AN ABSTRACT OF THE THESIS OF

DALE G. ZELINSKY for the degree   MASTER OF SCIENCE
         JEWELL
in Pharmaceutical Science presented on ___May 5, 1975___

Title: MONITORING PATIENT PROFILES FROM THE PHARMACY -

   AN OPPORTUNITY FOR THE PHARMACIST TO CONTRIBUTE

   TO PATIENT CARE

Abstract approved: ___Redacted for privacy___
                         Freya F. Hermann

The literature clearly indicates that pharmacist monitoring of

hospital patients by use of a patient profile is needed. The literature

does not, however, describe a method of selecting the information to

be included on the profile. Since monitoring needs vary from hospital

to hospital, a method of identifying specific needs is necessary.

Therefore, this study was undertaken in three parts to develop such a

method. Part I was concerned with devising a list of the types of

information which can be monitored by the pharmacist. This list

included both patient information, such as age and weight, and thera-

peutic information, such as drug regimens and laboratory tests.

Another list was then generated of all contributions a pharmacist can

make to patient care. A contribution was defined as any action the

pharmacist can take to insure safety of the patient's drug-related

therapy and to provide for the optimal use of medications. It was then

possible to identify which types of information lead to making specific

contributions to patient care and which were non-productive. Part II

consisted of designing the A-P-C (All-Possible-Contributions) profile.

This profile contains all of the information found in part I to be useful,

enabling the pharmacist to make all of the contributions possible to

patient care. The third part was the application of the newly devised

A-P-C profile to an actual hospital pharmacy practice. The contribu-

tions to patient care which were needed were identified on the basis

of finding drug-drug interactions, adverse drug reactions, etc. occur-

ring in the sampled patients' therapy. Once the needed contributions

were identified by use of the A-P-C profile, the pharmacist was able

to know which types of information he must monitor. Any extraneous

information was then eliminated from the A-P-C profile, and a new

profile drawn up for use thereafter. In part I, seventeen types of

information were found to be useful for making the fifteen possible

contributions to patient care. Application of the A-P-C profile to the

actual hospital practice indicated that fourteen types of information

should be monitored to make possible the twelve contributions shown to

be needed. The results of the study indicate that the A-P-C profile

can be used to identify the specific monitoring requirement of a given

hospital pharmacy practice, which can lead to safer and more effective

therapy.

Monitoring Patient Profiles From the Pharmacy -
An Opportunity for the Pharmacist to
Contribute to Patient Care

by

Dale G. Zelinsky Jewell

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

June 1975

APPROVED:

Redacted for privacy

Assistant Professor of Pharmaceutical Science

Redacted for privacy

Head of Department of Pharmaceutical Science

Redacted for privacy

Dean of Graduate School

Date thesis is presented ___May 5, 1975___

Typed by Susie Kozlik for___Dale G. Zelinsky___

ACKNOWLEDGEMENTS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

MONITORING PATIENT PROFILES FROM THE PHARMACY -
AN OPPORTUNITY FOR THE PHARMACIST TO
CONTRIBUTE TO PATIENT CARE

I. INTRODUCTION

Literature Review

Beginning in the 1960's, pharmacy literature reflects a trend

toward monitoring of patient therapy by the pharmacist, both in

hospital and in community practice. Wider use of the concept of

monitoring was perhaps primarily due to the change in the role of the

pharmacist, which in turn was due to the advancement and application

to pharmacy of two types of progress, technical and therapeutic.

The growth of technology has made itself felt in the profession

of pharmacy in many ways. The availability of computers and vending

machines which threatened to replace the pharmacist, the increase in

the use of manufactured, rather than extemporaneously prepared

pharmaceuticals, and the use of technicians who could perform many

of the traditional pharmaceutical roles that were left, created for the

pharmacist both the need to adopt a new role, and the opportunity to

pursue it.

The development of the pharmacist's new role was stimulated

by the increased complexity of patient therapy and an awareness of

adverse effects of drug therapy. This suggested the need for someone

to screen for problems associated with all aspects of therapy, and

also to council the patient on the appropriate and safe administration of his often multiple medications. In order for the pharmacist to do so, a patient profile can be maintained, and numerous statements are found in the literature which support this need for patient profiles (1-7).

Two types of therapeutic problems were investigated in the 1960's and were most influential in making visible the need for monitoring therapy, and indirectly for maintaining patient profiles. These studies concerned drug-drug interactions and drug adverse reactions. Visconti, one of the first to advocate the use of a patient medication record by the pharmacist, discussed their use to detect drug-drug interactions (8). In his study, involving 685 patients, 21 drug interactions were identified. Following that, other articles were written which delt specifically with the need to identify, detect, and prevent drug-drug interactions (9-11). The need for the recognition and prevention of adverse drug reactions was also described (2). One study, conducted in 1969, reported that, of 1160 hospital patients surveyed who received drug therapy, 118 experienced what they termed "drug adverse reactions," which included responses to over-dose, excessive effects, side-effects, hypersensitivities, and idiosyncracies (12). Studies concerned with the economic impact of adverse drug reactions occurring in the hospital provided additional impetus to prevent as many as could be predicted by monitoring. One study quoted the cost

of adverse drug reactions as three billion dollars per year (13).

In 1968, a tabulation of drug-induced modifications of laboratory test values was published which called attention to the fact that such modifications must be kept in mind when interpreting laboratory data (14). This was followed by a number of additional studies which were all or partly concerned with making the same kind of contribution to patient care - the prevention of the misinterpretation of laboratory test results (15-17). Visconti, in his paper of 1969, discussed a patient who, after two months of hospitalization, was found to have an elevated PBI with no apparent explanation. The patient was there-fore scheduled to return to the hospital for further testing. This was prevented only when it was noticed on the patient's profile that he had received SSKI on several days throughout his hospitalization (8).

Later studies, conducted in the 1970's, demonstrated the need to monitor additional points of therapy. One study, citing antibiotics as being associated with a large percentage of all IV incompatibilities, pointed out the need to monitor IV admixtures (18). Another study identified dietary restrictions as an area to be monitored by the pharmacist (19). Patients on special diets, such as low sodium, low potassium, low calcium, or diabetic, were identified, and their drug therapy screened for contraindicated substances.

Another group of authors reasoned that medication errors might be identified and prevented by monitoring therapy. They had redefined

the traditional meaning of a medication error so that the term now covered irrational choice of drug or dosage form, the wrong combination of drug and diet, drug and other medication, or drug and patient characteristics (3). If the pharmacist were provided a record and routinely screened for these problems, he could be expected to detect errors and function as an additional control on the rationality of therapy. Another discussion of physician-induced medication errors cites an error rate of 13 to 18 percent in pharmacies not using patient profiles, and places hope in the chance to decrease the error rate through the use of the pharmacist-monitor (20).

Profiles currently described in the literature give the pharmacist anything from only the patient's name and the drug prescribed, to a wide variety of data related to both the patient and his therapy.

Traditionally, the types of information that the pharmacist received included only the patient's name, and the name, strength, amount, and directions corresponding to the drug or drugs that were prescribed. Almost all profiles now described in the literature provide for recording at least allergies along with the traditional information. On such profiles, pharmacists are able to check the dose, and for drug-drug interactions, duplications, and allergic reactions (9, 21-24). Some profiles record one or two additional pieces of information such as laboratory tests ordered, diagnosis, or IV fluid therapy, allowing the pharmacist to monitor for drug-laboratory test

interferences (8, 25), the appropriateness of medications (24, 26, 27, 41), and IV incompatibilities (18) respectively.

At the other end of the scale are profiles which contain a full set of patient information, and may include many of the following: age, sex, weight, race, social and familial history, past medical and drug histories, hypersensitivities, diagnosis, concurrent conditions, results of the physical exam, pregnancies, birth defects of offspring, last onset of menstrual period, chemical poisonings, and exposure to alcohol, tobacco, and industrial and agricultural chemicals. Scheduled surgical procedures, and a comprehensive listing of all diagnostic procedures and findings may also be detailed, including blood pressure, hematocrit, VDRL, chest x-ray, pap smear, tonometry, rectal and breast exams, EKG, radiological studies, bacterial cultures, sensitivity data, and biopsy and surgical reports (28-31). This allows the pharmacist to be knowledgeable of all aspects of patient therapy.

One can find many combinations of types of information being monitored. Some authors apparently include all the information available to them; others use the traditional minimum of information and see the profile just as a form more conveniently suited to dispensing. In general, with the exception of a very few cases, such as the problem-oriented type of system, where the pharmacist is involved in the choice and administration of drugs as well as the

evaluation of therapy in order to reduce the physicians' load of routine patients (30), only a description of a particular system is provided, and no attempt is made to relate the information recorded to the specific needs and goals of the practice.

As pharmacists decide to have more information available, the handling of this information becomes more critical. The literature records a number of different methods by which patient information can be handled, both for inpatients and outpatients.

One common method is the manual handling of patient records. Beginning with Visconti's time-flow profile in which he generated a graphical overview of concurrent medication patterns by recording daily doses given versus time (8), various styles and modifications have been described (32). Most often the information is simply posted by hand on one of a variety of forms of rather similar design (4, 21, 33). A manual method of monitoring IV additives alone has been described, consisting of file folders with the physician's orders taped to the left side, and on the right, copies of each label attached to the IV containers (18). The problem-oriented profile is one modification of the manual system, and involves the utilization of the patient's chart (7, 30).

A modified manual method, described for outpatient practice, makes use of a duplicate, pressure-sensitive, carbon interleaved label which is typed and placed on the profile card (34-36). The

slightly increased cost is reportedly offset by the 18.6 to 44.2 second savings in time over traditional manual methods and by the possibility of increasing patient care (35).

A third method makes use of the computer to record and retrieve information and to signal potential problems, most commonly potential allergies, drug-drug interactions, drug-laboratory test interferences, and IV incompatibilities (25, 37-39). A significant savings in time is reported, since the computerized systems eliminate the necessity for making manual transcriptions on the profile and for spotting potential therapeutic problems. The IBM mag card selectric typewriter is an example of the type of equipment used in such a system, as it records retrievable information on a magnetic card as a result of the standard label typing procedure (40). For many pharmacies, however, the monetary outlay for such equipment and maintenance may prove to be prohibitive.

The cost of monitoring therapy is a major concern regardless of the method employed. The monitoring of all patients and all possible types of information concerning those patients may not be feasible, but neither may it be desirable. One author suggests that only the high-risk patients in a hospital be monitored, thereby decreasing the expenditure of time required to monitor all patients, and concentrating the pharmacist's effort where it is most likely to be needed (29). A problem presents itself then, not whether to monitor

patients' therapy, but how to do it most efficiently and effectively.
In introducing a broadening of pharmacy service, sound justification
relating cost to benefit should be developed. What method, fully
computerized, modified manual, or manual, is to be used, depends on
availability and cost of such systems. What patient information is to
be recorded and screened by the pharmacist depends on the quality of
patient care surrounding the pharmacist's practice. For example,
if physicians are well aware of drug-drug interactions, there will be
no need for the pharmacist to monitor this. If nurses are cognizant of
the optimal administration of doses, the pharmacist need not contri-
bute in this area. Such quality of care varies from hospital to hos-
pital, and determines the need for contributions to be made by the
pharmacist.

