONITOR

LIST

m001:1,5,11,15,21,25,39,53,56,59,63,67,71,75,83,86,90,94,102,107,110,  
m002:115,118,122,125,129,133,145,152,160,166,170,173,176,187,193,197,  
m003:201,208,218,222,226,229,233,240,243,246,249,252,255,267,270,275,  
m004:278,281,285,288,292,295,298,301,310,322,325,329,332,336,340,345,  
m005:350,355,358,361,366,369,372,375,378,381

J

## APPENDIX I

FIN,\*NURSTA

LISF

(001):ICU,3AN,2AS,3AS,2AN,3BN,2BS,2BN,NSY

]



6630	Fentanyl 2cc (Sublimaze)
6630	Fentanyl 5cc
6121	Ferrancee Tablet
6122	Ferrancee HP Tab
6105	Ferrous Gluconate 320 mg Tablet
6105	Ferrous Gluconate Syrup 300 mg/5cc
6123	Ferro-Sequels
6110	Ferrous Sulfate 325 mg 5 gr. Tablet
6110	Ferrous Sulfate Spns. 325 mg T
6110	Ferrous Sulfate 325 mg/5cc Liquid
6110	Ferrous Sulfate Ped Drops 15cc
6095	Fibrinogen Human 1 gm Inj.
6520	Fiorinal Tablet
6520	Fiorinal Capsule
9560	Flavoxate 100 mg Tablet
-8355	Fleet Enema 4 1/2 oz.
-8360	Fleet Enema 2 1/2 oz.
8588	Fludrocortisone 0.1 mg (Florinef)
9251	Fluocinolone Oint. 0.025% 15 gm
9251	Fluocinolone Soln. 0.01% 20cc
9251	Fluocinolone Oint. 0.025% 60 gm
9251	Fluocinolone Cr. .025% 15 gm
9251	Fluocinolone Cream 0.01% 60 gm

## APPENDIX L

MEMO

7/12/76

TO: Joseph M. Henke, M.D., Chairman, Dept. of Medicine  
FROM: Ronald W. Coberly, Director of Pharmacy  
SUBJECT: Proposed Research Study with Dept. of Medicine on  
Medication Related Problems.

The Pharmacy Department has been looking for improved methods to collate and review patient medication information for possible problems to assist the medical staff. Tim Evans, Pharmacy Resident, as a research project has developed a computer program in an attempt to accomplish this end. The computer program has the capability to review medication orders for a limited number of the following problems:

- 1) Point out possible influence of one medication on the effect of another medication.
- 2) Point out medication which the patient has "a stated allergy to".
- 3) Point out medications which might effect low sodium diet or calorie restriction.
- 4) Point out laboratory tests ordered which might be influenced by a medication ordered.

The program was written including only a limited number of problems in each one of these areas. (As a beginning approach.) The computer time being used is at Oregon State University, with a rented General Telephone terminal in the pharmacy. The input is on paper tape in a batch manner, one or two times daily.

I am requesting the members of the department of medicine to participate in a cooperative effort with the pharmacy to evaluate the usefulness of this approach by permitting its use on a trial basis on JAN and

later JAS medical patients. Any physician who would not desire to participate could do so by simply indicating this.

The actual method of operation would be to collate the input information in the pharmacy department, run the orders through the program probably two times daily, and output furnish information to the physician on a temporary sheet placed in the chart called "Physician-Pharmacist Work Sheet". This would be a nonpermanent part of the medical record, but would furnish a formal mechanism to make this information available, and for physician response if so desired. (See attached sheet). This form would be merely a work sheet similar to that used in medical school environments for communication between medical residents and interns. The information will also be presented in a standard format (see attachment II) to ensure that everyone understands that the information requires clinical assessment to determine significance and is for use as an educational tool only.

Interested physicians could get additional information about a specific problem by requesting the information on the form from the pharmacy. The physicians could also make suggestions about additions or deletions of information, and furnish assistance in improving the information available from their clinical experience. Hopefully, a better working relationship would be created between the physicians and pharmacists through this study.