If information is recorded and/or monitored unnecessarily, the
cost of patient care is increased but the quality is not. For each par-
ticular practice environment, the need for monitoring a type of infor-
mation should therefore be evaluated before the information is
routinely recorded and monitored. The basis for selection should not
be tradition or availability or the desire to have as much or as little
information as possible, but demonstrated need.

Purpose of the Study

This study is designed to develop a procedure for the selection of information to be included on the patient profile which is to be used in a specific hospital practice.

II. METHOD

Part I - Preliminary Study

The study consists of three parts. Part I was designed to
determine what types of contributions to patient care a pharmacist
can make, given the information on the profile sheet which he uses.
For the purpose of this study, a contribution to patient care was de-
fined as any action the pharmacist takes to insure the safety of the
patient's drug-related therapy and to provide for the optimal use of
medications.

Information was collected from a sample of three hospitals
randomly selected from all hospitals in Oregon having a patient profile
system in use. From each hospital selected, 20 profile sheets were
obtained randomly and were analyzed to determine the relationship
between the information available to the pharmacist and the theoretical
number of opportunities he has to contribute to patient care. For each
hospital, the types of information included on the profile were iden-
tified, and from this, the theoretical contributions were determined
by considering what types of information would be necessary to make
each contribution.

Part II - Development of the A-P-C Profile

Part II is concerned with the development of a patient profile

that would include all possibly useful types of information and there-
fore would facilitate all possible contributions to patient care. The

design of the profile was based on the findings of part I and the body

of knowledge contained in the literature. This All-Possible-Contribu-

tions (A-P-C) profile was designed to be used as a basic tool by which

a more specific profile can be generated for a given specific clinical

practice.

Part III - Experimental Use of the A-P-C Profile

Part III concerns the generation of the patient profile for a spe-
cific hospital practice by an experimental use of the A-P-C profile,

and an analysis of the possibilities for actual contributions to patient

care.

A fourth hospital was selected on the basis of its nearby location

and willingness to cooperate with the study. Twenty patients from the

total census of 158 were randomly chosen to be monitored. A five

percent sample is the statistically acceptable minimum for this type

of study; the number sampled was increased arbitrarily to 20 however,

because of the small population being sampled and the high inherent

variance.

Daily, each patient's new orders which arrived in the pharmacy

were entered on the profile, and all information which was called for

by the profile but not available in the pharmacy was obtained from the

appropriate personnel-i. e. nursing, laboratory, etc., and entered.

At the end of the patient's stay, the content of the profile was analyzed, and the actual contributions which could have been made were determined. Standard references were used to identify drug-drug interactions, correct doses, and appropriate use of drugs (42-50). On the basis of the findings, summarized for all profiles, a decision was made to modify the A-P-C profile so that it satisfied the needs of the practice. This new profile could then be used on a day-to-day basis.

III. RESULTS

Part I

From the tabulation of the profiles obtained from Hospital A, it can be seen that four types of information were routinely recorded for each patient (Figure 1). This allows the pharmacist to monitor information which leads to four types of contributions to patient care. By having the drug name and the dates of therapy for each drug, the pharmacist can make two contributions, a check for potential drug-drug interactions and for duplications of medications. With the third type of information, the dosage regimen, which in this study includes both the strength and frequency as well as the route of administration, he can verify the appropriateness of the dose of each drug. The fourth type of information from the profile, the administration time, allows the pharmacist to make another contribution to patient care, the insuring of optimal administration of drugs. Some drugs can be scheduled properly only when meal times are considered; however, since this information need not be recorded on the profile, it is not considered as a separate piece of information.

Although various other pieces of information were occasionally recorded, these were not counted in this study. For example, IV therapy was written in for one patient, and allergies were written in for two patients, but since there was no mechanism for recording the

Figure 1. Contributions possible in hospital A vs information
available.
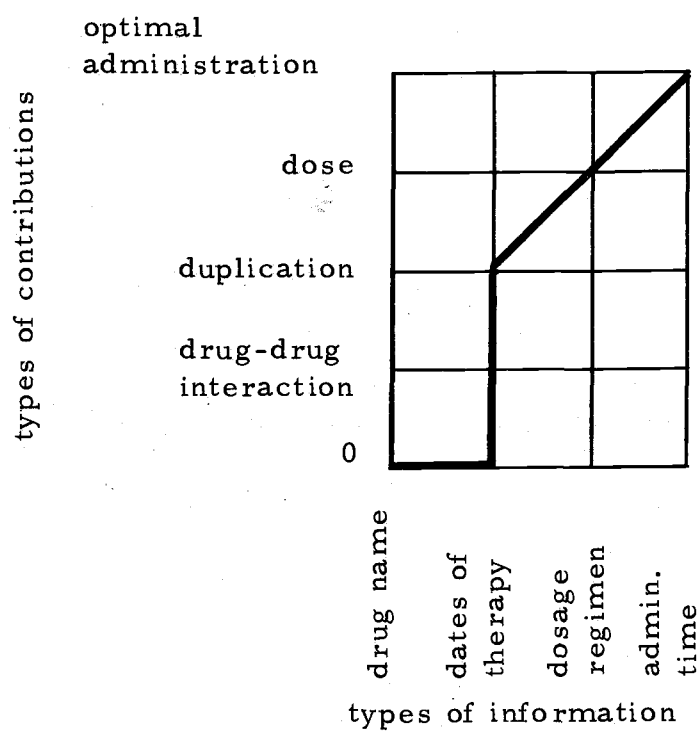
information routinely, it could not be assumed that the other patients

had no IV therapy or allergies and, therefore, these were not counted

as pieces of information.

In most cases, one can determine the patient's sex from the

name listed on the profile; however, this was not considered as a

separate piece of information contained on the profile because names

were not always found to be clear indicators of sex, the two examples

from Hospital A being Jess and Esmi.

The number of potential contributions to patient care the phar-

macist can make per patient depends on the number of drugs pre-

scribed and the number of useful types of information available about

the patient. The average number of drugs prescribed for each patient

in Hospital A was 6.8, with a range from 1 to 14. The number of

theoretical contributions per patient can be obtained by calculating

first the number of contributions arising out of potential drug-drug

interactions and out of potential duplications according to the formula,

$$\frac{\frac{n!}{(n-2)!}}{2}$$

calculated for each, a standard permutation of n objects, which, in

this case, is the number of drugs prescribed per patient, taken two at

a time and then divided by two, since the order in which the patient

receives drugs which interact or are duplications does not matter to

us. Yn is then added, where y = the number of other types of

contributions possible in the hospital. The number of potential con-

tributions ranged from 2 to 210 per patient per total stay. Of course,

the actual number of contributions would be much lower, as not every

drug would be a duplication of, or would interact with, every other

drug.

Hospital B regularly recorded two additional types of informa-

tion on their profile, the patient's age and his IV therapy, everything

else being the same as in Hospital A. By adding this additional in-

formation, two more contributions are possible, the checking of the

dose prescribed with respect to age, and the detection and prevention

of IV incompatibilities (Figure 2).

This particular hospital did have spaces on the profile in which

the diagnosis and allergic conditions could be recorded; however, in

no case were these spaces utilized, and thus neither diagnosis nor

allergic conditions were counted as pieces of information available to

the pharmacist.

The average number of drugs prescribed per patient in this

hospital was 12.6, ranging from 3 to 27.

The calculation of the number of potential contributions must

be modified when intravenous therapy is monitored because IV in-

compatibilities can occur only between the drugs given by that route,

and the contribution, optimal administration, is not applicable to the

drugs given intravenously. Duplications, drug-drug interactions,

Figure 2. Contributions possible in Hospital B vs information
          available.
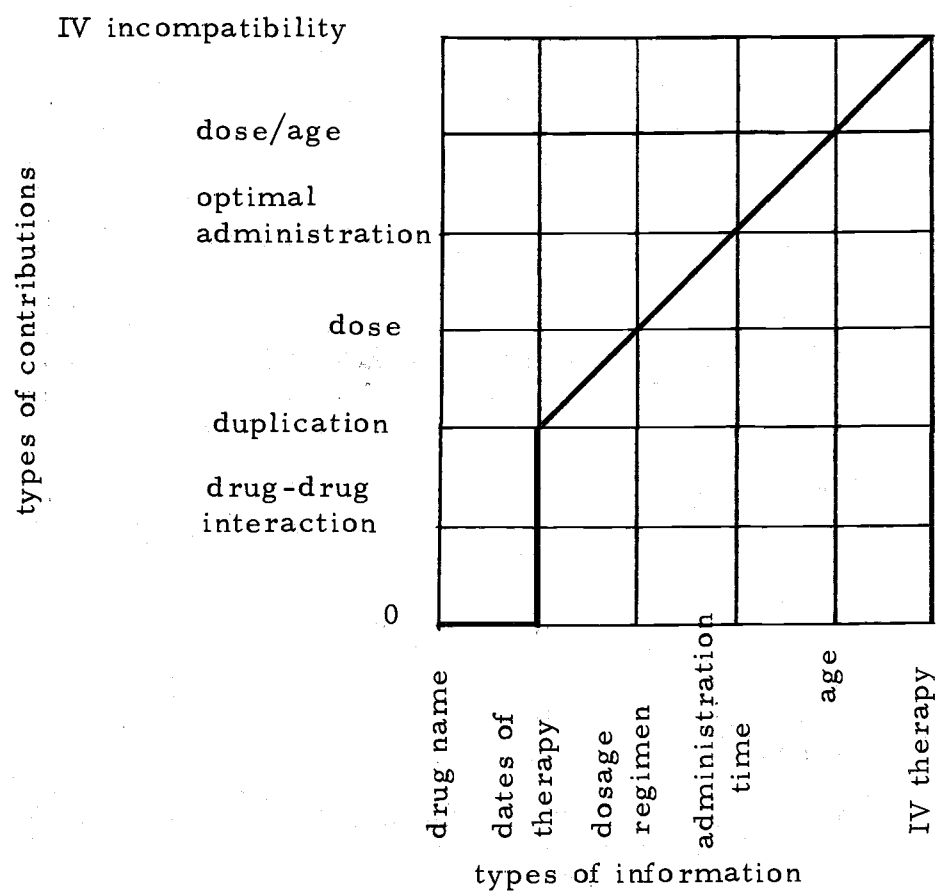
checking the dose, and checking the dose with respect to age are all applicable to the IV drugs. The modified formula for the calculation of the number of potential contributions is:

$$2 \left[\frac{n!}{\frac{(n-2)!}{2}} \right] + n(y-1) - z + \frac{z!}{\frac{(z-2)!}{2}}$$

where n = the number of drugs (including IV drugs), z = the number of IV drugs, and y = the number of types of contributions possible other than duplications and drug-drug interactions. Thus the number of potential contributions which could be made ranged from 15 to 783 per patient.

Hospital C regularly recorded four additional pieces of information for each patient. The admitting diagnosis allows the pharmacist to make two additional potential contributions, a check as to whether the duration of therapy is appropriate to the condition, and whether the dose is appropriate for the condition (Figure 3). Unless concurrent conditions are stated together with the diagnosis, however, drugs prescribed to treat conditions other than that specified by the admitting diagnosis cannot be evaluated for these points, and appear to be non-indicated.

Because existing allergic conditions, or the word "none," were recorded on each profile, the pharmacist could screen for and prevent allergic reactions.

Figure 3.   Contributions possible in Hospital C vs information
available.
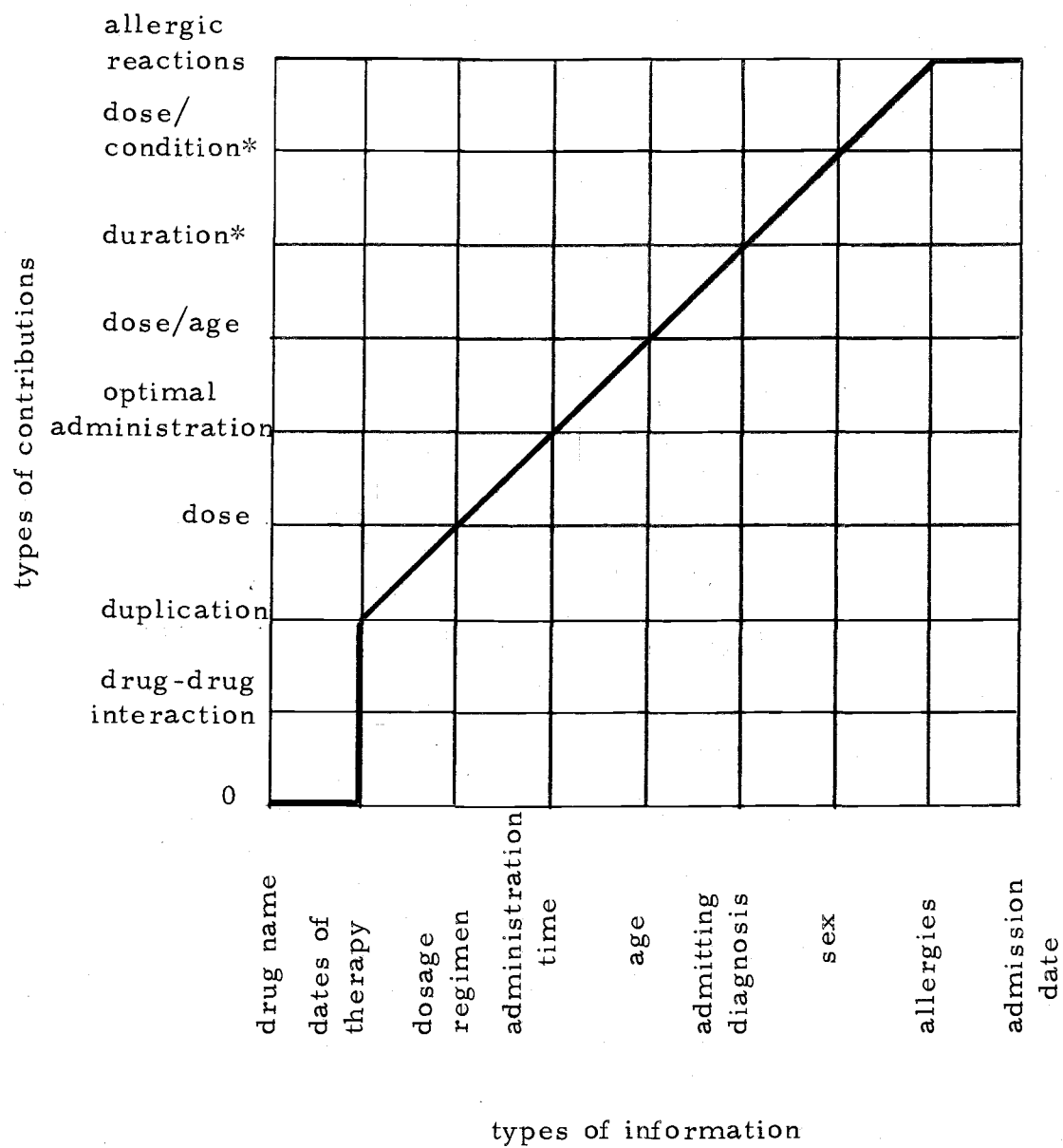
* For drugs prescribed to treat admitting diagnosis only

Also regularly included on these profiles were two additional types of information, the patient's sex, which allows the pharmacist to check the appropriateness of the dose in those cases where the dose of a drug is sex-related, and the date of admission. Date of admission made no additional contribution to patient care possible.

The average number of drugs prescribed per patient in this hospital was 13.0, ranging from 8 to 20. The average number of potential contributions which could be made per patient ranged from 104 to 500.

Figure 4 shows a comparison of the number of types of contributions possible in the three hospitals.

The number of theoretical contributions per patient possible in each hospital is determined by the type of contributions which are possible, which are in turn determined by the type of information present on the profile. The number is determined also by the number of drugs prescribed per patient. If a patient receives only one drug, certain types of contributions are logically excluded, such as duplications and drug-drug interactions. However, when more than one drug is prescribed, the total number of theoretical contributions increases, and is calculated as shown previously on pages 12 and 14.

By calculating the number of theoretical contributions possible per drug in Hospitals A, B, and C (theoretical contributions per patient divided by the number of drugs on the profile), one can

Figure 4. Comparison of the number of types of contributions possible in the three hospitals.

Hospital C ——————

Hospital B ✕✕✕✕✕✕✕

Hospital A ✕✕✕✕

types of information
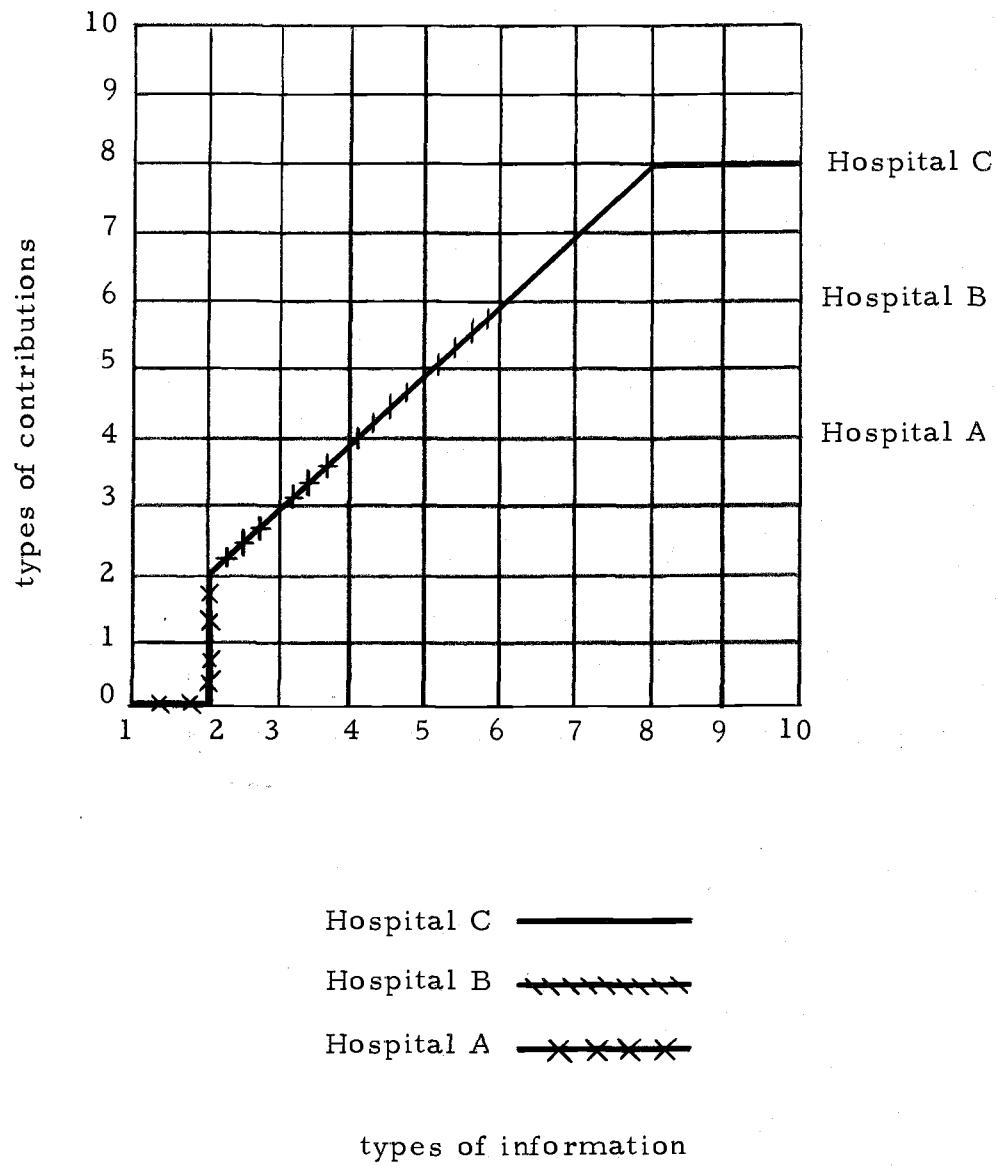
compare the amount of work involved in monitoring the three types

of profiles. For a given number of drugs on the profile, the pharma-

cist who monitors patients in Hospital C, with nine types of informa-

tion on the profile, does proportionately more work than he would at

Hospitals B or A for the same number of drugs, because the increased

number of types of information in Hospital C makes possible an in-

creased number of evaluations per drug (Figure 5). Similarly, the

pharmacist at Hospital B, with six types of information, does pro-

portionately more work than he would at Hospital A, with four types

of information, for the same number of drugs recorded on the profile.

One would expect the work, or time, involved in monitoring to

be one of the factors deciding feasibility of such a system. Since the

pharmacist has little control over the number of drugs prescribed for

a patient, the only way he can decrease the workload generated by

monitoring is by limiting the number of types of information on the

profile, although he would decrease the number of theoretical contri-

butions possible as well. Of course, even information that does not

lead to possible contributions, such as the admission date included on

the profile of Hospital C, adds to the work of maintaining patient pro-

files by causing additional posting and transcribing. These points

suggest the need for close scrutiny of information monitored.