I have presented basic information about this study to the Patient Care Committee, Staff Education Committee, and Medical Staff Executive Committee, who approved the use of the communication form on a trial basis as part of this study. I would like to actually implement the

program, which is presently operational, on Tuesday, July 20th, with your approval and the other physician's in the Department of Medicine.

RC/ds

cc: Joseph Morgan, M.D., Chief of Staff

Edwin Quinn, M.D., Chairman of Staff Education Committee

Jack Shiningher, M.D., Chairman, Patient Care Committee

Jon Mitchell, Administrator

Lucile Wood, Director of Nursing

Tim Evans, Pharmacy Resident

Dorothy Donnelly, Medical Record Librarian

ATE

PHARMACIST

PHYSICIAN

	PHARMACIST	PHYSICIAN

## ATTACHMENT II

Dr. \_\_\_\_\_  
 Patient \_\_\_\_\_ Nursing Unit \_\_\_\_\_

has reported an allergy to \_\_\_\_\_.  
 If valid, this may present a potential problem while receiving \_\_\_\_\_, which contains this medication or one similar in structure and activity. One alternative might be \_\_\_\_\_.

\_\_\_\_\_ R.Ph. Date \_\_\_\_\_

(The above information is furnished as part of a research project in which your assistance is requested.)

Dr. \_\_\_\_\_  
 Patient \_\_\_\_\_ Nursing Unit \_\_\_\_\_

is on a restricted sodium diet of \_\_\_\_\_ mg. \_\_\_\_\_, which contains \_\_\_\_\_ mg per dose (up to \_\_\_\_\_ mg per 24 hour period), may lead to a higher sodium intake than desired. An alternative medication might be \_\_\_\_\_, which contains \_\_\_\_\_ mg per \_\_\_\_\_ dose.

\_\_\_\_\_ R.Ph. Date \_\_\_\_\_

(The above information is furnished as part of a research study in which your assistance is requested.)

Dr. \_\_\_\_\_  
 Patient \_\_\_\_\_ Nursing Unit \_\_\_\_\_  
 has been receiving \_\_\_\_\_  
 medication & dosage interval

and \_\_\_\_\_, which  
 medication name & dosage interval  
 may represent a potential interaction. The combination may decrease the activity of \_\_\_\_\_, resulting in a decreased therapeutic effect. Literature documentation can be obtained from the pharmacy.

\_\_\_\_\_ R.Ph. Date \_\_\_\_\_

(The above information is furnished as part of a research project in which your assistance is requested.)

Dr. \_\_\_\_\_  
 Patient \_\_\_\_\_ Nursing Unit \_\_\_\_\_

The \_\_\_\_\_ laboratory  
 test results may be \_\_\_\_\_  
 (increased or decreased)  
 from the \_\_\_\_\_ the  
 (medication)

patient is receiving. This possible alteration might be useful in evaluating the results of this test. Additional information can be obtained from the pharmacy dept.

\_\_\_\_\_ R.Ph. Date \_\_\_\_\_

(The above information is furnished as part of a research project in which your assistance is requested.)

Dr. \_\_\_\_\_  
Patient \_\_\_\_\_ Nursing Unit \_\_\_\_\_  
is on a restricted calorie diet of \_\_\_\_\_  
calories. \_\_\_\_\_, which con-  
tains \_\_\_\_\_ calories per dose (up to  
\_\_\_\_\_ calories per 24 hour period), may  
lead to a higher caloric intake than desired.  
An alternative medication might be  
\_\_\_\_\_, which contains \_\_\_\_\_  
calories per \_\_\_\_\_ dose.

\_\_\_\_\_ R.Ph. Date \_\_\_\_\_

(The above information is furnished as  
part of a research study in which your  
assistance is requested.)



This study is designed to determine the effectiveness of a computer aided system developed to review hospitalized patient's drug regimen, diet, allergies laboratory tests and diagnosis for selected contraindications, interactions or other problems that occur. This system will assimilate a daily update of the above information, to aid the pharmacist in searching for new problems which may arise.