Figure 5. Work required in each hospital per given number of drugs prescribed.
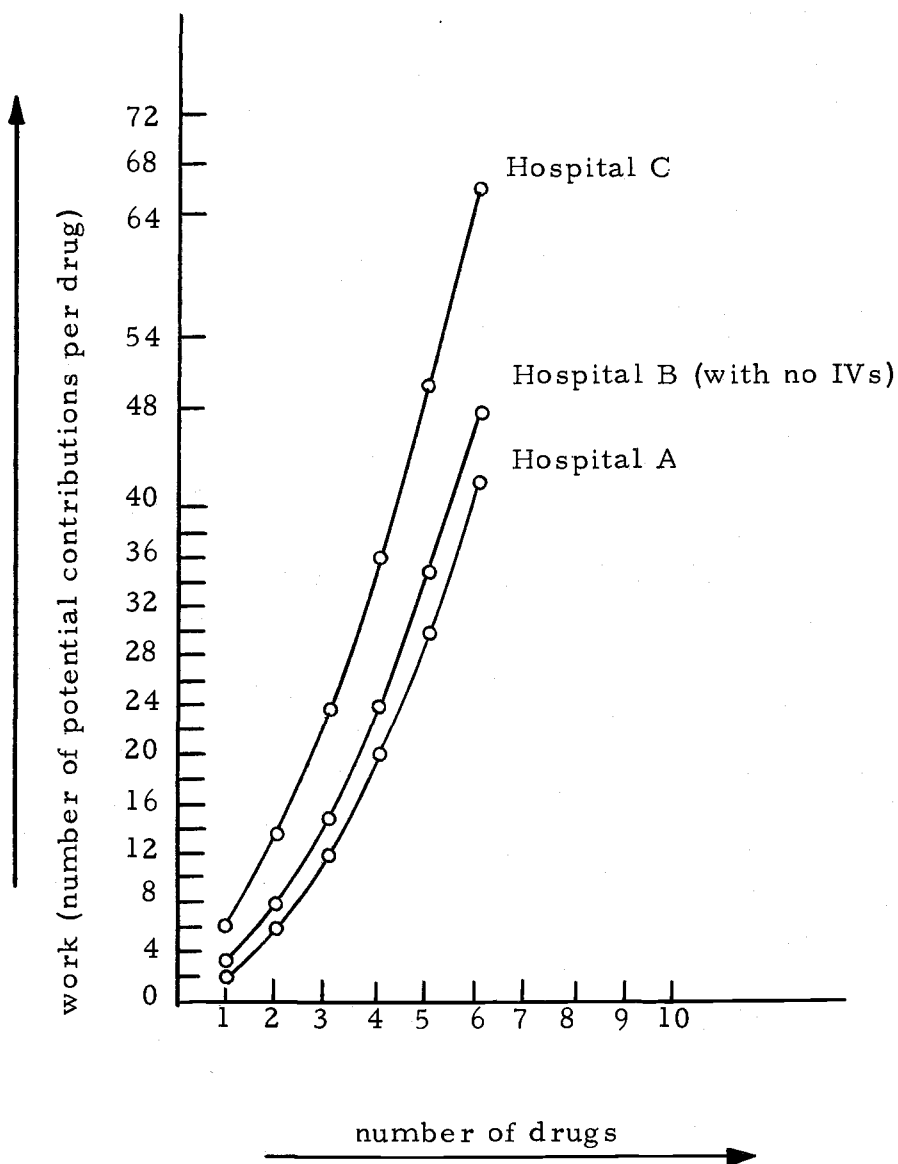
Part II

A profile was designed that included most of the information found in the profiles of the three hospitals sampled and also selected information presented in the literature as being useful. The information selected for the profile was that which is necessary to make those contributions to patient care which insure safe and optimal therapy. This profile was called the All-Possible-Contribution (A-P-C) profile for the purposes of this study.

The following types of information occurring in the sampled profiles were included: patient information such as name, age, sex, allergies, and diagnosis. Drug information included the name, strength, directions for use, route, administration time, and date prescribed for both regularly scheduled medications and those given as needed. IV solutions and additives were also included.

Additional types of information selected from the literature were the patient's weight, hypersensitivities, dietary restrictions, concurrent conditions, and laboratory tests ordered, along with the test date and results. In order to record adverse drug reactions, drug-related patient complaints were also included. Finally, the patient's drug therapy previous to entering the hospital was recorded, and the patient's gestational status was also included in order to test the usefulness of this type of information.

A place to record the stop date, to be filled in on the day a drug is discontinued or on the day the order is automatically terminated, was built into the profile to clarify for the pharmacist which drugs are currently in use (Figure 6).

The types of information included on the A-P-C profile allow the pharmacist to make the following types of contributions to patient care. The specific information necessary to make each contribution is presented in parentheses.

1.0 Prevent Allergic or Hypersensitivity Reactions (drug name, patient allergies & hypersensitivities)

2.0 Check Rational Choice of Drug
    2.1 Prevent dispensing counter-productive drugs (drug name, diagnosis, concurrent conditions, dietary restrictions, gestational state)
    2.2 Prevent dispensing non-indicated drugs (drug name, diagnosis, concurrent conditions)
    2.3 Prevent duplications of effect (drug names, dates of therapy, dosage regimen)

3.0 Prevent Drug-Drug Interactions (drug names, dates of therapy)

4.0 Prevent Drug-Food Interactions (drug names, meal times, administration times, dietary restrictions, dates of therapy)

5.0 Prevent Under and Over-Doses
    5.1 Check dose for each drug (drug name, dosage regimen)
    5.2 Check appropriateness of dose for the patient's condition(s) - including a check with regard to renal status (drug name, dosage regimen, diagnosis, concurrent conditions, patient's weight, sex and lab test results where needed)
    5.3 Check dose with respect to patient's age (drug name, dosage regimen, patient's age)

Figure 6.   A-P-C profile.

Name: A, B, C	Allergies & *Hypersensitivities:	Lab Tests:	Date:	Results:
Age: 56 Sex: F Wt: 128	antihistamines, strong pain medi-cations → confusion	Routine	2/25	(abnormal)
M.D. Anon.	Dietary Restrictions: none	glucose	2/25	126 mg o/c
I.D. No.	Dx & concurrent conditions: degen.			
Pregnant:	arthritis L. great toe - bunionectomy to be performed			

Drug Name:	Str.	Directions	Rte.	Start:	Stop:	PRN'S: Name, Strength, Sig, Route:	Start:	Stop:
Premarin	0.625	q.o.d.	po	2/27		Nembutal 100mg hs MR x1	2/25	
						Valium 10 mg po 10:00	2/26	
Indocin	50 mg	bid	po	2/27		MS 8mg Atropine 0.4 11:30	2/26	
						Trilafon 1cc q6h-nausea	2/26	
						Percogesic C T-ïï q3-4° pain	2/26	2/27
						Valium 5mg IM 10:00	2/26	
						Percodan T-ïï po q3-4°pain	2/27	

Drug-Related Patient Complaints: No relief from per-cogesic

Previous Medications: Premarin, Indocin, Vit. E

Figure 6. Continued.

Name: (or addressograph) X.Y.Z.				
Date	IV No.	Solution Name, Size, Time	Rate	Additives
2/26	1	NM c̄ D5W 1000cc 9^{20}_{a}-11^{20}_{p}.	72	
2/26	2	NR 1000cc 11^{20}_{p} - 1^{20}_{p}	72	
2/27	3	NR 1000cc 1^{20}_{p} - 5^{20}_{p}	72	
2/28	4	NR 1000 cc 3^{20}_{a} - 5^{20}_{p}	72	Geopen 5 Gm.

6.0 Insure Optimal Administration (drug name, dosage regimen, meal times, administration times)

7.0 Prevent Inappropriate Duration of Therapy (drug name, diagnosis, concurrent conditions, dates of therapy)

8.0 Detect Adverse Drug Reactions (drug name, drug-related patient complaints)

9.0 Identify Drug-Diagnostic Test Interferences (drug name, lab data - diagnostic tests ordered, date, results - medications taken previous to admission)

10.0 Prevent IV Solution Incompatibilities (IV solutions and additives)

One type of information regularly recorded by one of the sampled

hospitals was not included on the A-P-C profile because it did not help

to make contributions to patient care. This was the admission date

recorded by Hospital C. Numerous other types of information in-

cluded on profiles described in the literature were omitted from the

A-P-C profile for the same reason. This would exclude from the

profile such information as the patient's race, social and familial

history, extensive past medical history, past pregnancies, or last

menstrual period.

Part III

The A-P-C profile was used to monitor 20 randomly selected

patients in a fourth hospital, and all of the information necessary to

complete each profile was obtained. Drugs were entered on the pro-

file exactly as they had been ordered, and in this way, one could

document all possible contributions. In practice, inappropriate medication orders are modified and most likely never recorded on the profile, and for this reason the profiles obtained in part I were not suitable for analysis of actual contributions. After each patient was discharged, the completed profile was analyzed to ascertain what contributions could have been made. Results of the monitoring were the following:

1. 0 Prevention of Allergic and Hypersensitivity Reactions: Five patients reported a total of seven allergic and hypersensitivity reactions. The drugs reported to cause allergic reactions were aspirin, morphine, penicillin, quinidine, and two antihistamines. The hypersensitivity reported was mental confusion associated with strong pain medications. Because patients often pronounce themselves allergic or sensitive to a drug, mistaking a past untoward effect for a true allergy or hypersensitivity, a mechanism should be established which allows one to determine whether a reported allergy or hypersensitivity is valid before it is recorded on the profile sheet and acted upon by the pharmacist.

On two profiles the potential for allergic reaction was noticed. For the patient allergic to morphine, Tylenol #3 was prescribed, and for the patient allergic to quinidine, 400 mg of this drug was ordered.

2. 1 Prevention of the Dispensing of Counter-Productive Drugs: A counter productive drug was defined as any drug which would

increase existing symptoms rather than relieve them.

Seven profiles appeared to contain counter-productive medications, and in four cases, aspirin was the drug involved.

The first case involved a patient with tinnitis, and the second a patient with Meniére's disease, both receiving aspirin for pain. In both cases, the aspirin could increase the tinnitis present.

The third case was somewhat different in that it was noted on the profile that the patient, for back pain, had been taking Phenaphen #3, which contains 162 mg of aspirin per capsule, previous to being admitted to the hospital with peptic ulcer disease. That Phenaphen is counter-productive should have been picked up by the community pharmacist, but in this case, it was not until the patient entered the hospital that the prescribing physician could have been notified of the increase in gastric acidity and bleeding usually associated with aspirin therapy.

A fourth patient listed Belap #1 as one of the drugs he took regularly before admission. If the Belap was being taken for ulcer therapy, then the aspirin which was ordered for him would have been counter-productive.

The fifth patient had been placed on a no-salt diet, yet on his first day of hospitalization a Fleets enema was ordered. This product contains 5000 mg of sodium, 250 to 300 mg of which is absorbed (43).

A sixth patient was noticed who was on a low-salt diet. Although no single drug was prescribed which contained large amounts of sodium, the total amount of sodium in his six medications ordered was calculated as a minimum of 71 mg per day, an amount which should be taken into account when planning the patient's meals.

The seventh patient, a diabetic, received Phenergan for nausea, a drug which increases blood sugar in diabetic and pre-diabetic patients (42).

2.2 Prevention of the Dispensing of Non-Indicated Drugs: A non-indicated drug was defined as one which does not correspond to the patient's diagnosis or concurrent conditions.

One profile contained a drug order which was not indicated by the patient's condition. The patient, admitted due to severe vertigo, nausea, and vomiting, with a history of hypertensive vascular disease, arteriosclerotic cardiovascular insufficiency, and Meniere's syndrome, was prescribed tetracycline, in a dosage of 250 mg four times daily for ten days. That the drug was not indicated was confirmed by the fact that the drug was discontinued the following day and no other antibiotics ordered.

2.3 Prevention of the Duplication of Therapeutic Effect by Two Drugs: Two drugs working by the same mechanism to produce the same action was considered to be a duplication, whereas two drugs working by different mechanisms to produce the same effect was not

considered to be a duplication. Neither was the prescribing of one drug in two dosage forms, one or the other to be given, depending on the patient's condition, considered a duplication.

One duplication was noticed, where both Tuinal and Nembutal at bedtime were prescribed.

3.0 Prevention of Drug-Drug Interactions: A drug-drug interaction, for the purpose of this study, was defined as the unwanted alteration of effect of one drug, caused by another drug being given concurrently.

A drug interaction could have occurred in one patient who received tetracycline 250 mg four times daily for ten days. On the second day of this therapy, Maalox, one-half ounce to be taken as needed for nausea or indigestion was ordered.

4.0 Prevention of Drug-Food Interactions: A drug-food interaction was defined as any combination of food with a drug which causes a decrease in effect of the drug or an adverse effect. This would include interactions such as the hypertensive crisis experienced due to MAO inhibitors combined with tyrosine-containing foods, as well as the decreased absorption of certain antibiotics when given less than one hour before or two hours after meals.

Two patients received antibiotics in a manner which made decreased absorption through interaction with food likely. The first patient was prescribed tetracycline four times daily. In this hospital,

medications ordered qid are administered at 9am, 1pm, 6pm, and 9 pm, while meal times are 7am, 12pm, and 5pm. Thus, there could have been decreased absorption of the 1pm and 6pm doses. The second patient received erythromycin q4h, at 9am, 1pm, 5pm, 9pm, 1am, and 5am, and was on the same meal schedule. Here the 1pm and 5pm doses were likely to be interfered with.

5.0 Prevent Under and Over-Doses: 5.1 Check dose of each drug: This would be the first step in checking the safety of any given drug, and allows the pharmacist to verify whether the dosage prescribed is acceptable according to U.S.P. standards.

One unusually high dose was noticed. Seconal, in a dose of 200 mg for sleep, was prescribed for a patient without apparent indication on the basis of diagnosis or tolerance to the drug.

5.2 Check appropriateness of dose for the patient's condition: Since a particular drug may be prescribed in different doses for different conditions, the dosage should be checked out with the condition in mind for which it was prescribed. In addition, the dose should be checked with regard to certain of the patient's biological functions. If renal dysfunction is present, doses may have to be decreased in order to maintain therapeutic blood levels without producing drug toxicity.

No doses ordered were inappropriate for the patient's condition.

5.3 Check of the dosage with respect to the patient's age: The dosage of numerous drugs must be reduced when administered to

young children and elderly patients.

For one young patient, a four year old weighing 41 pounds, 50 mg of Dramamine and 15 mg of codeine had been prescribed to be taken as needed for nausea and pain. The acceptable dose for this patient's weight is 25 mg per dose up to four times in 24 hours for the Dramamine, and 10 mg per dose up to six times in 24 hours for the codeine.

The first of four elderly patients who received high doses of medications was 67 years old. He was digitalized with digoxin 0.25 mg at a dose of two tablets initially, one tablet twice daily for two days, and then one tablet every day. It is recommended that, for patients over 65 years, the dose be one-half to two-thirds the adult dose to avoid overdose due to the prolonged half-life of up to 73 hours, as compared to 51 hours normally (51). Jellife's method of dosing could be used here and appears to be reliable, with minimal side-effects (52). The second drug this patient had prescribed was Tofranil 10 mg to be taken four times daily. The literature recommends that lower doses of this drug be tried first (51).

The second patient, a 69 year old female, received Heparin, Coumadin, and Lasix in normal adult doses. For Heparin, it is recommended that care be used in women over 60 years due to an increased risk of bleeding, occurring in 50 percent of these patients, as compared to 14 percent in women under 60 (51). Lasix has the potential to precipitate myocardial infarction or cerebral thrombosis in patients

with advanced arteriosclerosis, which this patient did have. It is recommended that the dose be reduced to one-half the normal and then increased to the full dose only as needed (51). It is recommended that Coumadin also be given in a dosage of one-half the usual amount given to the average adult (51).

The third patient, 77 years old, also received Lasix at the usual adult dose and was digitalized with Lanoxin at a rate of one 0.25 mg tablet every six hours for four doses, one tablet twice daily for one day, and then one tablet daily. This patient, as will be pointed out later, experienced side-effects from this dosage. In addition, special care should be used when prescribing Lasix for elderly patients being treated with digitalis. There is a greater tendency toward hypokalemia in elderly patients due to increased urinary potassium excretion caused by Lasix, and this hypokalemia may precipitate digitalis toxicity (52).

The fourth patient, 83 years old, received Talwin 50 mg IM every four hours as needed. For this drug, it is reported that the dose can be lowered in elderly patients while still obtaining an equal amount of analgesia (51).

6.0 Insure Optimal Administration of Medications: Conditions of optimal administration exist when the manner in which medications are administered, (with water, with milk or food, diluted in juice) and the time of administration (15 minutes before meals, every six hours, two hours after meals) are such that they maximize therapeutic

effects and minimize adverse effects. Additional instructions and interpretation of the direction ordered by the physician can serve to enhance the chance for optimal administration.

Examples of orders as written and the corresponding instructions which could be added were:

ASA 10 gr q4h prn - give with a full glass of water or with milk or food (two cases);

Empirin #3 2 q4h prn and 1 q3h prn - give with a full glass of water or with milk or food;

Polycillin 1 qid - give every 6 hours;

Ampicillin 1 qid - give every 6 hours (two cases);

tetracycline 1 qid - give every 6 hours, one hour before or two hours after meals or antacids;

Surfak hs - patient should increase his daily fluid intake;

Maalox prn - best given 1 hour after meals and as needed;

erythromycin 1 qid - give on an empty stomach, 1 hour before or two hours after meals;

Gantrisin qid - give with a full glass of water, every 6 hours.

7.0 Prevent Inappropriate Duration of Therapy: Since some drugs should be given for a specified minimum amount of time and others have associated with them a maximum length of treatment, the patient can be monitored for this.

No examples of inappropriate duration of therapy occurred in this study.

8.0 Detect Adverse Drug Reactions: An adverse drug reaction was defined as any additional illness or discomfort experienced by the patient which was the result of drug therapy. The term was expanded, however, to include lack of effect experienced by the patient.

The adverse drug reactions were identified by monitoring drug-related patient complaints. Five such complaints were registered by four patients. One concerned the previously mentioned nausea following the high Lanoxin dose administered to an elderly woman. In the words of the physician, "Attempted digitalization was made but had to be slow because of nausea associated with a very large dose." This same patient complained also of excessive drowsiness following doses of 50 mg of Dramamine IM every three to four hours for nausea.

A second patient, also previously mentioned for receiving tetracycline for no apparent reason, complained of "sour stomach" and burning following the dose of this medication. However, since the burning lasted for several days, it is possible that this effect was due to other causes. It was noted by the nursing staff that the patient was very upset over the prospect of being sent to a nursing home upon discharge.

A third patient complained of nausea following the administration of Empirin #3.

The fourth patient reported no relief obtained from the Percogesic she received for pain.

9.0 Identify Possible Drug-Diagnostic Test Interferences:
Drugs may interfere with diagnostic tests, producing false negative,
false positive, or unreadable results. At times, such interferences
may result in erroneous diagnoses or treatment.

"Identify Possible Drug-Diagnostic Test Interferences" is used
here rather than "Prevent Possible Drug-Diagnostic Test Interferences"
because it is not possible to predict whether an interference will be
significant. One study of 100 general medical patients revealed that
only 3.2 percent of all lab tests were altered due to drug therapy, and
that no clinically significant problems or invalid conclusions resulted
from the drug-altered test values (15). What is suggested then is to
call possible interferences to the attention of the physician only when
an abnormal test value occurs. This enables him to decide whether
the abnormal test result is apparent or real.

In this particular hospital, each patient upon admission receives
a routine laboratory work-up. This routine work-up consists of tests
for serum glucose, urea nitrogen, uric acid, cholesterol, total pro-
tein, albumin, globulin, alkaline phosphatase, transaminase (SGOT),
total bilirubin, and PBI, and of a urinalysis and hematological study.

Twenty-seven potential interferences were found on ten profiles.
Of these, six correlated with abnormal test values.

The following data were obtained:

Profile No.	Test	Alteration/Value	Drug(s) Possibly Responsible
1	BUN	increase/30 mg%	none
	A/G	decrease/1/2	none
2	glucose	increase/188 mg%	Dilantin, Phenergan
	cholesterol	increase/380 mg%	Phenergan
3	A/G	decrease/1/2	none
4	glucose	increase/120 mg%	Lasix
	A/G	decrease/1.3	none
	PBI	increase/9.85 mcg%	none
5	cholesterol	increase/310 mg%	none
6	glucose	increase/126 mg%	Indocin
7	glucose	increase/139 mg%	Phenergan, thiazide
	A/G	decrease/0.9	none
	cholesterol	increase/320 mg%	Phenergan
	SGOT	increase/56U	none
	PBI	increase/8.4 mcg%	none
8	SGOT	increase/210U	none
	glucose	increase/184 mg%	none
	albumin	decrease/2.9 Gm%	none
	A/G	decrease/0.76	none
	alk. phos.	increase/112U	none
9	globulin	increase/4.1 Gm%	none
	albumin	decrease/3.2 Gm%	none
	A/G	decrease/0.78	none
10	glucose	increase/130 mg%	none
	cholesterol	decrease/141 mg%	none
	alk. phos.	increase/52 mg%	none
	PBI	increase/10.9 mcg%	none

10.0 Prevent IV Incompatibilities: An IV admixture is

incompatible when the prescribed drugs cannot be combined safely and

satisfactorily. The incompatibility may be between two or more drugs or between a drug and a solution into which the drug is placed.