The study will be a comparison of pharmacy initiated changes concerning scheduling or order changes collected before the system is initiated, with that collected afterward. This data will be obtained from tape recorded phone conversations in the pharmacy, with physicians or nursing staff. Any documentation needed will be made using:

- (1) physician's orders on the patient's chart;
- (2) the nursing MAR (medication administration record)

A written communique will be developed (pharmacist-physician worksheet) to aid in the transfer of information to physicians, when the system is initiated.

All possible attempts will be made to keep variables constant, so the computerized system itself will be the only factor causing change in the data. By comparing data before and after initiation of the system, many variables should be held constant.

Upon receiving the printed information via teletype, the pharmacist will follow up these possible problems and take appropriate action. In some cases the circumstances will dictate that nothing need be done. In other cases a consultation with other professionals must be made, and any resulting changes in scheduling or orders will be documented as part of the study.



Computer Center

Corvallis, Oregon 97331 (503) 754-2494

77

April 16, 1976

~~Dr.~~ Douglas Stennett  
Department of Pharmaceutical Science  
Oregon State University

Dear Dr. Stennett:

We have your request for computer time and are pleased to notify you of the following action by the committee on unsponsored research:

Amount of award: \$500  
Name: Douglas Stennett  
Student name: Timothy W. Evans  
Date of request: April 15, 1976  
Title of project: Computer Aided Pharmacy

You are urged to avail yourself of discount rates on computing done during second and third shift hours at the Computer Center--evenings, nights and week-ends.

As you are aware, responsibility for cancelling files and tapes upon completion of the project rests with you. Gayle, MCC 140, will be glad to issue your job number when you present this letter.

Please let us know if we may be of further assistance.

Yours very truly,

Ronald A. Davis  
Acting Director

td

cc: Dr. Roy A. Young  
Gayle Zandofsky  
~~Timothy Evans~~

Submit 2 copies

Please Print or Type

REQUEST FOR SUPPORT OF COMPUTING SERVICES FROM  
OREGON STATE UNIVERSITY COMPUTER CENTER

Name Timothy W. Evans Date July 12, 1976Department Pharmaceutical Science Faculty Member  Student Funds Requested \$ 200.

NOTE: This figure should not include data preparation such as keypunching.

Title of Project or Research Activity Development and Evaluation of a  
Computer Aided Pharmacy Profile Review System in 140-Bed Commun. Hosp.  
Brief description of computing to be done (see attached)

Approximate period for which services are requested (month/year).

From \_\_\_\_\_ To \_\_\_\_\_

Is this research otherwise funded: Yes  (Indicate source below),No 

Has the Computer Center been consulted in preparation of estimate?

Yes If yes, give name of consultant Dave NiessCurrent unsponsored research job number this grant is to be placed under, if any 758133 *Redacted for Privacy*

Signature \_\_\_\_\_

(Student)

*Redacted for Privacy*Signature /

(Major Prof)

Major Prof Dr. Douglas Stennett.  
(typed) Ms. \_\_\_\_\_

(If request is on behalf of a student, it must be signed by both student and major professor.)

-----

A brief description of the project (two copies) should accompany this request. The computational services should be outlined in sufficient detail that an estimate of computer time can be made in consultation with the Computer Center.

If the request is on behalf of a student, the nature of the student's participation relative to his academic program and to the sponsoring faculty member's research activities should be described.

Computer Center



Corvallis, Oregon 97331 (503) 754-2494

July 14, 1976

Dr. Douglass J. Stennett.  
Pharmaceutical Science  
Oregon State University

Dear Dr. Stennett:

We have your request for additional computer time, and are pleased to notify you of the following action by the committee on unsponsored research:

Amount of award: \$200.00  
Job number: 758133  
Name: Douglass Stennett  
Student name: Timothy W. Evans  
Date of request: July 12, 1976  
Title of project: Computer Aided Pharmacy

You are urged to avail yourself of discount rates on computing done during second and third shift hours at the Computer Center--evenings, nights and week-ends.

As you are aware, responsibility for cancelling files and tapes upon completion of the project rests with you. Gayle, MCC 140, will be glad to add time to your job number when you present this letter.

Please let us know if we may be of further assistance.