Only two patients received IV therapy, and no incompatibilities occurred.

IV. DISCUSSION AND CONCLUSIONS

A series of decisions were made to include or exclude types of information on the patient profile. In making these decisions, two factors were considered. The major factor was the apparent need to monitor this information as illustrated by the contributions which were identified as being needed during the study. It was decided that, in this study, even one contribution demonstrated need, since the sample was small. If need was not demonstrated in the study, the information necessary to make the contribution was excluded from the final profile.

Another factor considered when deciding whether or not to keep information on the profile is the difficulty incurred in obtaining necessary information from hospital staff members. The cooperation of the laboratory personnel, for example, is needed to obtain data for monitoring drug-laboratory interferences, and sometimes for monitoring whether a drug is indicated. Potassium, for example, may be prescribed in response to a low serum potassium value: however, after the deficiency is corrected, the drug should be discontinued, or perhaps the dose decreased if the patient is taking a medication which will continue to deplete potassium. As another example, unless the nursing staff cooperates, it is difficult for the pharmacist to receive drug-related patient complaints. Without this cooperation, the only way to monitor adverse drug reactions would be for the pharmacist to

make rounds and obtain the information from the patients directly.

In this study, the factor - cooperation of other departments - was not limiting.

Summarizing for this study, the contributions that demonstrated need to monitor certain types of information were:

1.0 Prevention of Allergic and Hypersensitivity Reactions: Two orders were written for drugs which patients were apparently allergic to.

2.1 Prevention of the Dispensing of Counter-Productive Drugs: Seven patient profiles contained counter-productive drugs.

2.2 Prevention of the Dispensing of Non-Indicated Drugs: One patient received a medication without indication.

2.3 Prevent Duplications of Effect: One patient received two hypnotic drugs at the same time.

3.0 Prevent Drug-Drug Interactions: One patient received tetracycline and Maalox concurrently.

4.0 Prevent Drug-Food Interactions: In two cases, food intake would have decreased the absorption of medications.

5.1 Check Dose for Each Drug: Seconal was prescribed in an unusually high dose.

5.3 Check Dose With Respect to Patient's Age: Five patients received doses of medications inappropriate for their ages.

6.0 Insure Optimal Administration of Medications: The administration of 11 medications was not optimal.

8.0 Detect Adverse Drug Reactions: Five adverse drug reactions were identified.

9.0 Identify Drug-Diagnostic Test Interferences: Six interferences are likely to have occurred.

There was no need demonstrated for the following three potential contributions, which were, therefore, deleted from the profile:

5.2 Check Appropriateness of Dose for the Patient's Condition(s),

7.0 Prevent Inappropriate Duration of Therapy,

10.0 Prevent IV Solution Incompatibilities.

Although it was found that, for the hospital to which the A-P-C profile was applied, it was unnecessary to monitor for three types of contributions, only three types of information could be excluded from the profile. Because IV incompatibilities would not be monitored, information concerning IV solutions and additives need not be recorded and thus were eliminated. In addition, since the patient's weight and sex are required to monitor only the dose as related to the patient's condition, which was a contribution apparently unnecessary to monitor in the fourth hospital, these pieces of information were deleted. However, the other information necessary to monitor the dose as related to the patient's condition and all of the information necessary to monitor the contribution, duration of therapy, is needed for the monitoring

of other contributions, and therefore must be retained on the profile.

The newly generated profile allows 12 contributions to be made from the 14 pieces of information included (Figure 7).

Among the contributions possible using the newly devised profile which cannot be made using the profiles from any of the three sampled hospitals are: a check for drug-food interactions, a check as to whether a drug is non-indicated, prevention of hypersensitivity reactions, a check as to whether a drug is counter-productive to any concurrent condition, monitoring for and ending adverse drug reactions, and identifying drug-laboratory test interferences.

The average number of drugs prescribed for each patient in the fourth hospital was 9.5, with a range from 2 to 23. The number of potential contributions ranged from 22 to 736 per patient.

A comparison of the number of types of contributions possible in the three sampled hospitals with that possible in the fourth hospital using the modified A-P-C profile is shown in Figure 8.

More types of contributions are possible with the increased number of types of information, but again, more work is required (Figure 9).

Table 1 summarizes the numerical data pertaining to profile use in hospitals A, B, and C, and in the fourth hospital using the modified A-P-C profile. It is not possible to compare the number of contributions possible between the four hospitals on the basis of the number of

Figure 7. Contributions possible in the fourth hospital, using the modified A-P-C profile, vs information available.
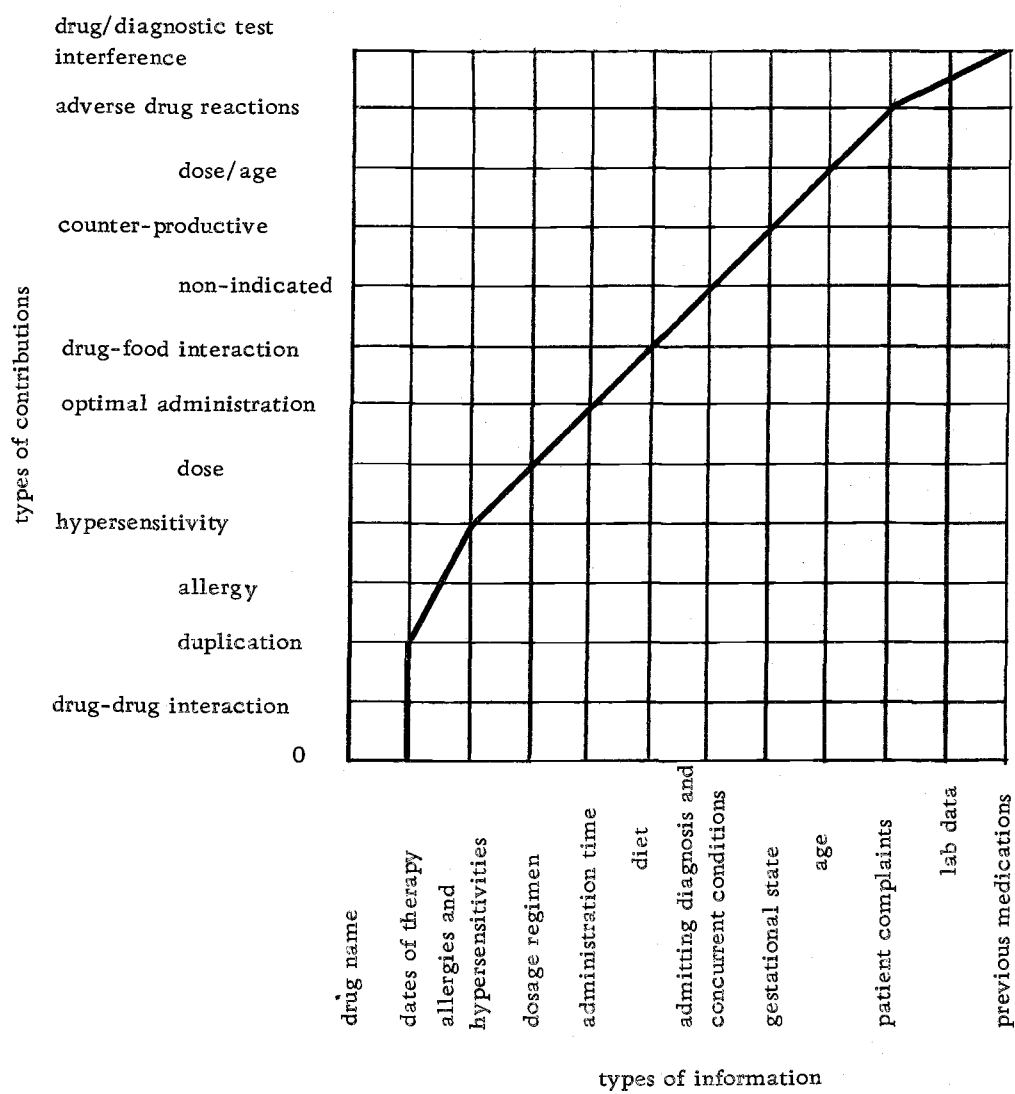

types of contributions

drug/diagnostic test interference

adverse drug reactions

dose/age

counter-productive

non-indicated

drug-food interaction

optimal administration

dose

hypersensitivity

allergy

duplication

drug-drug interaction

0

drug name

dates of therapy

allergies and hypersensitivities

dosage regimen

administration time

diet

admitting diagnosis and concurrent conditions

gestational state

age

patient complaints

lab data

previous medications

types of information

Figure 8. Comparison of the number of types of contributions possible
in the three hospitals with that possible in the fourth
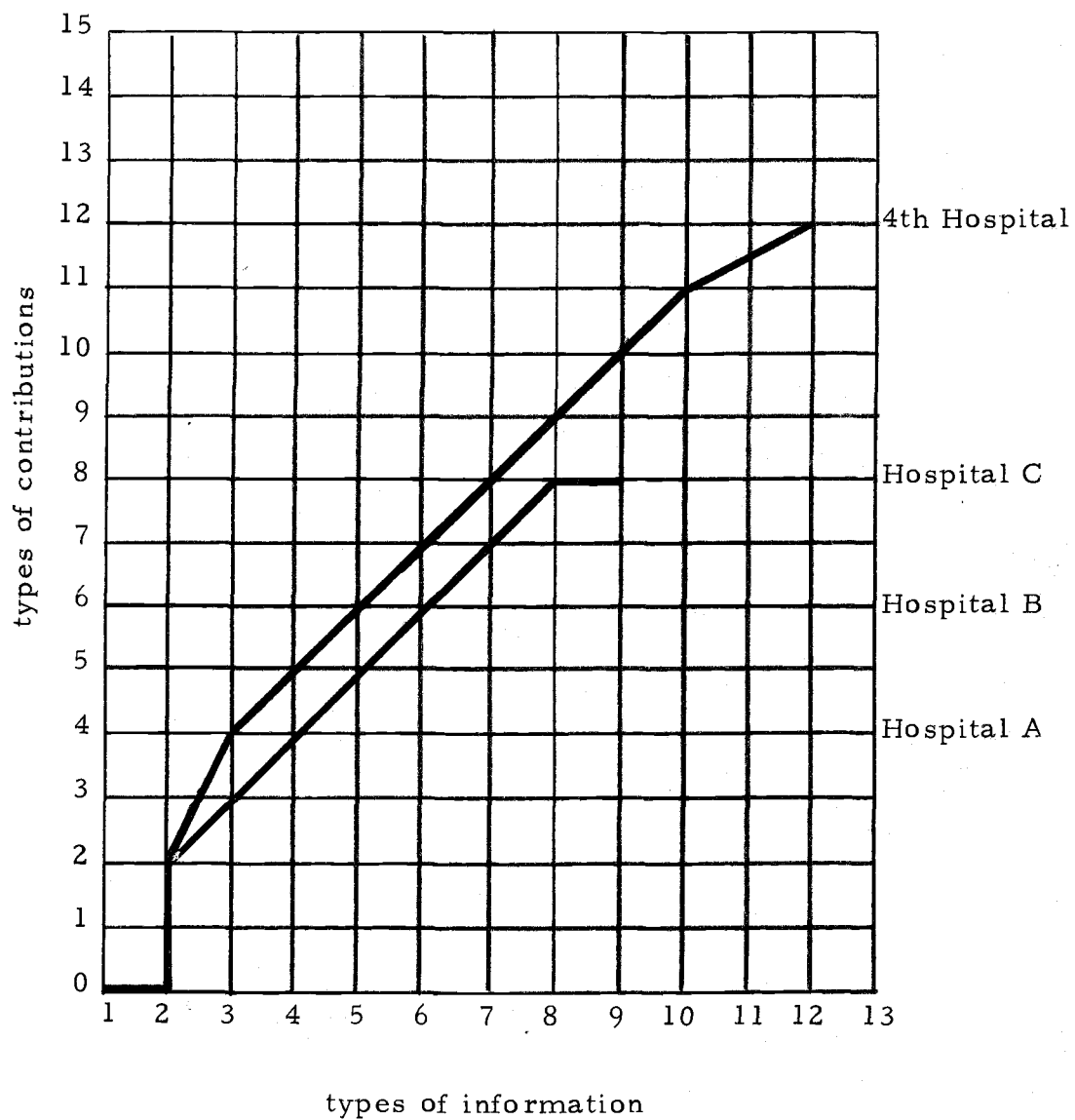hospital.

types of information

Figure 9. Work required in each hospital per given number of drugs
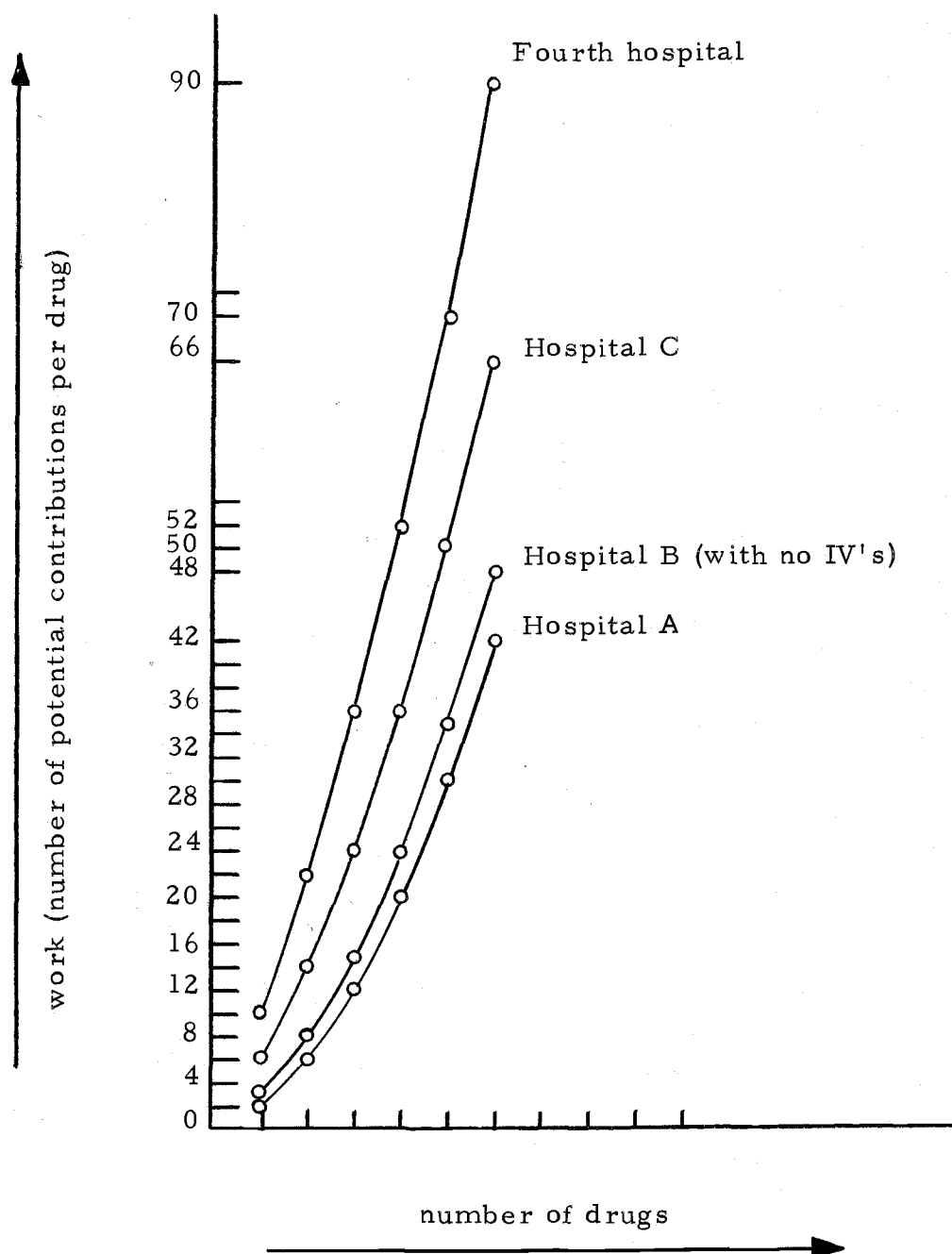   prescribed.

Table 1. Summary of numerical data.

Hospital	No. Types of Information On Profile	No. Potential Contributions Possible	Range of Drugs/Pt.	Ave. No. Drugs/Pt.	Range No. Potential Contrib./Pt.	Range No. Pot. Contrib./Drug (Range of Work)	Ave. No. Pot. Contrib./Drug (Ave. Work)
A	4	4	1-14	6.8	2-210	2-15	8.5
B	6	6	3-27	12.6	15-783	5-29	17.0
C	9	8	8-20	13.0	104-500	13-25	19.0
4th	14	12	2-23	9.5	22-736	11-32	21.5

contributions per patient, because the number of drugs prescribed per patient is not constant, and varies from profile to profile and from hospital to hospital. The clearest comparison of the number of contributions possible in the various hospitals is the last column, headed the "Average Number of Potential Contributions/Drug." However, as can be seen under the heading, the "Range of the Number of Potential Contributions per Drug," there are times when more contributions are possible in Hospital A than B, B than C, etc., depending on the number of drugs on their profiles. On the average, however, the most contributions, and therefore the most work, is done in the fourth hospital, followed by hospitals C, B, and A respectively.

With the completion of the study, a question comes to mind - is it safe to assume that the three potential contributions, found to be unnecessarily monitored in the fourth hospital, are in fact unnecessary? The literature suggests that this is not likely, and that the monitoring for these three particular contributions is usually needed. Thus it is probable that it is needed in this hospital as well. Take, for example, contribution 5.2, check appropriateness of dose for the patient's condition. The literature is explicit in that, for those drugs which have different indications, the dose of that drug is dependent upon the condition for which it is used. Drugs falling into this category include Milk of Magnesia with a 5 ml dose as an antacid and a

30 ml dose as a laxative, phenobarbital with a 15-30 mg sedative dose and a 100 mg hypnotic dose, and codeine with its antitussive effect at a dose of 15 mg and its analgesic effect at a dose of 60 mg.

In addition, if renal dysfunction is a part of the patient's condition, doses of drugs prescribed should be checked. When a patient's creatinine clearance falls below 80 ml/min, the increased biological half-life of the drugs excreted primarily by the filtration and secretion mechanisms of the kidney causes these drugs to accumulate in the body (53). The literature contains a number of articles clearly indicating that less frequent or smaller doses of these medications should be given when renal impairment exists (53-55).

The patient's weight, especially if he is unusually thin or heavy, also has a bearing on drug dosage requirements, since the usual doses prescribed for drugs are appropriate only assuming the patient is of average weight. In addition, some drugs are prescribed on a mg/Kg basis only, thus in order for the pharmacist to check doses of these medications, the patient's weight must be known.

Finally, there were no patients in the study who were pregnant during their hospitalization. There are, however, many drugs which are known to produce harmful effects on the fetus, and many others for which the effect on the fetus is unknown (48). Because both of these classifications of drugs should be avoided if possible, and only drugs

known to produce no harmful effects used, this type of information should be very useful in insuring safe therapy.

A case can be made for monitoring contribution 7.0, the duration of therapy, also. Whereas some drugs, such as phenylbutazone, should not be given for a longer period of time than ten days, at least not without regular blood testing, other drugs, such as penicillin when prescribed for strep, throat, should not be given for less than ten days (44).

Similarly, it can be argued that contribution 10.0, the prevention of IV solution incompatibilities, should also be monitored with the profile. The practice of adding drugs to IV fluids has increased rapidly over the last decade. A recent review quoted a figure of 80 percent as the proportion of IV fluids to which drugs had been added (56); however, the incidence of IV incompatibilities is a complex issue, and specific incidence figures are not available in the literature.

The number of incompatible intravenous drug combinations prescribed yearly in this country has been estimated at over four million (57), although this estimate can easily be far too low, considering that about 50 million IV admixtures are probably administered annually (58).

To solve the question of whether information leading to a potential contribution can safely be dropped from a profile, I would

suggest increasing the number of test profiles from 20 to perhaps 30 or more, in order to include every type of patient (pregnant, on IV therapy, etc.) in the study and to obtain an adequate exposure to all aspects of the particular practice being monitored. If additional monitoring yields the same results, then it can be more safely assumed that there is no need to monitor for a particular contribution.

In this study, two factors were used to determine whether a piece of information should be retained on the profile of the fourth hospital - demonstrated usefulness in the trial use of the A-P-C profile, and the availibility of the information from hospital personnel. Another factor relevant to most practices is the increased workload created by the monitoring. The increased workload can be defined as the sum of four operations:

1. collecting information

2. recording information

3. using information (checking for possible contributions)

4. implementing contributions

If, in a given practice, the workload must be decreased, there are several options one can take, and one must, therefore, establish priorities.

a. Information which leads to contributions that are difficult or impossible to implement can be dropped.

b. Information which leads to less significant contributions can be dropped.

c. Information which leads to only one contribution can be dropped before information which leads to two, three, or four contributions is dropped.

d. All information shown to be useful can be kept, and fewer, high-risk patients can be monitored.

In the face of demonstrated need, however, it is hoped that the increased workload can be accepted, and would be compensated for by the guarantee of safe and optimal therapy.