Yours very truly,

Thomas L. Yates  
Director

cc: Dr. John V. Byrne  
Gayle Zandofsky

✓ Timothy Evans

Submit 2 copies

Please Print or Type

REQUEST FOR SUPPORT OF COMPUTING SERVICES FROM  
OREGON STATE UNIVERSITY COMPUTER CENTER

Name Timothy W. Evans Date July 28, 1967Department Pharmacy Faculty Member \_\_\_ Student XFunds Requested \$ 200NOTE: This figure should not include data preparation such as  
keypunching.Title of Project or Research Activity Computer Aided Pharmacy--Profile  
Review SystemBrief description of computing to be done Review hospital patient's  
medication, diet, laboratory tests, allergies and diagnosis, for problems  
with drugs patients are taking.

Approximate period for which services are requested (month/year).

From Present To August 20

Is this research otherwise funded: Yes \_\_\_ (Indicate source below),

No X

Has the Computer Center been consulted in preparation of estimate?

X If yes, give name of consultant Lave WeissCurrent unsponsored research job number this grant is to be placed  
under, if any 753133Signature Redacted for PrivacyRedacted for Privacy

Signature \_\_\_\_\_

(Major Prof)

Major Prof Dr. Douglas Stennett  
(typed) Ms. \_\_\_\_\_(If request is on behalf of a student, it must be signed by both student  
and major professor.)

-----

A brief description of the project (two copies) should accompany  
this request. The computational services should be outlined in suf-  
ficient detail that an estimate of computer time can be made in con-  
sultation with the Computer Center.

If the request is on behalf of a student, the nature of the stu-  
dent's participation relative to his academic program and to the spon-  
soring faculty member's research activities should be described.

2467 Liberty  
North Bend, OR 97459  
July 23, 1967

Committee for Approval of Un-sponsored Research

Gentlemen:

I am writing to request additional money for computer time to complete my project. To run my program daily it has cost much more than originally estimated. Reasons are as follows:

- 1) I recently was granted \$200 in addition to my initial grant. However, the time delay in making that money available required me to start over in preparing a master file of patients and their medications, etc., due to turnover in the hospital. This loading of large numbers of patients required numerous runs and used a large percentage of the \$200 allotment.
- 2) The hospital census has been higher than normal for the last few months which has increased the usage considerably.
- 3) More recently, the program runs have been made during the day, to have current data ready for the physicians when they make their afternoon and evening rounds, which has increased the cost.

August 20th will be the last day of my study. This will give time for the proper data for a statistically significant project. The study needs to cover 30 consecutive days which will end 30 days (Aug. 20) after my last time delay in computer time.

The only bill I have available is for the month of June which is not really representative of the usage at this time. However, judging from previous costs this month, an additional \$200 should cover my expenses to finish by the above date.

I realize I have requested a great deal of computer time up to now. I would greatly appreciate your consideration and help once more, in letting me complete my study. If there is any other information you need, please let me know.

Thank you.

Sincerely,  
*-Redacted for Privacy*

Timothy W. Evens

Computer Center



Corvallis, Oregon 97331 (503) 754-2494

July 30, 1976

~~Prof Douglass Stennett~~  
~~Pharmacy~~  
~~Oregon State University~~

Dear Prof Stennett:

We have your request for additional computer time, and are pleased to notify you of the following action by the committee on unsponsored research:

Amount of award: \$200.00  
Job number: 758133  
Name: Douglass Stennett  
Student name: Timothy W. Evans  
Date of request: July 28, 1976  
Title of project: Computer Aided Pharmacy Profile Review System

You are urged to avail yourself of discount rates on computing done during second and third shift hours at the Computer Center--evenings, nights and week-ends.

As you are aware, responsibility for cancelling files and tapes upon completion of the project rests with you. Gayle, MCC 140, will be glad to add time to your job number when you present this letter.

Please let us know if we may be of further assistance.

Yours very truly,

Thomas L. Yates  
Director

td  
cc: Dr. John V. Byrne  
Gayle Zandofsky  
✓ T. Evans

## APPENDIX N

UPDATE CHECKLIST

DIET LIST \_\_\_\_\_

LAB TESTS \_\_\_\_\_

IV'S \_\_\_\_\_

PROFILE  
UPDATE \_\_\_\_\_