In summing up, a list of information useful in making contributions to patient care was developed. The A-P-C profile, encompassing this information, was then drawn up, and is presented as a tool useful in determining the specific types of information which must be monitored on a hospital patient profile in order to insure safe and efficient therapy.

The A-P-C profile was then applied to 20 hospitalized patients in such a manner that information that was necessary to be monitored in that practice was identified. Information not shown to be necessary was then dropped from the profile, and a new profile was made for use thereafter.

Three types of information were shown to be extraneous in that situation; however, it is recommended that, for further use of the

A-P-C profile, the sample size be increased from 20 to 30 or more

to insure the inclusion of all types of patients and all aspects of the

hospital practice.

REFERENCES

1. Baumgartner, R. P. Jr., Land, M. J. and Hauser, L. D.:
    Rural Health Care-Opportunity for Innovative Pharmacy Service,
    Amer. J. Hosp. Pharm. 29:394-400 (May) 1972.

2. Bowles, G. C. Jr.: Better Drug Histories Help Avoid Adverse
    Reactions, Modern Hospital, 112:128 (June) 1969.

3. Durgin, J. M., Hanan, Z. I. and Ward, C. O.: Medication
    Errors in the Seventies, Amer. J. Hosp. Pharm. 28:58-61 (Jan)
    1971.

4. Goldman, L.: The Pharmacist's Role in Monitoring Drug
    Therapy, Hosp. Pharm. 5-13 (June) 1971.

5. Klotz, R.: Pediatric Patient Drug Profiles, Hosp. Pharm. 7:
    27-28 (Jan) 1972.

6. Lesshafft, C. T. Jr.: How Clinical Pharmacy is Practical for
    Community Pharmacists, Pharm. Times, 39:39-41 (Mar) 1973.

7. Grove, W. R. and Fortner, C. L.: Drug Therapy Surveillance
    by a Pharmacist in a Cancer Research Center, Hosp. Pharm.
    8:46-52 (Feb) 1973.

8. Visconti, J. A.: Use of Drug Interaction Information in Patient
    Medication Records, Amer. J. Hosp. Pharm. 26:378-387 (July)
    1969.

9. Dunphy, T. W.: The Pharmacist's Role in the Prevention of
    Adverse Drug Interactions, Amer. J. Hosp. Pharm. 26:367-
    377 (July) 1969.

10. Zupko, A. G.: A New Professional Responsibility...Drug Inter-
    actions: Part I, Pharm. Times, 35:33-35 (Sept) 1969.

11. Hansten, P. D.: Drug-Drug Interactions in Perspective,
    Northwest Med. J. 43-45 (Mar) 1974.

12. Hurwitz, N. and Wade O. L.: Intensive Hospital Monitoring of
    Adverse Reactions to Drugs, Br. Med. J. 1:531-536 (Mar)
    1969.

13. Williams, B. O., Eckel, F. M. and Dewey, W. L.: The Need for an Adverse Drug Reaction Prediction and Prevention Program, Amer. J. Hosp. Pharm. 30:124-127 (Feb) 1973.

14. Elking, M. P. and Kabat, H. F.: Drug Induced Modifications of Laboratory Test Values, Amer. J. Hosp. Pharm. 25:485-519 (Sept) 1968.

15. Cripps, G. W., Martinez, D. R., Gilliam, R. A. and Caldwell, T. J.: Significance of Drug-Altered Laboratory Test Values, Amer. J. Hosp. Pharm. 30:603-606 (July) 1973.

16. Munzenberger, P. and Emmanuel: The Incidence of Drug-Diagnostic Test Interferences in Outpatients, Amer. J. Hosp. Pharm. 28:786-791 (Oct) 1971.

17. Young, D. S., Thomas, D. W., Friedman, R. B. and Pestaner, L. C.: Effects of Drugs on Clinical Laboratory Tests, Clin. Chem. 18:1041-1303 (Oct) 1972.

18. Schwartau, N. W., Schwerman, E. A., Thompson, C. O. and Hauff, K.: A Comprehensive Intravenous Admixture System, Amer. J. Hosp. Pharm. 30:607-610 (July) 1973.

19. Goldschmidt, L. A. Sr. and Durgin, J. M.: Drugs and Special Diets, Hosp. Pharm. 7:15-18 (Jan) 1972.

20. Anderson, R. D.: The Physician's Contribution to Hospital Medication Errors, Amer. J. Hosp. Pharm. 28:18-25 (Jan) 1971.

21. Almquist, D. D.: Manual Patient Drug Profiles as a Part of a Drug Distribution System, Amer. J. Hosp. Pharm. 27:988-993 (Dec) 1970.

22. D'Angelo, G. R., Faca and D'Angelo, A. C., Faca: Family Pharmacists, Pharm. Times, 36:64-67 (July) 1970.

23. Elliot, R.: Utilizing Unit-Dose Dispensing Controls in the Small Hospital, Amer. J. Hosp. Pharm. 26:602-605 (Oct) 1969.

24. Meagher, H. E., Harris, M. B. and Yates, R. A.: System Gives Pharmacist Control of Patient Medication Records, Hosp. Topics, 47:103-105 (Oct) 1969.

25. Almquist, D. D.: The Computer Never Forgets, Hospitals, 46: 152-156 (Mar) 1972.

26. Ivey, M. F.: The Pharmacist in the Care of Ambulatory Mental Health Patients, Amer. J. Hosp. Pharm. 30:599-602 (July) 1973.

27. Hutchinson, R. A.: Adverse Drug Reactions-A Review, Hosp. Topics, 48:69-76 (Sept) 1970.

28. Cacace, L. G.: How Patient-Drug Profiles Help the Clinical Pharmacist, Hosp. Topics, 47:53-56, 86(Aug) 1969.

29. Cooper, C. R.: Techniques for the Selection and Monitoring of Patients by Pharmacists, Amer. J. Hosp. Pharm. 29:334-337 (Apr) 1972.

30. Ellinoy, B. J., Schuster, J. S., Yatsco, J. C. and Rosenthal, L. C.: Pharmacist Audit of Patient Health Records-Feasibility and Usefulness of a Drug Surveillance System, Amer. J. Hosp. Pharm. 29:749-754 (Sept) 1972.

31. Owyang, E., Miller, R. A. and Brodie, D. C.: The Pharmacist's New Role in Institutional Patient Care, Amer. J. Hosp. Pharm. 25:624-630 (Nov) 1968.

32. Anon: Patient Record Systems, J. Amer. Pharm. Ass. NS13: 36-374 (July) 1973.

33. Davis, N. M.: Patient Profile Draws the Whole Picture, Hosp. 45:110-115 (Sept) 1971.

34. Kleinmann, K.: Outpatient Pharmacy-New Design Encourages Comprehensive Pharmaceutical Service, Amer. J. Hosp. Pharm. 29:419-422 (May) 1972.

35. Srnka, Q. M., Rosenbluth, S. A. and Niedelman, W.: Evaluation of a Patient Medication Profile Based on the Use of Duplicate Labels, Amer. J. Hosp. Pharm. 31:79-83 (Jan) 1974.

36. Toal, D. R.: Development of an Efficient Pharmacy Drug Record System, J. Amer. Pharm. Ass. NS13:375-378 (July) 1973.

37. Bouchard, V. E., Bell, J. E., Freedy, H. R. and Duffy, M. G.: A Computerized System for Screening Drug Interactions and Interferences, Amer. J. Hosp. Pharm. 29:564-569 (July) 1972.

38. Freund, R. G.: Evolution of a Computerizer Drug Profile, _Amer._ _J. Hosp. Pharm._ 30:160-164 (Feb) 1973.

39. McQueen, R. S. and Segal, H. J.: Patient Oriented Drug Interaction Communicative System, _Can. Pharm. J._ 104:414-416 (Nov) 1971.

40. Partridge, T. and Kizior, R.: Use of the IBM Mag Card Selectric Typewriter in a Unit Dose System, _Hosp. Pharm._ 7:5-14 (Jan) 1972.

41. Robles, R. R. and Winship, H. W. III: Pharmacy Involvement in the Neighborhood Health Center Environment, _Amer. J. Hosp. Pharm._ 29:68-71 (Jan) 1971.

42. Hansten, P. D.: _Drug Interactions_, 2nd ed., Lea & Febiger, Philadelphia, 1973.

43. Anon.: _Sodium in Medicinals_, 2nd ed., San Francisco Heart Assn., San Francisco, Calif. 1973.

44. Kastrup, E. K. (editor): _Facts and Comparisons_, Facts and Comparisons, Inc., St. Louis, Mo., 1974.

45. Anon.: _PharmIndex_, Skyline Publishers, Inc., Portland, Ore., 1974.

46. Shirkey, H. C.: _Dosage-Posology Handbook_, Amer. Pharm. Assn., Washington, D. C., 1965.

47. Probst, C., Pinto, D. (editors): _Chain Store Age_, Lebhar-Friedman, Inc., New York, New York, Jan. 1973.

48. Meyers, F. H., Jawetz, E. and Goldfein, A. (editors): _Review of Medical Pharmacology_, 2nd ed., Lange Medical Publications, Los Altos, California, p. 620-635, 636.

49. Anon.: _Pharmacist's Reference._ Eli Lilly & Co., Indianapolis, Indiana, 1970, p. 46.

50. Stedman: _Stedman's Medical Dictionary_, 21st ed., Williams & Wilkins Co., Baltimore, Md., 1966, p. 1830-1832.

51. Schultz, H. W.: Drugs for the Aged, _PharmIndex_, 15:4-7 (Jan) 1973.

52. Jellife, R. W.: Effect of Serum Potassium Level Upon Risk of Digitalis Toxicity, Ann. Intern. Med. 78:821 (May) 1973.

53. Bennett, W. M., Singer, I. and Coggins, C. H.: A Practical Guide to Drug Usage in Adult Patients with Impaired Renal Function, JAMA, 214:1468-1475 (Nov) 1970.

54. Jackson, E. A. and McLeod, D. C.: Pharmacokinetics and Dosing of Antimicrobial Agents in Renal Impairment, Part I, Amer. J. Hosp. Pharm. 31:36-52 (Jan) 1974.

55. Jackson, E. A. and McLeod, D. C.: Pharmacokinetics and Dosing of Antimicrobial Agents in Renal Impairment, Part II, Amer. J. Hosp. Pharm. 31:137-148 (Feb) 1974.

56. Engel, G.: Addition of Drugs to IV Fluids, Drug Intel. & Clin. Pharm. 6:145-148 (Apr) 1972.

57. Williams, J. T. and Moravec, D. F.: The Extent of Incompatible Drug Combinations, IV Therapy, Ch. 5, Clissold Books, Hammond, Indiana, 1967, p. 60-61.

58. Martin, E. W. and R. D.: Hazards of Medication, J. B. Lippincott Co., Philadelphia, 1971, p. 228.